WALATOWA PUEBLO OF JEMEZ HOUSING
DEPARTMENT TRIP REPORT
Assessment of Mold and Moisture Conditions

Final Report

Date:
March 14, 2005

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Office of Native American Programs

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PART I
WALATOWA PUEBLO OF JEMEZ TRIP REPORT
March 14, 2005

Introduction

An investigation of mold and moisture conditions was conducted on March 14, 2005, by Kate Brown of the Building Research Council at the University of Illinois and Paul Knight of Magna Systems Inc. Walatowa Pueblo of Jemez Housing Department (WPJHD) staff escorted the assessment team to inspect building conditions.

This is a summary report of activities and issues identified while on site. A detailed analysis of the findings and recommendations is found in the attached report, titled: Walatowa Pueblo of Jemez Housing Department Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes on the Walatowa Pueblo of Jemez.

Background Information

The Walatowa Pueblo of Jemez is one of nineteen pueblos located in New Mexico. Most of the 3,400 tribal members reside in a pueblo village known as Walatowa. Walatowa Pueblo of Jemez is located in Sandoval County, within the southern end of the majestic Canon de San Diego, on State Highway 4 approximately 45 minutes northwest of Albuquerque. In the plaza area of the village, there are about 250 traditional adobe homes. The housing department manages about 450-500 homes.

The average annual maximum temperature is 71°F, the average annual minimum temperature is 37.1°F, and the annual mean temperature is 54.1°F. The average annual precipitation is 10.15 inches of rain and 9 inches of snow. The average heating degree days number 4678 and the cooling degree days number 815. Currently, HUD records show the Formula Current Assisted Stock (FCAS) to consist of 79 Mutual Help homes. The three homes inspected were owner occupied.

Day 1: Sunday, March 13, 2005

Sunday was a travel day to the Walatowa Pueblo of Jemez.

Day 2: Monday, March 14, 2005

On Monday morning, the assessment team met with the WPJHD staff including: Dave Cade, Director; Sarah Powers, Resident Services Counselor; and Joe Toledo, Construction Foreman to discuss the mold situation and to determine how to proceed with the home inspections. On-site assessments began that morning with a tour of two homes before lunch. The selection of the properties to be inspected was not random, but pre-selected by WPJHD. Visual assessments were conducted at each site and digital photographs were taken to record conditions. The inspection process involved visual
assessment of both interior and exterior conditions, air flow measurements of bathroom ventilation systems, and discussion with residents when available.

In the afternoon, one more home was inspected along with two unoccupied homes undergoing rehabilitation. In the afternoon, Raymond Ashley, Environmental Health Specialist and Herbert Tsosie, Construction Worker joined the assessment team. The assessment team traveled back to Albuquerque in the late afternoon.

The attached *Technical Housing Assessment Report* provides a detailed analysis of findings and recommendations for the homes investigated.

**MOLD TESTING**

The assessment team agrees that mold inside a building should be cleaned up. Generally, identifying the species of mold growing in a residence is unnecessary. No baseline exists for acceptable or unacceptable mold concentrations in a home. This message concurs with other federal agencies and experts as documented below. *Attachment 1* is a copy of *The Measurement Problem Regarding Mold*.

The Bemidji Area Indian Health Service Office of Environmental Health and Engineering, Environmental Health Services Section (BAIHS EHSS), *Guidelines on Assessment and Remediation of Fungi in Indoor Environments*, takes this position on testing:

Consistent with Center for Disease Control (CDC) and Environmental Protection Agency, BAIHS EHSS does not recommend testing as the first response to an indoor air quality concern. Instead, careful detailed visual inspection and recognition of moldy odors should be used to find problems needing correction. Efforts should focus on areas where there are signs of moisture or high humidity or where moisture problems are suspected. The investigation goals should be to locate indoor mold growth to determine how to correct the moisture problem and remove contamination safely and effectively.

*The Adverse Human Health Effects Associated with Molds in the Indoor Environment* by the American College of Occupational and Environmental Medicine, states that to successfully remediate mold and moisture conditions, the water and moisture sources must be identified and corrected.

Mold spores are present in all indoor environments and cannot be eliminated from them. Normal building materials and furnishing provide ample nutrition for many species of molds, but they can grow and amplify indoors only when there is an adequate supply of moisture. Where mold grows indoors, there is an inappropriate source of water and moisture that must be identified and corrected before remediation of the mold colonization can succeed. Mold growth in the home, school, or office
environment should not be tolerated because mold physically destroys the building materials on which it grows, mold growth is unsightly and may produce offensive odors and mold is likely to sensitize and produce allergic responses in allergic individuals. Except for persons with severely impaired immune systems, indoor mold is not a source of fungal infections. Current scientific evidence does not support the proposition that human health has been adversely affected by inhaled mycotoxins in home, school, or office environment.

**BAIHS EHSS Guidelines on Assessment and Remediation of Fungi in Indoor Environments** discusses the limitations of testing as follows:

Mold testing only provides a snapshot estimate for a single point in time and a single location. How well the test represents other locations and times is uncertain since the amounts and types of mold in the environment are always changing. Furthermore, there is no basis for setting a baseline of acceptable or unacceptable mold concentrations. The variability can be especially large for airborne molds, with significant changes occurring over the course of hours or less. Caution must also be used in interpreting surface testing results, since mold growth or deposition may not be uniform over an area and may increase or decrease as time passes. Unless many samples are taken over a period of time and the investigator has been mindful of building operations and activities during the testing, the results might not be very representative of typical conditions; in addition, tests reflecting typical conditions may also miss evidence of problems that only occur infrequently (water leaks during rain storms).

Mold testing is often expensive. Dollars spent on unnecessary testing reduce the amount of money available for remediation and repairs. The following web sites and references provide further information on mold remediation and testing:

**Indoor Air Quality**

**Ball State University Indoor Environment Notebook** - General resource on a number of topics related to indoor air quality.
[http://publish.bsu.edu/ien/archives/archive_list.htm](http://publish.bsu.edu/ien/archives/archive_list.htm) (*will open a new browser window*)

**Mold**

**EPA** - Mold Remediation in Schools and Commercial Buildings
[http://www.epa.gov/iaq/molds/index.html](http://www.epa.gov/iaq/molds/index.html) (*will open a new browser window*)

References

Guidelines on Assessment and Remediation of Fungi in Indoor Environments, Bemidji Area Indian Health Service Office of Environmental Health and Engineering, Environmental Health Services Section


Attachment 1
APPENDIX C: LIMITATIONS OF MOLD SAMPLING

The Measurement Problem Regarding Mold
By William B. Rose, Research Architect
Building Research Council/School of Architecture
University of Illinois, Urbana-Champaign

When complaints of mold problems occur, two courses of action are appropriate: 1) visually assess the site, remove the mold, and correct the conditions that led to the mold and 2) contact health professionals for allergy or respiratory problems. The proper action is to discover sites of mold growth. Where this approach has been used, the outcome has been, in every case, improvement of indoor environment conditions (though the improvements may take time) and improvement of health conditions. This is the recommended approach for dealing with mold problems in housing in Indian areas.

Techniques for sampling biological aerosols were developed for industrial and agricultural settings. They were designed to help industrial hygienists determine the safety of workplaces and other environments. The value of their work was evident in determining the causes of the Legionella outbreak of 20 years ago, and in sampling for biological warfare agents at present. Sampling produces counts of mold material from samples taken in the air or on surfaces. It may determine the number of viable spores in a sample from the air or a surface. And it may be used to identify genus and species of mold found in the sample.

