Final Report

Date:
August 23-24, 2004

Prepared for:
U.S. Department of Housing & Urban Development
Office of Native American Programs

Prepared by:
UIUC/Building Research Council
One East St. Mary’s Road
Champaign, IL 61820

Under sub-contract to:
Magna Systems, Inc.
340 E. Second Street, Suite 409
Los Angeles, CA 90012-4249
Contract Number: U02 HUD SBC-B-2366
**TABLE OF CONTENTS**

<table>
<thead>
<tr>
<th>Part I</th>
<th>Juneau and Hoonah Communities Trip Report</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Attachment I: Measuring Problem Regarding Mold</td>
</tr>
</tbody>
</table>

| Part II      | Juneau and Hoonah Communities Technical Housing Assessment Report |

<table>
<thead>
<tr>
<th>Appendix A</th>
<th>Summary Site Visit Report</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Appendix B</th>
<th>Housing Assessment Results</th>
</tr>
</thead>
</table>
PART I

JUNEAU AND HOONAH COMMUNITIES TRIP REPORT

INTRODUCTION

Robert Nemeth from Magna Systems, Inc. conducted a site visit to the Juneau and Hoonah Communities on August 23-24, 2004. The Tlingit-Haida Regional Housing Authority (THRHA) administers the housing program for these Southeast Alaska Communities. The site visit provided technical assistance to THRHA in assessing mold and moisture conditions in housing units. This report summarizes activities and issues addressed while on site. A detailed analysis of findings and recommendations is found in PART II: Juneau and Hoonah Communities Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes for the Juneau and Hoonah Communities.

THRHA serves over 594 families and over 1,764 clients total in 15 different communities throughout Southeast Alaska. Following is a breakdown of demographics based on their 2003 Annual Report for Hoonah and Juneau:

<table>
<thead>
<tr>
<th>COMMUNITY</th>
<th>FAMILIES</th>
<th>CLIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoonah</td>
<td>65</td>
<td>199</td>
</tr>
<tr>
<td>Juneau</td>
<td>158</td>
<td>445</td>
</tr>
</tbody>
</table>

BACKGROUND INFORMATION

JUNEAU

Juneau is the capital city in the State of Alaska, nestled at the base of two mountains rising more than 3,000 feet from the Gastineau Channel. Juneau is located on the southeast coast which is composed of a mainland portion which borders Canada’s British Columbia as well as numerous islands. The climate of this region is quite mild compared to most other regions of Alaska with relatively warm winters and cool summers. This area also experiences some of the highest rainfall totals in the state.

HOONAH

Hoonah is located in Yakutat Borough on the northeast shore of Chichagof Island across Icy Strait from the entrance to Glacier Bay. It is about 40 miles west of Juneau. Commercial fishing is the main activity, with a large cold storage facility. Hoonah means "village by the cliff." It is the principal village for the Huna, a Tlingit tribe which has occupied the area for centuries. Hoonah is the largest Tlingit village in southeast Alaska. Commercial fishing and logging have long supported the population, and most residents maintain a subsistence lifestyle. The population in year 2000 was 860, and the estimated population in July 2002 was 811, constituting a -5.7% change. There were a total of 348 housing units, of which 203 were owner occupied, 97 were renter occupied, and 48 were vacant. The average household size of owner-occupied units is 2.98
occupants, and average size of renter-occupied units is 2.53 occupants per household. Eighty-two percent of the homes rely on fuel-oil or kerosene for heating, approximately ten percent heated with wood, and the rest heat with LP gas or electricity.

**Day 1: Monday: August 23, 2004**

On Monday morning the assessment team met with David Vought of the HUD Alaska ONAP office, Craig Moore from the THRHA Development, Construction and Maintenance Department, Harold Houston, the Construction Coordinator from the THRHA, and John Davies of the Cold Climate Housing Research Center (CCHRC) to discuss housing issues in Juneau and Hoonah. The assessment team drove to Glacier Village in Juneau Alaska's Mendenhall Valley to look at new housing units. During the late afternoon, Robert Nemeth gave a presentation on Visual Mold Inspections to the THRHA staff.

**Day 2: Tuesday: August 24, 2004**

The team traveled to Hoonah, inspected 4 houses, and took digital photographs to record all home conditions. The inspection process involved visual assessments of both interior and exterior conditions. The team flew back to Juneau in the late afternoon.

**Day 3: Wednesday: August 25, 2004**

The team returned to Illinois.

**FINDINGS**

An overview of findings and recommendations for the site visit follows. *PART II: Juneau and Hoonah Communities Housing Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes in Glacier Village and Hoonah* provides a detailed analysis of findings and recommendations for the homes investigated.

**GLACIER VILLAGE, JUNEAU, AK**

1. The team inspected two homes in Glacier Village, a new development approximately three years old. THRHA discussed their current methods of construction and ventilation strategies incorporated into their new housing. One of the units was occupied, and the other was recently completed and ready to be occupied. None of the inspected homes had mold.

2. All homes had metal gutters and downspouts.

3. The one inspected crawl space was an exemplary model of a proper crawl space. The vapor barrier was sealed to the perimeter and around all interior piers.

4. In the crawl space, a custom ventilation system had separate intake and exhaust fans. The exhaust drew air out of the bathroom, laundry and crawl space, and the
supply fan provided partially conditioned fresh air to the living, dining, and bedrooms.

5. The newest homes in this subdivision employed Insulated Concrete Forms (ICF) for the foundation stem walls.

6. The bath and laundry room fans were high quality Panasonic units.

7. Special care was taken in the bathroom to thoroughly seal the perimeter of the sheet-good flooring.

8. Range hoods ventilated to the exterior.

9. Minor insulation deficiencies were found in the one inspected attic.

10. In general, the units appeared to be very well constructed.

HOONAH, AK

1. The team inspected four Hoonah homes and found mold in every one.

2. Two homes had partial gutter systems; the other two had none.

3. The homes sat on piers with skirting enclosing the space beneath the homes.

4. Several problems with vinyl siding were observed, such as holes and cracks in the siding and siding that was coming loose from the wall.

5. Two homes were modular units and the marriage joint between the modules leaked or had condensation problems.

6. Plumbing problems existed in two houses and one house had an inoperable bath fan.

7. Thermal bridges at the wall to ceiling junction, window jambs, at exterior corners and at the marriage joint were common locations for mold growth.

8. Occupant lifestyles also contributed to moisture and other indoor air quality issues. Lifestyle issues included clutter inside, around the perimeter of the home, in the crawl space beneath the home, and in the attic.