Neither of the two recognized guidelines for mold remediation, the NYC Department of Health’s Guidelines on Assessment and Remediation of Fungi in Indoor Environments and the USEPA’s Mold Remediation in Schools and Commercial Buildings, calls for environmental sampling for routine mold problems. Both guidelines discourage environmental sampling in most cases. This opinion is summarized on the CDC website:

Generally, it is not necessary to identify the species of mold growing in a residence, and CDC does not recommend routine sampling for molds. Current evidence indicates that allergies are the type of diseases most often associated with molds. Since the susceptibility of individuals can vary greatly either because of the amount or type of mold, sampling and culturing are not reliable in determining health risk . . . reliable sampling for mold can be expensive, and standards for judging what is and what is not an acceptable or tolerable quantity of mold have not been established.

In general, the use of mold sampling must be discouraged. There are several reasons for this. First, aside from allergic effects, the health outcomes of mold in homes, schools or offices have not been established. Second, given those circumstances, there is no basis for setting a baseline of acceptable or unacceptable mold concentrations. Third, the internal repeatability of mold sampling results has not been shown in the literature. Fourth, weaknesses in the visual assessment protocols have not been demonstrated.
Mold sampling has been done in residential settings, leading to conclusions about the presence of mold, about the presence of individual species of mold, and about high concentrations of mold in some locations. However, much of the information provided by sampling is already known from common sense. The following are some facts about mold in indoor environments that are known even before measurements are taken:

1. Mold is everywhere. The outdoor air contains rather high concentrations of mold spores, which are naturally occurring. By contrast, most building interiors contain lower concentrations, though the concentrations indoors and outdoors vary over time. Indoor air comes from the outdoors. If the indoor is cleaner than the outdoors, something served as a filter, accumulating mold, dust and airborne material over time. Some commercial buildings have filtration systems designed to clean air as it passes from outdoors to indoors. But in most buildings, the outdoor air infiltrates through cracks and cavities in the building envelope as it travels indoors. If the indoor air is cleaner, then the building envelope acts like a filter. Therefore, when a sample of indoor air is taken, mold spores will be found. The conclusion “This building has mold” can be made of all buildings.

2. Dust, dirt, mold spores and other particulates accumulate in building cavities over time. There is no passive cleaning process for building cavities to match this cumulative process. Because the walls and roofs filter outdoor air as it moves indoors, all building cavities must be considered as sites with high concentrations of mold spores and other airborne material.

3. Evidence indicates that where proper conditions are in place, sooner or later the species that typically inhabit such spaces will arrive. *Stachybotrys* is known to inhabit pulpy cellulose materials that are maintained at a high water activity level. With the right quantity of water, the paper facing of gypsum products generally shows the growth of *Stachybotrys*. Where the appropriate conditions are maintained for a long enough time, *Stachybotrys* and other species appear and grow. “Wet it, and they will come.”

4. It is logically impossible to prove a negative statement. There are no tests that allow one to draw the conclusion that absolutely no mold spores representing a species are to be found in a space. Even if a test should turn up no spores of a given species that does not provide conclusive evidence of the total absence of that species from the interior space. And conditions may change from one hour to another. So a finding in a room or building of any given species, including *Stachybotrys*, should not be considered exceptional. The absence of a species from a space can be determined statistically to a pre-selected degree of confidence, requiring several tests.

What, then, remains to be discovered through mold measurement? It is already determined, for all buildings, that mold is contained in the air, that any species may be found in the air or on the surface, and that high concentrations of mold are contained in the cavity. If a tenant or occupant complains about living conditions, it is clear that any unit that occupant will move to will have mold in the air, will have all common species of...
mold in the air or on surfaces, and will have high concentrations of mold in the building cavities. It is wrong to presume that buildings are sterile simply by virtue of their never having been measured.

Measurements of mold are not useful if the purpose of the measurement is to determine any or all of the following:

1) if the building has mold,
2) if a certain species, say, *Stachybotrys*, is present, or
3) if the building cavities have high concentrations

For the measurement criteria above, no measurements should be made, as the results will be dismissed as being of no use.

**Possible Occasions for Mold Measurement**

After the effective implementation of visual assessment and remediation of mold as described above and conditions of mold are suspected to still exist, it is possible (though unlikely) that a visual assessment will overlook a cause of distress. If that happens, one strong possibility is that the distress is not related to mold in the first place. However, in the case where a mold problem has not been accurately identified and remediated through visual assessment, three scenarios are often suggested as possible occasions for mold measurement:

1. Active mold growth is usually accompanied by amplification, the strong increase in mold of one or two species out of proportion to the background taxa.

2. Mold may have an odd source, such as air conditioning ductwork, and may be present in the building only when that source contributes to the space, or

3. An investigator may use a fixed level as a measure of acceptability or cleanliness (though it bears repetition: there are not exposure limits set by any authorities).

In each of these cases, mold measurement may be able to provide some insight.

**The statistics of mold measurement**

For mold measurement to provide insight, or to provide material for decision-making, the results of mold testing must be statistically significant. One measurement is never statistically significant. Understanding the notion of statistical significance requires understanding error and bias.

Two samples of the same space will never provide the same results. There is always some spread (or precision error) in the data. The mold sampling industry generally fails to make public their estimates of the precision error in their sampling methods. It would be good to know, for the same equipment, same operator, same laboratory, same technician, what the estimate of the error would be. That information is not presently available.
addition to precision error, there are many other factors that tend to bias the results one way or another. These include the following:

1. Time of the day (ascomycetes tend to release spores in the afternoon, basidiomycetes in the morning)
2. Season (lower during winter)
3. Snow cover (greatly reduces outdoor concentrations)
4. Sampling technique (lowest with culturable samples, medium with impactors, highest with PCR)
5. Variations over space (highest, usually, in basements and crawl spaces)
6. Variations by surface (highest near carpets)
7. Disturbance (greatly higher with scuffing and fluffing of carpets, etc.)
8. Variations by wetness (higher concentrations on wetter materials)
9. Laboratory
10. Technician

It is evident that achieving statistically significant results requires considerable care, in addition to thoroughly accounting for variables. All proposals for mold study that involve sampling must contain information that describes:

1. The yardstick, or baseline values, that will be used for interpretation,
2. The variables that are accounted for in the study,
3. The error estimate associated with those variables,
4. The confidence interval to be used (95% confidence in the results is recommended),
5. How the study will deliver that level of confidence.

Sampling campaigns that give numbers without giving statistical significance to those numbers are worse than worthless. They come at a financial and social cost and are very disruptive to the lives of individuals, families and tribes.

The range of concentrations often found in mold measurements is several orders of magnitude—sometimes several dozen spores or colony-forming-units (CFUs) per unit of mass or volume out to several million. Most guidance advises representing the distribution as lognormal; that is, if the data values are represented not as numbers with zeroes but as powers of ten, then the exponents occur in a normal distribution. This is quite helpful, as one of the tails of the distribution never drops below zero.