RECOMMENDATIONS

Recommendations related to the technical issues are summarized below. For a more detailed discussion, see the Juneau and Hoonah Communities Technical Housing Assessment Report.
1. Site drainage issues are particularly important in an enclosed crawl space or basement. Grade the site so water flows away from the foundation. When the house is up on piers and somewhat decoupled from the grade, site drainage is less critical. However, moisture beneath the structure is still undesirable and site drainage should be addressed.

2. Install gutters, downspouts, leaders and splashblocks to drain water away from the home and reduce the negative impact that the current site drainage has by causing wet foundations.

3. Keep clutter out of the crawl spaces to reduce the potential for mold beneath the homes.

4. Bathrooms and kitchens generate large amounts of moisture. Properly operating exhaust fans remove this moisture from these spaces. The fans should exhaust to the outside rather than into spaces such as attics or crawl spaces. Recirculating kitchen range hoods do not provide ventilation and therefore do not remove moisture from the home.

5. A number of maintenance items related to moisture and other Indoor Air Quality (IAQ) problems should be addressed. Plumbing leaks were prevalent and should receive priority from the maintenance department.

6. In several instances the building envelope allowed air and water infiltration into wall and floor systems leading to structural deterioration.

7. Mold was found growing on the insulation dam at the attic hatch. Not all the inspected hatches were insulated or air sealed. Air seal with suitable weatherstripping.

8. Occupant cooperation is essential to minimize moisture and other IAQ problems.

9. Review remediation plans carefully to assure that moisture problems, along with the mold, are being resolved.

Programmatic Recommendations:

Local organizations responsible for housing should develop a service-delivery system to effectively address mold and moisture conditions. This would include training for the maintenance staff on how to implement the technical recommendations, and training for residents on their roles and responsibilities as renters and homeowners. Some strategies follow:

1. As part of the annual recertification process, require attendance at annual homeowner/renter clinics. These clinics will provide instruction on home maintenance issues. Topics such as identifying and repairing leaks could be presented.
2. During the annual recertification process, ask occupants to fill-out a survey based on Housing Quality Standards (HQS) along with some additional questions on mold and moisture conditions in their homes. Completing the survey further engages the occupants in their home maintenance. The survey responses will provide additional information to the housing authority on any unreported problems (especially leaks and inoperable fans) that may contribute to an unsafe, unhealthy home environment.

MOLD TESTING

The assessment team maintains that if there is mold inside a building, it 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 snap-shot 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 or poorly done testing, reduces 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 (will open a new browser window)

**Mold**

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

**New York City Department of Health Bureau of Environmental & Occupational Disease Epidemiology** - Guidelines on Assessment and Remediation of Fungi in Indoor Environments  
http://www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html (will open a new browser window)
References

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


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 $(t) \cdot (SE)$.

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

JUNEAU AND HOONAH COMMUNITIES

TECHNICAL HOUSING ASSESSMENT REPORT

EXAMINING MOLD AND MOISTURE CONDITIONS IN HOMES IN JUNEAU AND HOONAH

Executive Summary

Introduction

Section 1: Methodology

Section 2: Glacier Village and Hoonah Housing

Section 3: Findings

Section 4: Technical Discussion and Recommendations

Appendix A: Housing Survey Summary Site Visit Report

Appendix B: Housing Assessment Results
EXECUTIVE SUMMARY

The site assessment team inspected two homes in Juneau in the Glacier Village subdivision, and four homes in Hoonah for moisture and mold conditions. The principal findings include:

Juneau

1. The homes in Glacier Village were no more than three years old and were very well built. They had a custom ventilation system to reduce the potential for moisture problems. High quality ventilation fans were installed in the bathrooms and laundry room, and range hood exhausts were ventilated to the exterior.

2. All Glacier Village homes had metal gutter systems that drained onto splashblocks, and, also, relatively flat sites that conducted water away from the foundations keeping the soil surrounding the homes as dry as possible.

3. Minor and easily resolved insulation problems in the attic and exterior problems were identified on the Glacier Village homes.

Hoonah

1. The inspected homes in Hoonah were all approximately three decades old. Some were in need of substantial repair due to mold problems.

2. Two inspected homes in Hoonah had a partial gutter system to manage rainwater above the entry and front deck; the other two homes did not have gutter systems, as a result, rain water sheds off the roof uncontrolled around the home. Fortunately, the homes have roof overhangs which help shed water away from them.

3. All the homes in Hoonah were situated on top of piers approximately three to four feet above grade. The area beneath the homes was skirted, but not airtight. Although most of these areas below the structures were wet, they were also isolated from the home interiors.

4. The thermal envelope for the base of the structure was the floor system.

5. Two homes had plumbing problems such as leaky vanities and kitchen sinks.

6. Poor or inoperable bathroom exhaust ventilation systems were noted in two homes. Poor bathroom exhaust ventilation can result in significant interior moisture loads, which can increase the potential for mold growth.

7. Bath and laundry fans were exhausted through the soffits. The soffit vent was positioned directly adjacent to the exterior wall so that the warm moist air blew onto
the wall. Adjacent to the vents was a perforated soffit which would allow moist exhaust air to migrate into the attic. There was slight mold on the roof sheathing.

8. Three homes lacked perimeter baffles and had marginally installed attic insulation which precipitated wall to ceiling mold problems.

9. Thermal bridges at corners, window jambs and at the wall to roof junction resulted in cold spots where high humidity or condensation occurred resulting in mold growth.

This report provides technical recommendations and discussions focusing on these items. Appendix A includes a summary of findings from the inspections. Appendix B provides a detailed assessment of each home.
INTRODUCTION

Robert Nemeth of Magna Systems, Inc. conducted a site visit to the Juneau and Hoonah communities on August 23-24, 2004. The Tlingit-Haida Regional Housing Authority (THRHA) administers the housing program for these Southeast Alaska Communities. The site visit provided technical assistance to THRHA in assessing mold and moisture conditions in housing units. This report details findings and recommendations for the homes in Juneau and Hoonah.

The assessment team investigated two homes in Juneau and four in Hoonah. The homes in Juneau were in a new subdivision and all the homes in Hoonah were approximately 30 years old. The primary sources of heat in both the old and new construction were oil-fired boilers with hydronic hot water systems.