Let us presume that an environmental consultant hypothesizes that the airborne mold spore concentration in a room exceeds a certain value. Of course, the consultant would be obliged to cite the reference for the value selected. Taking a single sample gives a distinct reading for the sample but says nothing about the concentration in the room. A second sample, with a result different from the first, proves that a single sample cannot characterize the actual concentration. Also, clearly, the more samples that are taken, the more sure one can be that the mean of the measured values represents the actual value, and can be used in this comparison test.
Let us also presume that the confidence interval used is 0.05 ($\alpha = 0.05$). That means that 5% of the time the confidence in the veracity of the finding will be misguided. Nevertheless, many scientific and management findings use a 0.05 confidence interval. Tribal leaders or others who are entertaining proposals from environmental consultants might consider having a stated confidence interval at the time of the work proposal, perhaps of 5%.

Then standard statistics allows us to calculate the confidence interval. The result is usually expressed as a value $y \pm z$ ($\alpha = 0.05$). The value $y$ is the mean (average) of the sample values. The value $z$ is composed of the Standard Error (SE, equal to the standard deviation divided by square root of the count-1) times a factor called "student's-t" ($t$). This factor is commonly used in statistics when the number of samples is small; it is found in textbooks of statistics and as a common spreadsheet function. The value $z$ is equal to $(t) \times (SE)$.

An environmental consultant may wish to sample to determine if a certain species is present or not. Common species of mold should always be deemed to be present, but may be proved to be absent, if indeed they are absent, to any selected degree of confidence (never for certain).

Testing is expensive. So there is a strong tendency on the part of both consultants and clients to conduct testing without regard to the statistical significance. This practice should end, as the results cannot be used for decision-making. If testing is to be done at all, then the testing campaign must be designed to have the power to provide answers to the critical questions.

All mold testing must include a minimum of two samples per measurement site. Taking only one sample leaves the impression that the value is somehow elevated above error. With two samples per site, the issue of error is inescapable. In addition all mold testing should:

- State the question or hypothesis that is being answered or addressed through testing
- State the criteria (absolute or comparison) used to address the hypothesis
- State the proposed confidence level.
- List the errors and biases that are accounted for (or controlled for) in the testing.
- Calculate the margin of error.
- Report the findings with the margin of error.
- Attach statistical significance to the conclusions.

July, 2003
PART II

WALATOWA PUEBLO OF JEMEZ HOUSING DEPARTMENT
TECHNICAL HOUSING ASSESSMENT REPORT

Executive Summary

Introduction

Section 1: Methodology

Section 2: Walatowa Pueblo of Jemez Housing Department

Section 3: Findings

Section 4: Technical Discussion and Recommendations

Section 5: Discussion of Common Problems

Appendix A: Housing Survey Summary Site Visit Report

Appendix B: Housing Assessment Results
EXECUTIVE SUMMARY

Five homes were inspected for mold and moisture problems for the Walatowa Pueblo of Jemez Housing Department (WPJHD). The investigation was conducted on March 14, 2005 by Kate Brown of Building Research Council and Paul Knight of Magna Systems Inc. Three homes were occupied, one was under construction, and one was being rehabilitated.

The existing inspected homes ranged in age from 18 to 38 years old. Two homes were traditional style – adobe walls, dirt floors, and low pitched roofs without attic cavities and drained by canales.

Exterior and interior inspections were conducted at all the homes. The inspection process involved visual assessment of both interior and exterior conditions, air flow measurement of bathroom exhaust fans and resident interviews.

Mold was found in the three occupied homes. The other two homes were under construction and unoccupied. The most severe cases resulted from unvented propane space heaters. Two homes had roof leaks, although it appeared that these leaks were not presently causing major mold problems. The homes had under-performing or absent bathroom exhaust fans. The two traditional homes did not have kitchen exhaust fans.

Site drainage was fairly good around the homes. Roofs drained by canales did not have downspouts. Water was pooling next to the foundation. Back-splashing against the stucco finish was visible. Over time, this action may cause degradation of the stucco and water may be drawn up into the home through capillary action in the foundation/floor. The modern homes had gutter systems.

Only five of the approximately 450 homes at WPJHD were inspected. The findings listed below are specific to the homes inspected and may not be issues in other homes at WPJHD. WPJHD can reference these findings and subsequent recommendations when similar moisture problems are encountered in other homes.

Principal Findings:

1. Poor indoor ventilation seems to be a consistent problem among the homes. Bathroom exhaust fans, when present, are not providing sufficient ventilation. Kitchen exhaust fans were not found in the traditional homes. Interior clothes drying and unvented clothes dryers were also contributing to poor indoor ventilation.

2. Unvented space heaters put a significant amount of moisture into a home and can cause moisture and mold problems. Other combustion products can have a negative impact on indoor air quality.
3. Site drainage did not appear to be a significant factor to increased interior moisture loads. Installation of downspouts under canales would improve localized site drainage around the homes.

4. Roof leaks and improperly flashed windows are affecting building durability and contributing to elevated interior moisture loads.

5. Improving air flow in traditional homes with wood stoves or space heaters can help reduce condensation issues on windows and walls.

6. Pouring concrete slabs over dirt floors will increase interior moisture loads significantly for at least three days following the pour. Open homes as much as possible to facilitate air drying.

7. Occupant lifestyles may also contribute to moisture and other indoor air quality issues, although this did not appear to be a major factor in the three inspected homes.

The report provides technical recommendations and discussions focusing on these items. Appendix A includes a summary of findings at each inspected unit. Appendix B provides observations and recommendations for the three occupied homes.
INTRODUCTION

The Building Research Council (BRC) responded to a request from the Eastern/Woodlands Office of Native American Programs to assess site and structural conditions contributing to mold and moisture problems in homes managed by the Walatowa Pueblo of Jemez Housing Department (WPJHD) at the Pueblo of Jemez, northwest of Albuquerque, NM. The investigation was conducted on March 14, 2005 by Kate Brown of BRC and Paul Knight of Magna Systems Inc.

Five homes were inspected for mold and moisture problems for WPJHD. Three homes were occupied, one was under construction, and one was being rehabilitated. Two occupied homes were traditional style adobe architecture with adobe walls, dirt floors, and low-pitched roofs without roof cavities and drained by canales. The third home was modular. Both the new home and the rehabilitated home were site-built modern homes.

Mold was found in the three occupied homes. The most severe case resulted from unvented propane space heaters. Two homes had roof leaks, not causing major mold problems. The homes with exhaust fans had under-performing bathroom fans. The two traditional homes did not have kitchen exhaust fans.

Site drainage was fairly good around the homes. Roofs drained by canales did not have downspouts, thus water was pooling next to the foundation and back-splashing against the stucco finish. Over time, this action may cause degradation of the stucco and water may be drawn up into the home through capillary action in the foundation/floor. Modern homes had gutter systems.

One traditional home was heated with three propane-fired space heaters; two were unvented and one was vented. The other was heated with a wood stove. Modern homes had propane-fired furnaces with a ducted supply system and central return.

SECTION 1 – METHODOLOGY

Visual inspection was primarily used to assess mold and moisture conditions in the homes. Actual exhaust rates from bathroom exhaust fans were measured.

The results of the mold and moisture assessments were compiled on a spreadsheet, with broad categories of common moisture problems noted. This data is presented in Appendix A of this report. Findings and recommendations for the individually inspected occupied homes are presented in Appendix B.
Visual Inspection

Housing inspections consisted of visual assessments of mold and moisture conditions. The assessment forms are organized for a room-by-room inspection. All rooms were examined for water damage and evidence of mold. Assessment of kitchens, bathrooms, utility rooms, crawl spaces, basements and attics included additional inspections of plumbing, localized ventilation, water entry and other moisture source issues.