SECTION 1 - METHODOLOGY

Visual Inspection

Housing inspections consisted primarily of visual assessment of mold and moisture conditions. The assessment team used forms developed for the Chicago Mold and Moisture Project, a HUD Healthy Homes Program, organized for a room-by-room inspection. The team recorded information on water damage and evidence of mold for all rooms inspected. Additionally, the team inspected the plumbing, localized ventilation, water entry and other moisture source issues in kitchens, bathrooms, crawl spaces, utility rooms and attics.

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

Whenever possible, the team interviewed residents to gather history on moisture problems, plumbing leaks, winter condensation, health issues, number of occupants and other useful information.

Digital photographs visually recorded notable conditions at each home.

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 in this report. The findings from individual home inspections are presented in Appendix B.
SECTION 2 – JUNEAU AND HOONAH HOUSING

JUNEAU

THRHA, established in 1973, is Southeast Alaska’s largest provider of affordable housing. The private non-profit THRHA owns & manages approximately 815 housing units located throughout the region and provides services to both Native and non-Native Alaskan families and seniors. Additionally, over 250 prior tenants have achieved ownership of their homes through THRHA programs. THRHA is completing its second phase of housing at Glacier Village in Juneau’s Mendenhall Valley. This completes 50 affordable, single-family homes for Native and non-Native families. Construction of 16 condominiums has begun. THRHA is in the process of purchasing a 24-unit apartment complex in the Mendenhall Valley and a 10-unit complex in Douglas. THRHA has purchased 180 acres of property, for future developments, and is completing an agreement to purchase 30 acres of land to build over a hundred new units.

HOONAH

Hoonah is located in Yakutat Borough on the northeast shore of Chichagof Island across Icy Strait from the entrance to Glacier Bay. It is about 40 miles west of Juneau. Commercial fishing is the main activity, with a large cold storage facility. Hoonah means "village by the cliff." It is the principal village for the Huna, a Tlingit tribe which has occupied the area for centuries. Hoonah is the largest Tlingit village in southeast Alaska. Commercial fishing and logging have long supported the population, and most residents maintain a subsistence lifestyle. Population in the year 2000 was 860, and the estimated population in July 2002 was 811, indicating a -5.7% change. There were a total of 348 housing units, of which 203 were owner occupied, 97 were renter occupied, and 48 were vacant. Average household size of owner-occupied units was 2.98 persons, and average size of renter-occupied units was 2.53 persons. Eighty-two percent of the homes relied on fuel-oil or kerosene for heating, approximately ten percent heated with wood, and the rest heat with LP gas or electricity.

The assessment team examined housing units selected by housing and maintenance personnel for mold and moisture issues. These units do not represent a typical cross-section of the units under their management since their selection was not based on a random sample.

SECTION 3 – FINDINGS

The differences between the homes visited in Glacier Village (in Juneau) and the homes in Hoonah were distinct. The homes in Glacier Village were no more than three years old while the homes in Hoonah were approximately 30 years old. The new homes had minor problems, whereas the older homes had far more severe problems. One older home had extensive mold growth on interior walls. Mold contamination is always associated with moisture problems. Nine general findings based on the inspection follow:
3.1 Exterior Site Drainage and Rainwater Management

Good site drainage and rainwater management is essential to maintaining dry foundations and houses. The Glacier Village subdivision was relatively flat making drainage from roof surfaces an important issue. All the homes had metal gutter systems that drained onto splash blocks diverting the water away from the foundations.

Two homes in Hoonah had partial gutter systems over the front steps and deck, and the two other homes did not have a gutter system. Site drainage was an issue in Hoonah. In several instances homes were located on hillsides and the grade at the rear of the structure sloped toward the home. Fortunately, the homes in Hoonah sat on piers approximately four feet above grade which eliminated the site drainage problems.

Section 4.1 provides a detailed discussion of site drainage and rainwater management.

3.2 Elevation of House above Grade

The homes in Glacier Village rested on conventional crawl space foundations. The homes were located so close to the ground that crawl space vents were cut through the band joist rather than locating them below the sill plate and underground.

The foundations for the homes in Hoonah consisted of piers surrounded by skirting. This placed the homes approximately four feet above grade and almost completely eliminated site drainage issues.

3.3 Crawl Spaces

The one inspected crawl space in Glacier Village in a recently completed home, ready to be occupied, was an excellent example of how to construct and finish crawl spaces properly. The foundation walls were constructed out of Insulated Concrete Forms (ICFs). The vapor barrier was a thick piece of plastic thoroughly sealed to the perimeter walls and to all interior penetrations, and all seams were sealed. In this unit, access to the crawl space was through a hatch located in the mechanical room which was only accessible to maintenance workers. In the first inspected home, the mechanical room also served as a storage closet and had so much clutter that the access hatch was not accessible.

In Hoonah, the area below two homes was inspected. Both were damp but well ventilated. Neither had a vapor barrier or clutter in the crawl space.

3.4 Winter Moisture Condensation

In Glacier Village, there was no evidence of winter moisture condensation. The walls were 2 x 6 construction and the roof system employed high-heel trusses. In the one inspected and occupied unit, the resident mentioned that there was condensation on a drafty, bedroom window.
In Hoonah, all the inspected homes had problems with winter moisture condensation and associated mold. There was wall to ceiling mold due to thermal bridges and poorly insulated perimeters, mold in cold exterior corners, mold at the base of walls, and water and moisture damage around window and door frames. Condensation occurs when moisture-laden air comes in contact with a building surface that is chilled below the dew point (temperature at which dew begins to form or vapor condenses into a liquid) of the air. This problem indicates a combination of two factors:

- High wintertime moisture load (relative humidity).
- Lower than desired interior temperature.

Lowering the moisture load and/or insulating or heating surfaces to prevent cold surface temperatures can treat the problem. Section 4.3 discusses condensation issues.

**3.5 Bathrooms and Bathroom Exhaust Ventilation**

The bathrooms in Glacier Village had high quality bath fans and extra care had been taken to thoroughly seal the perimeter of the vinyl sheet flooring. In addition to the bath fan there was an intake port that was a part of a constant-ventilation system. Therefore, even if the bath fan was not used, there would be a constant supply of air from within the unit to replace air being exhausted from the bathroom.

Bathrooms experience high moisture loads and often develop localized mold problems which ventilation can reduce by lowering the interior moisture load. The bath fans in the homes in Hoonah all functioned, but with low efficacy. The one bathroom with particularly bad mold problems had a very noisy exhaust fan that the occupants probably did not use for that reason.

Section 4.5 discusses bathrooms and localized exhaust ventilation.

**3.6 Overcrowded Conditions**

Although overcrowding was not a problem in the inspected homes, the moisture level from human sources may contribute to elevated interior moisture loads that can lead to mold contamination from condensation problems.

Discussion of human moisture sources can be found in Section 4.6.

**3.7 Heating Method and Heat Distribution**

All the homes in both Glacier Village and Hoonah had oil-fired boiler systems with hydronic baseboard heating. Heating method and heat distribution play a vital role in preventing wintertime mold and moisture problems. Warm air or water, if hydronic, should be evenly distributed throughout the home. Remote bedrooms often have
problems because they can be colder than the rest of the home, causing water vapor condensation on cold exterior walls, particularly in closets.

Heating systems are discussed in Section 4.7.

3.8 Plumbing Leakage Issues

The homes in Glacier Village did not have any plumbing problems.

The homes in Hoonah did. Plumbing leaks can cause great damage to cabinets, flooring, and structure, and contribute to elevated levels of interior humidity that cause mold. In Hoonah, leaky plumbing beneath vanities and kitchen sinks was common. If left unrepaired, mold grows and the cabinets deteriorate. Although these problems were relatively minor, they could cause significant problems. Occupants should be aware that when these types of problems occur, they should immediately contact housing so the leak can be repaired.

Plumbing problems are discussed in Section 4.8.

3.9 Envelope Leakage Issues

All the homes in Glacier Village and most of the homes in Hoonah were clad with vinyl siding. Minor envelope problems were found on one home in Glacier Village, while several homes in Hoonah had far greater problems. Envelope integrity is always a concern since an envelope that allows air and water infiltration will slowly deteriorate, and an out of sight problem will eventually require costly repairs.

Siding issues are discussed in Section 4.9.

3.10 Maintenance and Lifestyle Issues

Homes in both Glacier Village and Hoonah had some maintenance and lifestyle issues that contributed to mold and moisture conditions.

• All four homes in Hoonah had poorly operating bathroom fans. Bathing produces large amounts of moisture that must be removed from the home. Typically, bathrooms show the first signs of mold growth because of the recurring high moisture load. Maintenance of bathroom fans and replacement of broken fans should be high on the priority list.

• Occupant attention to cleanliness can reduce mold problems. In bathrooms and other wet areas, regular cleaning could keep mold conditions under control. Maintenance issues are discussed in Section 4.10.

• Certain housekeeping habits contributed to mold growth on the interior of the structures: overstuffed closets, windows covered with heavy drapery and
inadequate cleaning regimen can all contribute to mold growth. Modifying occupant lifestyles is as important as solving technical problems. In general, most mold problems can be resolved; however, without addressing occupant lifestyle many mold problems will rapidly resurface.

SECTION 4 - TECHNICAL DISCUSSIONS AND RECOMMENDATIONS

The following discussions and recommendations are based on the nine general findings identified during the site visit to Glacier Village and Hoonah:

4.1 Site Drainage and Rainwater Management

Site Drainage

Site drainage is more of an issue in Glacier Village than in Hoonah. In Glacier Village, the homes have a conventional crawl space foundation. If crawl spaces such as these are wet, even if they are ventilated, the structure above is subjected to high levels of humidity and is much more susceptible to mold.

Site drainage helps maintain a dry home. Poor site drainage typically results in wet foundations and the problems associated with wet foundations. The houses in Hoonah are not as susceptible to poor site drainage because the homes are separated from the ground by piers with skirting around the perimeter, none of which are airtight. The floors of the homes are insulated and are sealed on the bottom of the joists with plywood or an air barrier. With the sealed floor system being located above grade, moisture beneath the structure is not as much a concern as it is in conventional construction.

The following discussion regarding site drainage applies primarily to housing in Glacier Village, although homes in Hoonah would still benefit from adhering to these principles.

Design and build the roof of a building so rain moves out to the edge of the roof, falls on a soil surface, and some will percolate downward through the soil—more in sandy soils and less in clayey soils. The water that does not percolate downward will move along the soil surface following the slope, out to the downhill edge of the site. Houses that allow water to accumulate in the soil in contact with the foundation will develop moisture problems. The best way to prevent mold and moisture problems in houses is to ensure that rainwater moves off the roof, across the site and off the property. In a well-managed property, the soil in contact with the foundation is the driest soil on the site following a rainstorm. Houses with dry foundations (basements, crawl spaces and slabs) are usually dry houses. Two general rules and some specific guidelines to keep the foundation dry by keeping the soil next to the foundation dry:

1. The first general rule concerns concentration – the greatest concentration of water causes the worst damage. A valley on a roof acts like a funnel, with the greatest concentration of water at the base of the valley. Gutters also act like funnels that collect water from the edge of the roof and direct it to the downspouts. On the
land, valleys and swales act like collectors or funnels that concentrate the water on the site. Water management design that makes use of funnels (such as valleys, gutters or swales) requires maintenance to ensure the funnels work as intended. Frequently water damage occurs where a valley, gutter or swale is blocked.

2. The second general rule concerns the ground roof rule - treat the soil surface as if it were a low-slope roof surface. Pitch the ground surface away from the house - the steeper the pitch, the better the drainage. The principle is to move all the water to the low edge of the site. Do not allow areas that can act as water collectors to remain near the building.

Specific site drainage guidelines include:

- Build the house on a crown, not in a hole. If there is sufficient exposed foundation, site grading at the house can be improved. If the house hugs the ground, improvements at the foundation are more difficult. There should be a minimum of eight inches of exposed foundation between the ground and the beginning of the siding.

- Identify localized dips and holes immediately adjacent to the foundation, fill them with dirt, and tamp the fill material to prevent future settling. Use enough of the fill material so drainage occurs away from the foundation.

- If the house has no gutters, then the base of the soil around the house has to act as a gutter. The ground surface should prevent splash back onto the siding of the house and should have enough pitch to effectively move water away from the house.

- Good tamping or compaction of the backfill is very helpful in keeping water on the surface where it can be managed by slope. Soil at the outside corners of the foundation, where the downspouts are usually found, should always be tamped so the corners will not collapse inward.

- Bushes and other plantings can help with drainage if their root balls soak up a large amount of water. They can be planted strategically near downspouts so that downspout extenders are less likely to be kicked off or removed during lawn mowing.

**Rainwater Management**

In most locations rainwater management is critical to maintaining a dry environment surrounding a house’s foundation. In Southeast Alaska, snow and ice buildup on gutters pose special challenges to maintaining functional gutter systems. The houses in Glacier Village all had well installed metal gutter systems. In Hoonah, except for partial gutter systems on two homes, most of the homes did not have gutter systems. Generous
overhangs that shed water away from the home serve these houses better. Site drainage becomes very important if water is not managed as it drains off of roof surfaces.