The exterior of the homes were inspected for rainwater and snow melt management, including site grading, roof condition and gutter system.

Residents were interviewed to gather history on moisture problems, plumbing leaks, site drainage issues, winter condensation, health issues, number of occupants and other useful information.

Digital photographs were taken at each home to visually record notable conditions.

Measurements

Actual ventilation rates of bathroom fans were measured with an exhaust fan flow meter. The flow meter consists of a gasketed pan that is placed tightly over an operating exhaust fan. The pan has a variable orifice and a connection for a digital manometer. The manometer measures the pressure difference between the pan and the house during fan operation. Based on the setting of the variable orifice and the measured pressure difference at the fan, the cubic feet of air per minute (CFM) exhaust by the fan is calculated (Figure 1).

SECTION 2 - WALATOWA PUEBLO OF JEMEZ HOUSING DEPARTMENT

HOUSE DESCRIPTIONS

WPJHHD manages about 79 Mutual Help homes out of the 450 homes at Pueblo of Jemez. Five homes were inspected; three were occupied, one was a new home under construction and the fifth home was receiving a major rehabilitation. The occupied inspected homes ranged in age from 18 to 38 years old.

Two homes were traditional style homes with adobe sidewalls, stucco interior and exterior finish, dirt floors (The compacted dirt floor has flooring, such as carpet or sheet vinyl installed over it). Roofs are low-pitched without roof cavities and canales drain the roof through parapet walls (Figure 2).
Windows were usually double-glazed sliders. However, some single-glazed units were found. Originally, the bathrooms and kitchens were not vented. Wood stoves were used for both heating and cooking. Generally, the traditional homes were clustered, often sharing common walls.

One traditional home had been rehabilitated. A concrete slab was poured over the dirt floor. The wood stoves were replaced with propane-fired space heaters – two of which were unvented. A token bathroom exhaust fan was installed, but not a kitchen exhaust fan.

Modern homes were wood frame 2” x 6” construction, either stick-built or modular. Sidewall insulation could not be inspected and was assumed to be R19 fiberglass batts. Homes were built over vented crawl spaces. Foundations were concrete and insulated with rigid insulation foam board. The floors above the crawl spaces were also insulated with R19 fiberglass batts. The new home was being built over a slab-on-grade. Pitched roofs with attic cavities were used. Inspected attics were insulated with blown fiberglass insulation. Attic insulation R-values ranged between 13 and 38. Soffit and gable vents were the common attic ventilation strategy.

Propane-fired forced air furnaces were the primary heating systems used in the modern homes. Heating ducts were either located in the attics or in the crawl space. Some homes had evaporative cooling systems that utilized the furnace ductwork. Water heaters were electric in the traditional homes and propane in the modern homes.

New Home

A new home was being stick-built with 2” x 6” framing over a slab-on-grade (Figure 3). Ducts were located in the attic (the attic could not be inspected). Double-glazed sliding windows had a U-value\(^1\) of 0.49 and a Solar Heat Gain Coefficient\(^2\) (SHGC) of 0.65. The bathroom exhaust fan was rated at 50 CFM. The kitchen fan will vent to the outside. Although the furnace and water heater were not yet installed, it was presumed that the furnace would be 80% efficient and that the water heater would be propane or electric.

The Department of Energy makes the following recommendations with respect to insulation R-values\(^3\) for propane-heated homes built in the Pueblo of Jemez area:

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1 - Conductance value; the lower the U-value, the better the insulating qualities of the window. For comparison purposes, a single-glazed window has a U-value of 1.00.

2 - The SHGC is the fraction of incident solar radiation admitted through a window, both admitted through a window, both directly transmitted, and absorbed and subsequently released inward. SHGC is expressed as a number between 0 and 1. The lower a window’s solar heat gain coefficient, the less solar heat it transmits.

3 - R-value means resistance to heat flow. The higher the R-value, the better the insulation.
• Attic Insulation – R49
• Sidewalls – R19
• Edge of Slab-on-Grade – R8
• Crawl Space Walls – R11 or Floor above Crawl Space – R25

The sidewall R-value is being met. It was unclear whether the attic was insulated to R49 (about 15 inches of fiberglass) or whether the slab edge was insulated (2 inches of foam board is R10). For additional information regarding recommended R-values, see http://www.ornl.gov/~roofs/Zip/ZipHome.html

Recommended window values for the Pueblo of Jemez area are shown below.

• U-value no higher than 0.40
• Solar Heat Gain Coefficient (SHGC) values between 0.40 and 0.55

Both the U-value and SHGC values of the windows being used were above the recommended values.

For additional information regarding windows, see http://www.efficientwindows.org/

Rehabilitation

One home was undergoing major rehabilitation (Figure 4). Rooms were re-configured for accessibility with walls of 2” x 6” construction and insulation is at R19. The attic had been insulated only to R11 and pieces of insulation were missing exposing the ceiling drywall (Figure 5). These areas became quite cold during the heating season. If indoor humidity levels increase, condensation was likely to occur on these surfaces.

The home was built over a vented crawl space. The floor above the crawl space was adequately insulated. Mechanicals (ductwork, plumbing) were located in the crawl space (Figure 6). Inspect ductwork to ensure that duct joints were sealed and that the ducts were properly insulated (minimum R-value of 8). Insulate plumbing supply lines, also.

The furnace was 80% efficient. Although not yet installed, combustion air will be drawn from either the vented crawl space or the attic.
SECTION 3 – FINDINGS

3.1 Bathroom & Kitchen Exhaust Fans; Clothes Dryers

Properly operating and vented exhaust fans and clothes dryers remove moisture from bathrooms and homes. Bathroom exhaust fans were found in two occupied homes. The fans rated at 50 CFM in the home under construction, as well as the home being rehabilitated.

Measured exhaust flow rates ranged between 21 CFM and 28 CFM. Sone\textsuperscript{4} rating was 4.0. Table 1 shows the measured exhaust flows.

<table>
<thead>
<tr>
<th>House</th>
<th>Bathroom</th>
<th>Laundry Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1</td>
<td>28 CFM</td>
<td>---</td>
</tr>
<tr>
<td>1-2</td>
<td>21 CFM</td>
<td>24 CFM</td>
</tr>
<tr>
<td>1-3</td>
<td>No fan</td>
<td>---</td>
</tr>
<tr>
<td>Rehab</td>
<td>28 CFM</td>
<td></td>
</tr>
<tr>
<td>New Constr</td>
<td>2\textsuperscript{nd} not measured</td>
<td></td>
</tr>
</tbody>
</table>

Bathroom exhaust fans should provide a minimum ventilation rate of 70 CFM. None of the bathroom exhaust fans vented near this rate. It is not unique to the housing stock at WPJHD to have bathroom fans measuring below their rated exhaust capacity.

The two traditional homes had no kitchen fans. The other homes had kitchen fans that vented to the outside. Kitchen exhaust fans vented to the outside is imperative to controlling moisture levels while cooking.

Only two clothes dryers were seen: one vented to the outside and the other vented to the inside (Figure 7).