4.2 Crawl Space Design

Moisture entry and evaporation from foundation sources are major contributors to the moisture load in a house. Because they are rarely visited or inspected and problems go unaddressed, crawl spaces are particularly notorious for leading to foundation moisture problems. When moisture entry is acute, framing and subflooring can deteriorate and support mold. The following points relate to crawl spaces in general, regardless of thermal boundary:

- Ensure crawl spaces have easy access, good lighting, and sufficient headroom to allow for reasonable ease of movement and ability to perform inspections, repairs, and improvements.

- Water in crawl spaces typically comes from poor rainwater management outdoors, plumbing leaks, air conditioner condensate or water softener discharge. Poor rainwater management is by far the leading source of water in crawl spaces.

- Cover crawl spaces with a ground material: a slab of concrete, a polyethylene sheet or other vapor-proof material. The ground cover must be sealed to the foundation walls. Seal all joints and seams. Seal the ground cover to the foundation piers interior to the crawl space.

- Insulate crawl spaces. There are two ways to insulate a crawl space, depending on where the thermal boundary is to be established. The thermal boundary is the building section that separates conditioned space from outside conditions. Insulation can either be placed on the crawl space walls (placing the crawl space inside the thermal boundary) or in the floor of the house (placing the crawl space outside the thermal boundary). If the crawl space contains mechanical systems (plumbing, ductwork), the space should be inside the thermal boundary.
The following discussion on new crawl space design is provided to clarify principles, and to serve as a guide for future construction. First a clear distinction should be made whether the crawl space walls or the floor above the crawl space is the thermal boundary for a home. Insulation on the foundation walls indicates that the foundation walls form the thermal boundary (Figure 1) and that the crawl space is part of the conditioned space. In this case, it is not desirable to provide crawl space ventilation, which is analogous to opening a window in a heated room. If insulation is placed in the floor above the crawl space, then the floor is the thermal boundary, and ventilation can be installed. Mechanicals (plumbing, ductwork) should be inside the thermal boundary in all cases.

**Crawl Space Walls Are the Thermal Boundary**

This crawl space is unvented (Figure 1). It shows an exterior insulation system that allows a shallower frost wall, although the foundation wall may be insulated down to the footing, either on the inside or outside of the foundation wall. The drawing also shows a concrete pad sloped to a sump pump. Should water get into the crawl space, it can be drained and pumped from the crawl space. The concrete pad serves as a ground cover that can be cleaned and is more durable than a polyethylene ground cover.

The crawl space is designed as a stubby basement that is conditioned as a result of ductwork, or in some cases, furnaces being located there. As unvented crawl spaces are not usually allowed by most codes, it may be necessary to add closeable vents in order to obtain a building permit.
Floor above the Crawl Space is the Thermal Boundary

Figure 2: Crawl space with thermal boundary at the floor system

Figure 2 shows a vented crawl space where the subfloor of the home serves as the thermal boundary. The bellyboard membrane seals the home from the crawl space. A small drain to discharge any leaks or overflows from the bathroom and kitchen may be added. No ductwork or piping should be at floor level and run into the crawl space.

Water service piping should be insulated with electric heating tape. Generous venting is required in the foundation walls, with the vents installed well off the ground. Vents installed according to code can only deal with small amounts of moisture. Consequently, it is essential to include a continuous and sealed ground cover to ensure that water drains away from the crawl space.

4.3 Winter Condensation Problems

Condensation occurs when moisture-laden air comes in contact with a building surface that is chilled below the dew point of the air. When this happens, the moisture content of the materials at the location increases, often up to saturation, and mold grows on the surfaces. This problem indicates a combination of two factors:

1. A house with a high wintertime moisture load (relative humidity), and
2. Areas of the building that are below the desired interior temperature.

Two approaches could address this problem:

1. Identify the moisture sources that contribute to the elevated humidity in the house and reduce or eliminate these moisture sources.

2. Identify the cause of the chilled surface and add insulation or airflow improvements to reduce or eliminate the chilling of the surface.

Identifying and reducing moisture sources to lower relative humidity in the winter should be the first step. Moisture sources can include:

- Foundation moisture sources, i.e. wet basements and crawl spaces
- Bathroom moisture sources due to lack of effective localized ventilation
- Human moisture sources resulting from overcrowding.

Several of these moisture sources were identified in the inspected houses that had experienced condensation problems. These moisture sources and recommendations are related to other issues discussed individually in the report, including site drainage and rainwater management (Section 4.1.), crawl space design (Section 4.2.), bathrooms (Section 4.5.), and human moisture sources (Section 4.6.).

Especially in cases with overcrowding in weather-tight homes, adding whole house ventilation can reduce the moisture load in the home. However, consider ventilation after all of the other moisture sources have been addressed.

Maintaining surface temperatures above the dew point temperature is the second approach. Moisture source control should always be considered first, because the lower the relative humidity, the lower the temperature that is tolerable within the home. However, the problem can occur at a reasonable interior humidity if there is a specific construction flaw that allows a surface to get chilled in the winter.

A common condition contributing to winter condensation and mold problems occurs in closets on an exterior wall. The design and use of closets create this common condition, specifically:

- Lack of heat supplied to closets and closed closet doors.
- Lack of airflow in closets, which distributes heat to the closet exterior surface.
- Closet clutter that prevents airflow and heat from reaching the exterior walls.
Clothes hanging against the wall act as insulation and lower the temperature of the wall.

Since a relatively cold room contributes to mold growth, ensuring that the exterior wall of the closet does not get chilled will help prevent this mold growth. Closets should not be cluttered and residents should maintain some distance between the clothes and the exterior wall. Closet doors should be louvered and the room kept at a comfortable temperature. Exterior walls should also be insulated. Again, the moisture load in the house should be kept at a minimum.

The exterior wall/ceiling junctures often experience chilling and subsequent condensation and mold contamination, especially in northern climates in older ranch-style homes with low-pitched roofs.

Three reasons why the exterior wall/ceiling juncture gets cold are (Figure 3):

1. Cold wind may enter through soffit vents and pass through the porous insulation material, degrading its thermal performance.