3.2 Unvented Space Heaters

Wood stoves were replaced with three propane-fired space heaters when rehabilitation work was done on one home in 2001. Two space heaters were unvented (Figure 8). The third space heater was vented to the outside. Unvented combustion heaters use indoor air for combustion and vent the combustion by-products directly into the room.

\textsuperscript{4} - Sone rating is for sound. The higher the sone rating, the louder the fan. Quiet fans have sone ratings of 1.5 or under.
Unvented gas appliances release combustion products into the indoor air, including carbon dioxide, carbon monoxide, nitrogen dioxide, water vapor, and possibly trace levels of formaldehyde and respirable particulates. Using unvented gas appliances increases the concentration of these pollutants in a home and may exceed established health-based thresholds. Depending upon the level of exposure, these pollutants and the lack of oxygen can cause eye irritation, headaches, dizziness, fatigue, respiratory problems, and possibly death. See Section 5.2 for additional information about the adverse health effects of unvented space heaters, particularly carbon monoxide.

During combustion, the hydrogen in carbon-based fuels combines with oxygen, producing water vapor, the most plentiful product of combustion, making up about 60% of the output of a gas fire. For every gallon of propane burned, one gallon of water is produced. Water vapor is harmless to human health, however, high wintertime humidity can cause condensation-based problems and promote moisture damage and mold contamination, leading to other health concerns. In cases where other moisture sources are present, the addition of a major new moisture source from unvented combustion can be problematic.

Mold was found throughout one home. Condensation was on the windows. Although the dryer vented into the home, the unvented space heaters was probably the major source of moisture in the home.

3.3 Site Drainage

Site drainage was not a significant factor to increased interior moisture loads. Modern homes had gutter systems. The pooling of water under some canales and back-splashing against the stucco finish was visible (Figure 9). Installing downspouts under canales would improve site drainage around the homes. However, these downspouts may impact the appearance of the homes, particularly the traditional style homes (Figure 10). Downspouts should solve back-splashing problem, but may not solve the pooling of water at the base.

3.4 Roof Leaks/Improperly Flashed Windows

Repair roof leaks as soon as possible. Two occupied homes had roof leaks (Figure 11). Though precipitation was occurring during the site visit, water was not dripping into the homes. Roof leaks affect building durability that will lead to interior moisture problems.
Windows not properly flashed on the exterior can also cause building durability and indoor moisture problems (Figure 12). Include proper flashing with the window installation to allow for proper rain water drainage.

3.5 Improving Air Flow

Unvented gas appliances have poor heat distribution. Bedrooms and bathrooms away from the radiant view of the heater remain unheated and prone to wetness and mold growth. Improving air flow in traditional homes with wood stoves or space heaters can help reduce condensation issues on windows and walls.

Mold was found in the two homes with the space heaters and the wood stove. Mold was found in corners and at the floor level behind furniture - areas where air circulation may be poor. Window condensation was also present in the homes without ducted forced air furnaces. Window condensation is usually not a problem in homes with ducted systems as supply air is provided below or from above the windows. The warm air washes the window surface, eliminating the condensation problem.

High indoor relative humidity during the winter combined with cooler than desired interior surface temperatures will cause window condensation and condensation based mold growth on walls. Reducing indoor relative humidity (vented space heaters, properly functioning bathroom exhaust fans, and vented clothes dryers) will reduce the potential for condensation. Increasing surface temperature (better quality windows) or improving air flow (fans) will also reduce the potential for mold growth on these surfaces.

3.6 Concrete Slabs

Pouring concrete slabs over dirt floors will increase interior moisture loads significantly for at least three days following the pour. Open the homes as much as possible to facilitate air drying.

About 10 pounds of water (1-1/4 gallon) are contained within 1 cubic foot of concrete (a slab of concrete that is 4” thick by 12” by 36”). A 1000 ft² concrete slab at 4” thick is 330 ft³ of concrete. At 10 pounds per ft³, the slab contains 3,330 pounds of water (about 395 gallons of water). However, most of this water is released within the first three days of pouring the slab. Homes should be opened as much as possible during these three days to facilitate drying.
3.7 Occupant Lifestyles

Occupant lifestyles may also contribute to moisture and other indoor air quality issues, although this did not appear to be a major factor in the three inspected homes.

Timely reporting and repairing of plumbing and roof leaks, wood storage in homes and poor air circulation were specific observations made during the site visit. Occupants should be educated to help solve and eliminate moisture and mold problems in their homes.

Overcrowding is a fairly common problem in Indian housing, although this was not an apparent issue in the homes visited at Pueblo of Jemez. Although often unavoidable, overcrowding should be recognized as a major contributor to indoor humidity levels. High occupancy levels increase the moisture loads from human activities (breathing, cooking, washing, etc.). Elevated interior moisture loads can lead to mold contamination from condensation problems.

SECTION 4 – TECHNICAL RECOMMENDATIONS

The following recommendations are based on the site visit findings.

4.1 Bathroom & Kitchen Exhaust Fans; Clothes Dryers

Properly operating exhaust fans are key to removing large amounts of moisture generated in bathrooms and kitchens. Improperly working bathroom exhaust fans should be replaced. Fans should be rated for a minimum 70 CFM at 0.25" of static pressure (the rating provided on the box is generally at 0.10" of static pressure). These same fans should be specified for new construction and when homes are rehabilitated.

1. New bathroom fans should have sone ratings no higher than 1.5. Sone is a rating for sound – the lower the sone rating, the quieter the fan. Occupants tend not to use loud fans because of the noise. Low-sone fans include Broan Solitaire and Panasonic WhisperCeiling and WhisperLite series. Low-sone fans generally cost between $75 and $100.

2. Replace flexible ribbed vent with smooth metal vent. The use of round, smooth sheet metal ductwork is recommended. Minimize duct length, turns and bends in the ductwork. Smooth duct provides less resistance and improved flow over ribbed ductwork. Recommend to occupants that intake grilles be cleaned of dust and lint on an as needed basis.
3. Replace fan on/off switches with 60 minute timer switches (Figure 13). Recommend to occupants that fans operate for at least 15 minutes (See note on Page 19) following showering or bathing. Timer switches cost between $15 and $50.

4. Replace any existing combination bathroom light/fan switches with fan delay timers (Figure 14). A fan delay timer is a two function switch that is typically wired to a fan and a light. When the switch is turned-on, both the light and exhaust fan are turned-on. When the switch is turned-off, the light is turned-off but the fan continues to operate for an extended period of time. The extended period of time can be adjusted from 1 to 60 minutes. Fan delay timers cost approximately $35.

5. Periodically inspect bathroom and kitchen exhaust fan ducts. Ensure exhaust ducts are vented outside, properly attached, and sealed to the exhaust fan housing and to roof or wall vent caps.

6. As rehabilitation work is done in kitchens, install kitchen exhaust fans that vent outside with a minimum rating of 150 CFM.

7. Periodically inspect dryer vents. Correct the following conditions when found:
   - Vent dryers to outside.
   - Install dryer vent when missing or damaged.
   - Replace crimped or cracked dryer vents.
   - Reconnect disconnected dryer vents.
   - Replace plastic ribbed dryer vents with smooth metal vents as space permits.

4.2 Unvented Space Heaters

Replace all unvented combustion space heaters as soon as possible. Unvented gas appliances have never been rated for use as the sole heat source in a dwelling, only as supplemental heating devices. Nevertheless, one home had unvented propane-fire space heaters as the sole heat source, contradicting the product directions and guidelines.