2. The insulation may have been poorly installed resulting in reduced amounts of insulation in the corner.

3. The geometry of the corner may prevent slow-moving currents of warm air from reaching into the corners.

Dark spots occur on chilled interior surfaces that because of poor insulation. In new construction, use a raised-heel truss and carefully insulate the wall-roof joints. It is difficult to adequately insulate the exterior edge of the attic, especially in homes with low-pitch roofs. With batt insulation, special pusher sticks may be used to push the
insulation out to the edge. With loose fill insulation, the outside edge should be prepared correctly so that it is packed with insulation.

In existing homes, consider retrofitting the wall-roof joint (Figure 4). The work is done from the outside. Remove the soffit material. Install a fiberglass baffle in each cavity space. Push the existing insulation back up against the sheathing or the baffle. Blow in new cellulose insulation or pack in fiberglass insulation into the cavity. Then install pre-cut rectangles of rigid foam insulation to block air flow. If blowing in loose-fill insulation, the rigid foam insulation should be installed first, followed by blown insulation. Use spray-applied foam insulation to keep the rigid rectangle in place. Replace the soffit. If the attic is ventilated, make sure that nothing blocks the baffles.

Many individuals, organizations, and model codes stress the importance of attic ventilation. While it has some benefits, it also has some drawbacks. Wind washing of insulation at the edge is one major drawback. Designs without attic ventilation may improve the performance of the eave area. Most designs without ventilation rely upon the verified airtight ceiling plane for good moisture performance. For more information about the benefits and drawbacks of attic ventilation see “Issues Related to the Venting of Attics and Cathedral Ceilings” at http://www.fpl.fs.fed.us/documents/pdf1999/tenwo99a.pdf.

The retrofit described above is designed to keep the wall/ceiling juncture warm and eliminate the condensation site. These efforts to lower the moisture load in the house and reduce the relative humidity also help prevent wintertime mold and moisture problems.

Some homes in Hoonah consist of two modular units fastened together at the centerline of the home. The longitudinal marriage joint between the two modular units was a common location for mold at the ceiling. The marriage joint structural members are frequently not insulated causing a thermal bridge. To resolve the mold problem on the
interior, insulate this junction in the attic with fiberglass insulation. Lay the insulation over the top of the lumber and between the vertical truss members on each side of the horizontal members.

4.4 Insulate & Air Seal Attic Hatches

A non-air sealed attic hatch is a type of bypass or alternate space through which air can pass. Mold can condense on access hatch blocking if not air sealed. Airseal the hatches with weatherstripping or a gasket (Figure 5). Install latches to lock the hatches in place and provide positive closure.

Insulate the attic hatches to R38 but no less than R19. A lightweight attic hatch may be cut from damaged insulated foam core doors. The door has an R-value around 7. Attach batt insulation to the back of the door panel to achieve the desired R-value. The door panel are often pre-finished, lightweight and requires no additional painting.

4.5 Bathroom, Kitchen, and Laundry Mold Problems

Many common home mold and moisture problems occur in bathrooms, kitchen and laundry rooms due to the presence and use of much water. Keeping these rooms dry depends on care in several areas:

1. Bathroom plumbing should not leak in either the water supply system or the drain-waste-vent (DWV) system. Promptly fix all plumbing leaks. Some hard to detect leaks at the toilet flange or at a shower drain require careful inspection.

2. Use shower curtains so shower water does not splash outside the tub. Do not wet the areas around the toilet. Select and install the surfaces in the bathroom to keep water away from drywall and other materials that may permit mold growth. Wipe up spills promptly and clean dirty and discolored spots. Correct the water problems that may have led to the spotting. Remove and replace damaged drywall. Keeping surfaces clean and dry is primarily the responsibility of the occupants of the home.

3. Some rooms are natural moisture sources due to the nature of their function. Showers are taken in bathrooms resulting in 100% humidity in that room. Kitchens are used for cooking and cleaning. In laundries, clothes dryers must remove large quantities of water from wet clothes. By removing moisture at the source in these areas, exhaust ventilation serves as a source control strategy for reducing the moisture load in a home. 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.

4. Vent bathroom exhaust fans, kitchen exhaust fans, and clothes dryers to the outside rather than into the living space. Venting to the basement, crawl space and attic can lead to moisture problems occurring in these areas. For this reason, localized exhaust ventilation requires ductwork. If the vent discharges through the roof, make sure the vent has an effective check valve to prevent wind blowing back through the vent.

5. Bathroom exhaust fans should exhaust no less than 50 to 70 cubic feet per minute (CFM). The effectiveness of exhaust fans depends 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 airflow through the duct. turns and bends in the ductwork also increase the static pressure and reduce flow. Conversely, a smooth duct provides less resistance and improved flow than ribbed ductwork. Round, smooth sheet metal ductwork is recommended for all types of exhaust ventilation. Generally, a large duct with the fewest bends or elbows, and the shortest duct run, is preferred. A dirty intake grille will also greatly increase resistance and reduce airflow.

6. Noisy exhaust fans are not likely to be used, so select exhaust fans with a low sone rating. To ensure they are used, consider:
   - Exhaust fan hard-wired to the bathroom light.
   - Exhaust fan on a timer, to extend moisture dilution time after showering.

   Good systems have both of these features. The fan is hard-wired to the light, but also runs for a programmed period following bathroom use. (Available from Energy Federation Incorporated, www.efi.org, Fan/Light Time Delay Switch). Residents should be encouraged to always use the bathroom exhaust vent.

4.6 Human Moisture Sources

Human occupation also produces moisture in buildings. Humans are similar to internal combustion engines, and respiration, the act of breathing, produces considerable moisture. Other human activities and preferences also produce moisture:

- Showering
- Cooking
- Cleaning
- Drying laundry indoors
- Accidental spills
- House plants
• Firewood storage
• The use of humidifiers and vaporizers

All of these moisture producing activities contribute to the moisture load in a house.

 Normally, human moisture sources alone do not produce enough moisture to cause winter condensation and mold problems in the winter. However, two circumstances under which human moisture sources may create mold problems include:

1. **Overcrowding** When the number of residents living in a house exceeds the expected capacity of the house, the moisture burden increases. Each person participates in moisture-producing activities (breathing, cooking, washing, etc.), increasing the moisture load. If the number of people living in the home doubles the set capacity of a house, the moisture load from human sources also doubles.

2. **Weather-tight construction** 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 house varies with the house. Some houses are naturally leaky, while others are more airtight. A particularly tight house may exhibit high relative humidity in the winter, which could lead to moisture and mold problems.

When a house 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 house, all other sources of moisture should be identified and minimized. If the problems persist, then the house should be tested for its relative tightness or leakiness using a blower door test. 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 house. This can be accomplished in a number of ways. Installing a good bathroom exhaust fan on a humidistat control might accomplish the goal. If the house has a central forced-air heating system, the existing fan and ductwork can be augmented with a connecting duct to the exterior and controls to provide fresh air circulation. The services of a mechanical engineer with experience in residential ventilation systems would be valuable when addressing a problem of this kind.

### 4.7 Heating Systems and Moisture Control

In winter, heating systems provide occupant comfort. Heating systems also impact winter moisture problems in several ways. Two critical ways follow:

1. The heating system is a major determinant of the temperature of interior surfaces. If heat is inadequate or poorly distributed, some wall and ceiling surfaces may be
chilled near or below the dew point temperature leading to condensation problems. Occupants exacerbate this problem if they close off rooms, cover supply ducts, block airflow to exterior walls, or adjust the thermostat too low.

2. With the exception of electric heat, most heating systems depend on the combustion of fuels. A major byproduct of combustion is water vapor. If a combustion appliance is improperly vented, or not vented at all, then the heating system can contribute significant amounts of moisture into the interior air.

With regard to the first issue, central heating systems are preferred over stationary, single source heating systems, such as propane space heaters and wood stoves. Central heating systems feature ductwork that supply heated air (or heated water to radiators in hydronic systems) to all the major living spaces of the house. A properly designed and functioning heating plant and distribution system keeps all the rooms warm. This minimizes the potential for chilled surfaces, which are potential condensation and mold contamination sites.

Economic reasons sometimes cause residents to limit the heating of spaces such as bedrooms. Although this is understandable, it can also contribute to chilled exterior surfaces and result in condensation and mold growth.

With regard to the second issue, any appliance that burns a fuel, such as gas, fuel oil, or wood, produces moisture. Generally, for every molecule of fuel consumed, two molecules of water vapor are produced. If the combustion gases are not well ventilated to the outside of a home, the appliance can contribute large quantities of moisture into the indoor air. The excessive moisture load in the air can be a major contributor to winter moisture problems in the home.

4.8 Plumbing Problems

There were no plumbing problems in the homes in Glacier Village, but the homes in Hoonah did have problems. The most common problems were found in kitchen and bathroom sink bases, and in mechanical rooms. There should be no leaks in either the water supply system or the drain-waste-vent (DWV) system. Some hard to detect leaks at the toilet flange or at a shower drain require careful inspection and can oftentimes be identified from below (from the crawlspace or basement) well before they become apparent in the bathroom. Left unresolved, subtle leaks can lead to serious problems. Promptly fix all plumbing leaks. Inform homeowners that minor issues, such as small drips, should be repaired quickly before serious damage occurs. Leaks in sink bases can result in a damaged base cabinet and floor system and contribute to increased interior humidity levels which can cause problems elsewhere.

4.9 Envelope Issues

Envelope integrity encompasses the roof, walls, floor, and foundation assemblies of a home. Air and water infiltration through any one of these assemblies can lead to its
deterioration and failure, and contribute to mold problems. Violations of any of these assemblies should be addressed promptly. The primary envelope problems identified during the site visits involved violations of the vinyl siding on the homes in Hoonah. Cracks and holes in the siding, damaged corners and junctions with other wall elements such as doors and windows, and unsealed penetrations around vents and spigots can all allow water into wall systems. Inexpensive vinyl siding is frequently the siding of choice. Unfortunately, vinyl siding is not very durable, repairable, or weather-tight. Repair any violations of the vinyl siding so water can not enter the wall system.

Another problem identified on one of the houses in Hoonah was the use of caulk to seal large gaps between siding and trim. Caulk may work for a short period of time, however, most caulks dry-out and will eventually separate from one or both materials to which it was applied. Use sparingly only high quality caulks. Do not rely on caulk as the first line of defense to keep water out of walls.

4.10 Maintenance Issues

Many moisture problems and consequent mold contamination result from deferred maintenance. Even minor water infiltration problems from plumbing, roofing, or foundation sources that linger can turn into a major mold contamination site, if not repaired quickly. Unfortunately water leaks often go unreported and unattended. Attend to roof and plumbing leaks promptly.

A housing authority's best defense against mold and moisture complaints is its maintenance department. A good proactive maintenance program guards against mold and moisture problems by including the following procedures:

- Perform regular inspections of properties to identify problematic moisture conditions.

- Encourage residents to report moisture problems.

- Respond promptly to identified and reported moisture problems to prevent excessive mold contamination.

Clearly, a prompt response requires a partnership between tenants and the housing authority. Residents must promptly report mold and moisture problems, and maintenance staff must promptly respond to the residents' reports. If either party defers in their responsibility, the list of deferred maintenance items will grow, and small moisture and mold problems will turn into major problems with possibly severe mold contamination. Maintenance staff should be trained in the following items to assist in solving and eliminating moisture and mold problems.

General

- What is mold
- What causes mold
- Other Indoor Air Quality (IAQ) problems
- Sources of moisture
- Moisture assessment procedures

Exterior

- Site drainage
- Maintenance of roof drainage systems (gutters, downspouts, etc.)
- Paving adjacent to homes
- Repair of roofs and roof flashings

Foundations

- Crawl space design issues
- Sump pump system desired, installation, and disposal of water

Attics

- Attic bypasses
- Attic hatches
- Attic ventilation
- Insulation
- Wall/ceiling junctures

Mechanical

- Bathroom and kitchen exhaust fans
- Venting exhaust fans to the exterior
- Plumbing leaks
- Humidifiers
- Unvented appliances

Mold Remediation

- Clean-up
- When to call for outside help

At the same time, occupants should be aware of their crucial role in preventing mold and moisture problems. A number of occupant issues bear directly on the causes and severity of moisture and mold problems. Occupants should receive training on the following topics to assist in solving and eliminating moisture and mold problems in their homes.

- What is mold and what causes it
• Use of exhaust fans
• Regular bathroom cleaning
• Avoidance of clutter in critical locations (exterior walls of closets, etc.)
• General housekeeping
• Use of crawl spaces
• Gutter and downspout maintenance
• Difference between plumbing leaks and water condensation on pipes
• Use of sump pumps
• Humidifiers and dehumidifiers

4.9 Remodel & New Construction Recommendations

The following are some recommendations for rehabilitation and new construction projects for Southeastern Alaska Communities.