Replace unvented space heaters located on exterior walls with vented space heaters. Vent unvented space heaters located on interior walls through the roof. If not possible, consider replacing these heaters with unvented heaters with sensors to automatically shut off the burner when the oxygen level in the room falls below a safe level.
Consider utilizing direct vent space heaters which use sealed combustion so the combustion process is totally separate from the room air. Combustion air is drawn in from outdoors. It mixes with the propane in the burner and the flue gases exhaust back outdoors (Figure 15). It is a safe and efficient manner to heat and eliminates drafts in the home.

Alternately, consider the following options:

1. Recommend to the occupants that a window be opened at least ½" to let in fresh air.

2. Consider replacing unvented space heaters with electric resistance heaters. This may be an expensive option depending upon the price of electricity.

4.3 Site Drainage

Site drainage was generally good at the inspected homes.

1. Fill in the small holes and dips found adjacent to foundations, particularly under the canales.

2. Grade directly at the foundation to ensure that soil pitches away from new homes by at least 5% (6 inches per 10 feet).

3. Replace missing splash blocks to direct water away from the foundation (Figure 16).

4. Consider installing canales when roof drainage is causing damage to the exterior finish.

4.4 Roof Leaks/Improperly Flashed Windows

1. Repair roof leaks as soon as possible.

2. Properly flash windows when they are replaced. For window flashing details, see:

Building Research Council
4.5 Improving Air Flow

The following recommendations are made with respect to improving air flow in homes.

Traditional Homes with Wood Stove and Space Heaters

1. Encourage occupants to keep doors open between rooms.

2. Encourage use of small portable fans to move air around the homes, especially to rooms with no heating source.

3. Encourage occupants to avoid covering windows with heavy fabrics. Use light fabrics or blinds, if possible, to promote airflow across window surfaces.

4. Encourage use of exhaust fans to remove moisture from bathrooms and kitchens.

Modern Homes with Forced Air Furnaces

1. Encourage occupants to avoid placing furniture or clutter over supply air vents on the floor.

2. Consider replacing solid panel closet doors with louvered doors to improve air flow in closets.

3. If low flow rates are suspected in rooms, measure supply air CFM at registers with a velometer. Flows generally range between 70 CFM and 100 CFM, depending on room size. Balance system as necessary to increase air flow to rooms if needed. Additional information about this test may be found in section 4.6 Concrete Slabs.

4.6 Concrete Slabs

Use a dry mix for pouring slabs. Dry mix should have a water to concrete ratio (w/c) no higher than 0.5. A cubic foot (ft$^3$) of concrete weighs about 150 pounds. Approximately 20 pounds of that is cement assuming rather fine aggregate is used. At a 0.50 w/c, 10 pounds is water. If the w/c ratio is increased to 0.7, there is an extra 4 pounds of water per ft$^3$ of concrete. Concrete at 0.5 w/c also provides good strength.

Most of the water is released within the first three days after pouring a slab. Make provisions to allow good airing for the first three days after the pour.

4.7 Occupant Lifestyles

Occupant lifestyles may also contribute to moisture and other indoor air quality issues. Educate occupants in the following areas to assist in solving and eliminating mold and moisture problems:
1. Inform occupants to avoid using heavy blankets to cover windows. If possible, use louvered blinds that would allow air flow to wash the surface area of windows. If blankets continue to be used, instruct occupants to keep the blankets off the windows as much as possible.

2. Instruct occupants to change furnace filters monthly.

3. Instruct occupants on importance of using bathroom and kitchen exhaust fans when showering or cooking. Operate bathroom exhaust fans for a minimum of 15 minutes following showering or bathing.

4. Encourage occupants to report plumbing leaks to the housing office as soon as possible.
SECTION 5 – DISCUSSION OF COMMON PROBLEMS

5.1 Bathroom and Kitchen Exhaust Fans/Dryer Vents

Bathrooms, kitchens and utility rooms result in 100% humidity during showering, bathing, cooking, cleaning, and clothes drying. By removing moisture at the source in these areas, exhaust ventilation serves as a source control strategy. Exhaust ventilation dilutes the moisture and places the room in a negative pressure, thus limiting the spread of moisture to the rest of the home until most of the moisture has been removed to the outside.

Vent bathroom exhaust fans, kitchen exhaust fans and clothes dryers to the outside rather than into the living space. Venting to a crawl space or attic can lead to moisture problems occurring in these areas, thus, localized exhaust ventilation requires ductwork.

The effectiveness of exhaust fans is based on the power of the exhaust fan, length and type of exhaust duct and cleanliness of the fan grille. When there is excessive resistance in the ductwork, the exhaust fan motor may not be powerful enough to vent sufficient airflow through the duct. The longer the duct length, the greater the static pressure in the duct and the less air flow through the duct. Turns and bends in the ductwork also increase the static pressure and reduce flow. Similarly, a smooth duct provides less resistance and improved flow over ribbed ductwork. For all types of exhaust ventilation, using round, smooth sheet metal ductwork is recommended. A dirty intake grille will also greatly increase resistance and reduce airflow.

Fan capacity is typically listed at 0.10” and 0.25” of static pressure. Bathroom exhaust fans should provide a minimum ventilation rate of 70 CFM at 0.25” of static pressure. Selecting a fan capacity at 0.10” static pressure is appropriate only if the exhaust duct is smooth, straight (no more than one elbow) and less than 15’ in length. For example, a bathroom fan with an exhaust ventilation rate of 90 CFM or 100 CFM (at 0.10”) may be required to obtain 70 CFM at 0.25” of static pressure if the exhaust duct has numerous elbows, is ribbed, and the length is over 15’. Review fan performance curves to determine ventilation rates at 0.25”.

Install range hoods or kitchen exhaust fans that vent to the outside. The hoods should have a minimum exhaust capacity of 150 CFM. Do not install recirculating fans.

Use smooth-surfaced rigid duct or non-combustible flexible metal duct on dryer vents. Duct joints should be in the direction of air flow and fastened with screws or fasteners that extend into the duct. Minimize the length of the duct run, especially with flexible metal duct. Install flexible metal duct without dips or sags. Insulate dryer vents extending through non-conditioned spaces.

Minimum duct diameter should be 4 inches and length should not exceed 25 feet from the dryer outlet to the termination point. If duct length is greater than 25 feet, use 5 inch diameter duct.
Dryer vent caps should have a backdraft damper that closes when the dryer is not being used. Do not install insect screens or small wire cages over the vent cap.

5.2 Unvented Space Heaters

Unvented gas appliances release all combustion products into the indoor air. Combustion products include carbon dioxide (CO₂), carbon monoxide (CO), nitrogen dioxide (NO₂), water vapor (H₂O), and possibly trace levels of formaldehyde (HCHO) and respirable particulates. The use of unvented gas appliances increases the concentration of these pollutants in an indoor environment and can reach concentrations that exceed established health-based thresholds. The health risks of acute CO and NO₂ exposure are well established, and there is growing concern over chronic, low-level exposures of these combustion products.

Carbon monoxide (CO) is a toxic gas emitted from incomplete combustion of carbon-based fuels. It binds reversibly with blood hemoglobin impairing the transport of oxygen to body tissues. In the competition of carbon monoxide versus oxygen, the affinity of human hemoglobin for carbon monoxide is roughly 240 times that for oxygen. In the most severe cases, CO poisoning can lead to serious illness and even death. Unintentional CO deaths caused by non-vehicular sources number approximately 500 deaths per year in the United States.

The effects of chronic low-level CO exposure are difficult to recognize and treat, because individuals present non-specific symptoms (headaches, dizzy spells, malaise), and because there is a lack of awareness of the problem. Prolonged exposure to NO₂ has been suggested to increase the risk of respiratory infection and may be linked to the contraction of lung diseases such as emphysema.

5.3 Site Drainage

Design and build the roof so that rainwater lands on the roof, flows to the edge of the roof, and falls on a soil surface or percolates downward through the soil—more in sandy soils and less in clayey soils. The water that does not percolate downward moves along the soil surface following the slope to the downhill edge of the site. The best way to prevent mold and moisture problems in homes is to make sure that rainwater moves off the roof and across the site and off the property. The soil that is in contact with the foundation should be the driest soil on the site following a rainstorm. Homes with dry foundations (basements, crawl spaces and slabs) usually have dry indoor environments.

Keeping the soil that touches the foundation dry involves two general rules:

1. Rule of concentration: Damage is worse where greater quantities of water are concentrated. A valley on a roof acts like a funnel, with the greatest concentration of water at the base of the valley. Gutters act like funnels that collect water from the edge of the roof and concentrate it in the downspout. On the land, valleys and swales act like collectors or funnels that concentrate the water on the site. If the
water management design makes use of funnels (such as valleys, gutters or swales) then they require maintenance to make sure they work as they are intended. Damage is worst where a valley, gutter or swale is blocked.

2. Rule two is the ground-roof rule: Treat the soil surface as if it were a low-slope roof surface. Pitch the surface away from the home - the steeper the pitch, the better the drainage. Determine the best way to ensure all the water moves to the low edge of the site. Avoid areas near the building that can act as water collectors.

Specific site drainage guidelines include:

1. Build the home on a hill, not in a hole. With sufficiently exposed foundation, site grading may be improved. If the home hugs the ground, improvements are more difficult. A minimum of eight inches of exposed foundation between the ground and the beginning of the siding is recommended.

2. Identify the localized dips and holes adjacent to the foundation and fill with dirt. Tamp the fill material to prevent future settling. Provide sufficient fill material such that drainage occurs away from the foundation.

3. If the home has no gutters, then the base of the soil around the home has to serve as a gutter itself. It should have a surface that helps prevent splash back onto the siding of the home. It should be designed with pitch so that it effectively moves water away from the home.

4. Good tamping or compaction of the backfill is very helpful because it helps keep water up on the surface where it can be managed by slope. Soil at the outside corners of the foundation, where the downspouts are usually found, can always be tamped because the corner will never collapse inward.

5.4 Improving Air Flows

The following test procedures may be used in modern homes with forced air furnaces to check air circulation.

Improperly balanced duct systems can cause comfort, building durability, and indoor air quality problems. This test measures pressure differences between the bedrooms and main body of the house. The test is conducted with a manometer while the furnace air handler is operating.

Pressure differences greater than +2.0 Pa or more negative than -2.0 Pa should be corrected. The test is conducted in the following manner:
1. Set up home for winter conditions. Close all the windows and exterior doors. Turn off all the exhaust fans.

2. Close all interior doors.

3. Turn on furnace air handler.

4. Place hose from input tap on the manometer under the door. Leave reference tap open to main body of home.

5. Read measurement for each room (Figure 17).

If pressure difference is more than $+2.0$ Pa or $-2.0$ Pa with the air handler operating, pressure relief is necessary. To estimate the amount of pressure relief, slowly open door until pressure difference drops between $+2.0$ Pa and $-2.0$ Pa. Estimate area of open door. This is the area required to provide pressure relief.

Pressure relief may include:

1. Undercutting the doors.

2. Installing transfer grilles (Figure 18).

3. Retrofitting jumper duct consisting of one register in the bedroom ceiling and one register in the hall ceiling with a duct in between located in the attic.

The previous test simply measures the pressure difference between a room and the main body of the house – it does not measure actual flow, or CFM, coming out of the supply air register. A velometer (Figure 19) can be used for this type of test. Most heating contractors should have this device.
5.5 Occupant Items

A number of occupant items that can cause moisture and mold problems were identified. Train the occupants in the following items to assist in solving and eliminating moisture and mold problems in their homes:

- What is mold and what causes it,
- Slightly open a window when an unvented space heater is being used,
- Use of bathroom and kitchen exhaust fans,
- Use of crawl spaces and not storing items in them,
- Changing furnace filters,
- Prompt reporting plumbing leaks and water condensing on pipes, and
- Keeping supply air registers open and not blocked by furniture or household items.

Although not observed at the Pueblo of Jemez, overcrowding can be a significant contributor to elevated interior moisture levels. Overcrowding is when the number of residents living in a home exceeds the expected capacity. The moisture load increases as each person participates in moisture-producing activities (breathing, cooking, washing, etc.). If the number of people living in the home doubles, the moisture load from human sources also doubles.

The weather-tight construction of a home may also contribute to high relative humidity in the winter, which could lead to moisture and mold problems. In the absence of a mechanical ventilation system, natural infiltration (air leakage) provides fresh air in homes during the winter. This fresh, dry, winter air dilutes the moisture in the interior air and helps keep relative humidity under control. The amount of infiltration (the air change rate) that occurs in a home varies, depending on weather conditions (windy, non-windy day). In addition, some homes are naturally leaky while others are more airtight.

When a home is both overcrowded and has a low air change rate, an excessive moisture load can occur maximizing the potential for localized condensation and mold growth.

If winter condensation problems occur in a crowded home, identify and minimize all other sources of moisture. If the problems persist, then test the home for its relative tightness or leakiness using a blower door test (Figure 20). Agencies responsible for performing low-income weatherization usually have the equipment and expertise to perform this test and can confirm whether the air change is
too low for the size of a house and its number of residents. If this proves to be the case, then consider providing additional ventilation for the home through the following methods:

1. Install a good bathroom exhaust fan with more than just a simple on/off switch (See Section 4.1, Bathroom & Kitchen Exhaust Fans; Clothes Dryers).

2. If the home has a central forced-air heating system, augment the existing fan and ductwork with a connecting duct to the exterior and controls to provide fresh air circulation. Use the services of a mechanical engineer with experience in residential ventilation systems when addressing this problem.
## SITE VISIT SUMMARY REPORT

**DATE:** March 14, 2005

### Appendix A: Walatowa Pueblo of Jemez

#### Building Specifications

<table>
<thead>
<tr>
<th>Inspection Number</th>
<th>Address</th>
<th>Building Age</th>
<th>Occupancy</th>
<th>Foundation Type</th>
<th>Model and Framing Type</th>
<th>Heat Type</th>
<th>Site Drainage Problems</th>
<th>Gutter System Problems</th>
<th>Wet Basement or Crawl Space Problems</th>
<th>Plumbing Problems</th>
<th>Bathroom Problems</th>
<th>Exterior wall/ceiling problems</th>
<th>Attic Problems</th>
<th>Visible Mold (Column #)</th>
<th>CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>PO Box 177</td>
<td>38 years old</td>
<td>Owner Occupied</td>
<td>Concrete slab over dirt floor</td>
<td>Ranch, adobe</td>
<td>Space heaters (propane)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>NA</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>1.2</td>
<td>House 49, Hummingbird Lane</td>
<td>25 years old</td>
<td>Owner Occupied</td>
<td>Crawl Space (poured concrete)</td>
<td>Modular</td>
<td>F.A. Propane</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>14</td>
<td>28 CFM</td>
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<tr>
<td>1.3</td>
<td>House 006, Walatowa</td>
<td>18 years old</td>
<td>Owner Occupied</td>
<td>Dirt floor</td>
<td>Ranch, adobe</td>
<td>Wood stoves</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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</tr>
</tbody>
</table>

1. - Roof leak  
2. - Window flashing
Inspection Number: 1-1
Address: PO Box 177
Age: 38 years
House Type: Adobe ranch
Occupancy: 1
Bedrooms: 1
Foundation: Dirt floor with slab
Heat Type: Space heaters (propane)
Construction: Adobe

Mold and Moisture Conditions: The home was rehabilitated in 2001. Mold was not an issue in the home until that work was done. The work included pouring a concrete slab over the existing dirt floor, removing a wood stove and wood fireplace, replacing with three propane space heaters of which only one vented to the outside, and roofing work.

Mold was found at the base of the walls and in the corners of the exterior walls (Figure 2). All windows had or showed signs of condensation. The roof was leaking in the bedroom. The clothes dryer was vented to the inside of the home. Moisture from the two unvented space heaters was a major cause of moisture and other potential indoor air quality problems.

Rainwater Management: The site drainage was fairly good and canales drained the roof. With no downspouts, water was pooling near the base of the home (Figure 3).

Floor: A 4 to 6 inch slab was poured over the dirt floor during rehabilitation. A significant amount of moisture was released during the first three days of pouring the concrete.

Bathroom/Kitchen: There was no kitchen fan. The bathroom fan measured 28 CFM (fan was rated for 50 CFM) and vented to the outside. The dryer was vented to the interior of the home (Figure 4).
Roof: The roof was flat with no attic cavity. The roof had been repaired as part of the rehabilitation work scope, but was leaking in the bedroom (Figure 5).

Heating System: The wood stove and wood fireplace were replaced with two unvented propane space heaters (Figure 6) and one vented propane space heater (Figure 7). The water heater was electric.

Occupant Notes: One person lived in the home.

Recommendations: The major sources of moisture in the home were the unvented space heaters and clothes dryer. Initially, moisture released from the concrete slab as it was curing may have contributed a significant amount of moisture to the home, also.

Recommendations include:

1. Replace unvented space heaters with vented space heaters, a fairly straight-forward correction for the living room heater as it was located on an exterior wall. The bathroom heater was located on an interior wall, so consider replacing with an electric space heater.

2. Vent the clothes dryer to the outside.

3. Replace the bathroom exhaust fan with a low sone fan rated at 75 CFM at 0.25" of static pressure and controlled with a dehumidistat with booster switch.

4. A new bathroom exhaust fan may be sufficient to vent both the bathroom and kitchen. If not, install a kitchen exhaust fan.

5. Fill depressions at the base of the exterior wall, especially at points under canales.

6. Repair the roof leak.

7. Pull back carpeting near the locations of the wall mold and inspect for mold under the carpet.
Appendix B: Walatowa Pueblo of Jemez Housing Department
Technical Housing Assessment Report

**Inspection Number:** 1-2
**Address:** House 49, Hummingbird Lane.
**Age:** 25 years
**House Type:** Ranch
**Occupancy:** 7
**Bedrooms:** 3
**Foundation:** Poured concrete
**Heat Type:** FA furnace (propane)
**Construction:** Modular

**Mold and Moisture Conditions:** Mold was found on the bathroom ceiling.

**Rainwater Management:** Site drainage was good with gutters and downspouts (Figure 2).

**Crawl Space:** The dry crawl space was unvented with the exterior walls insulated with foam board. The floor above the crawl space was insulated with fiberglass insulation (Figure 3). A ground cover may be present under the sand, but could not be found.

**Bathroom/Kitchen:** The kitchen fan vented to the outside. The bathroom fan measured 21 CFM. The exhaust fan in the laundry room measured 24 CFM. Both fans were rated for 50 CFM. Mold was found on the bathroom ceiling (Figure 4). Ceiling supply air register was rusty (Figure 5).

**Attic:** The attic was insulated with approximately 9" of blown fiberglass insulation. The attic was dry with no visible signs of moisture or mold.

**Heating System:** The furnace and water heater were propane fired. Combustion air was provided to the furnace closet from the attic. An evaporative cooling system was used during the summer. The roof top unit was covered from the winter. A wood stove located in the living room provided a secondary heating.

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**Figure 1 – House 49, Hummingbird Lane**

**Figure 2 – Good site drainage from gutter system**

**Figure 3 – Crawl space with insulated walls and floor**

**Figure 4 – Bathroom ceiling mold**

**Figure 5 – Rusty ceiling supply air register in bathroom**
source (Figure 6). Combustion air was provided to the stove through a damper located in the wall. Wood for the stove was stored in the home.

**Occupant Notes:** Seven people lived in the home.

**Recommendations:**

1. Replace the bathroom exhaust fan with a low sone fan rated at 75 CFM at 0.25" of static pressure. There is no need to replace the exhaust fan in the laundry room.

2. Inspect the attic insulation over the bathroom ceiling. Ensure that supply air boot is fully insulated with no exposed metal surfaces.

3. Consider storing wood for the stove outside of the home.
Appendix B: Walatowa Pueblo of Jemez Housing Department
Technical Housing Assessment Report

Inspection Number: 1-3
Address: House 006, Walatowa
Age: 18 years
House Type: Adobe ranch
Occupancy: 3
Bedrooms: 2
Foundation: Dirt floor
Heat Type: Wood stove
Construction: Adobe

Mold and Moisture Conditions:
Severe water damage included: damage to the bathroom wall finishes (Figure 2), deterioration of wood and mold at the base of the bathroom walls (Figure 3), a roof leak in one bedroom (Figure 4), exterior window trim deteriorating and pulling away from wall (Figure 5), a small leak found under the kitchen sink (Figure 6), and some windows were single glazed with signs of condensation problems.

Rainwater Management:
The roof drained with canales with no downspouts, and water was pooling near the base of the home (Figure 7).
Bathroom/Kitchen: There was no kitchen or bathroom exhaust fan. A small leak was found under the kitchen sink. Significant deterioration of materials in the bathroom included a wood ledge at one end of the bathtub (Figure 8). No clothes dryer was in the home.

Roof: The roof was flat with no attic cavity. The roof was leaking in both bedrooms.

Heating System: The home was heated by a wood stove located in the living room (Figure 9).

Occupant Notes: Three people lived in the home.

Recommendations: The most significant problem was the bathroom. Recommendations for repair include:

1. Install a bathroom exhaust fan with low sone fan rated at 75 CFM at 0.25” of static pressure. Vent to the outside.
2. Replace the single glazed windows with double glazed units.
3. Re-flash windows and replace exterior trim.
4. Fill depressions at the base of the exterior wall, especially at points under canales.
5. Repair roof leaks.
6. Install a kitchen exhaust fan.