On the Exterior of the House

• Siting & elevation of house
  See Section 4.1 - Site Drainage and Rainwater Management

• Gutter and drainage systems
  See Section 4.1 - Site Drainage and Rainwater Management

• Foundation waterproofing and drainage for new construction

Keeping soil dry next to a foundation is the preferable approach for maintaining a dry basement or crawl spaces. However, there are occasions where this may not be possible and a good second line of defense is to use a high quality waterproofing membrane on the exterior face of the foundation wall. There are many towel or spray applied products on the market. Once applied, these products create a monolithic and highly flexible membrane with crack-bridging properties (e.g. www.appliedtechnologies.com, or www.carlisle-ccw.com). These membranes should be protected with either a geotextile covering (e.g. http://www.deltams.com/deltadrain/) or rigid insulation (e.g. DOW Styrofoam Perimate) before backfilling.

In addition to carefully waterproofing foundation walls, install drain tiles at the base of the foundation walls to dispose of water that has drained down the face of the wall. Usually this tile is connected to the sump pit, or if possible, run to daylight.

Properly sealing and draining crawl spaces or basement foundation walls is as important as properly installing shingles on a roof. Unfortunately, foundation
walls are frequently not provided the same attention that roofs are. Roofs are visible and everyone understands that a leaky roof will result in a host of problems. On the other hand, foundations are below grade and not visible, and thus do not appear to be as important as roofs. However, this belief is incorrect. It does not matter whether moisture comes from above or below. All unwanted moisture should be kept outside the building structure. Although foundation leakage may not result in obvious water spots on the ceiling such as from a roof leak, water from a foundation leak can cause structural damage, contribute to mold growth, and compromise habitable spaces. The importance of properly sealing and draining foundations cannot be overemphasized.

- Siding options for new construction and remodel projects

Consider the following criteria when selecting the siding for a structure:

- Performance (maintainability, durability, repairability, permeability, etc.)
- Aesthetics
- First-cost
- Life-cycle-cost

Frequently the selection of siding is based on lowest first-cost. The housing authority should carefully scrutinize siding options and consider all factors not just cost. Investing a little more initially can result in significant savings later. A life-cycle-cost analysis should be conducted to justify the selection process.

**On the Interior of the House:**

- Toilet tank condensation problems

One common problem in several Indian communities is mold and the deterioration of drywall behind toilet tanks. Due to condensation on the outer surface of the toilet tank, the adjacent wall area is often wet. Since the wet wall behind the toilet tank is difficult to clean, due to limited access, mold grows and the wall deteriorates.

There are two ways to mitigate this problem:

1. Install a toilet with an insulated tank. The insulation results in higher toilet tank surface temperatures and thus less surface condensation.

2. Supply both hot and cold water to the toilet through a mixing valve. The increased water temperature inside the tank will result in less surface condensation. The supply of hot and cold water through a mixing valve has been implemented at several Indian housing communities with positive results.

- Insulate all plumbing supply lines
The temperature of water supplied to Indian housing in the northern United States is very cold. Uninsulated water supply pipes in the basement or crawl spaces can drip water due to condensation on their surface, contributing a significant amount of water to the interior moisture load. Insulate all hot and cold supply piping; the hot water lines for energy conservation, the cold water lines to eliminate condensation.

- Ceiling finishes

If the ceiling has a rough textured finish, cleanup of mold growing at the wall to ceiling junction is very difficult, if not impossible. It is highly recommended that ceilings be finished with a smooth or a skip-trowel finish in lieu of a rough popcorn finish.

- Drainage of condensate

One of the by-products of high-efficiency furnaces is water. During winter months, when the furnace is running frequently, these units produce a significant amount of water. This water should be either drained directly to the exterior, or into a condensate pump which then pumps the water to a drain or exterior, or into the sump pit from where it can then be pumped to the exterior.
## Appendix A: Juneau and Hoonah Communities

### Site Visit Summary Report

**Date:** August 23-24, 2004

<table>
<thead>
<tr>
<th>Inspection Number</th>
<th>Address</th>
<th>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>Leaks from Exterior</th>
<th>Wet Basement or Crawlspace</th>
<th>Kitch. Plumbing Problems</th>
<th>Bath Plumbing Problems</th>
<th>Bathroom Problems</th>
<th>B1R Exhaust Ventilation Problems</th>
<th>Kitch. Exhaust Ventilation Problems</th>
<th>Exterior Wall/Ceiling Problems</th>
<th>Attic Problems</th>
<th>Visible Mold (Column #)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1</td>
<td>Glacier Village</td>
<td>3 years</td>
<td>2A: 2C</td>
<td>Concrete block crawl space</td>
<td>Ranch: 2X6</td>
<td>Oil fired boiler with hydronic heat</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>None</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2</td>
<td>Glacier Village</td>
<td>New Vacant</td>
<td>ICF block crawl space</td>
<td>Ranch: 2X6</td>
<td>Oil fired boiler with hydronic heat</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>DNV</td>
<td>None</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>Hoonah</td>
<td>29 years</td>
<td>3A: 1C</td>
<td>Piers wiskirting</td>
<td>Ranch: 2X6</td>
<td>Oil fired boiler with hydronic heat</td>
<td>Yes</td>
<td>System Absent</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>15, 16, 19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-2</td>
<td>Hoonah</td>
<td>29 years</td>
<td>2A: 2C</td>
<td>Piers wiskirting</td>
<td>Ranch: 2X6</td>
<td>Oil fired boiler with hydronic heat</td>
<td>Yes</td>
<td>System Absent</td>
<td>Yes</td>
<td>DNV</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>DNV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-3</td>
<td>Hoonah</td>
<td>29 years</td>
<td>*DNV</td>
<td>Piers wiskirting</td>
<td>Ranch: 2X6</td>
<td>DNV</td>
<td>Yes</td>
<td>Yes</td>
<td>DNV</td>
<td>Yes</td>
<td>DNV</td>
<td>DNV</td>
<td>DNV</td>
<td>DNV</td>
<td>DNV</td>
<td>DNV</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>2-4</td>
<td>Hoonah</td>
<td>31 years</td>
<td>2A: 1C</td>
<td>Piers wiskirting</td>
<td>Ranch: 2X6</td>
<td>Oil fired boiler with hydronic heat</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>DNV</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>16, 19</td>
<td></td>
</tr>
<tr>
<td>6 Homes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* DNV = Did Not View
Appendix B-Juneau and Hoonah Communities Technical Housing Assessment Report  August 23-24, 2004

Inspection Number: 1-1
Address: Glacier Village
Model Type: Ranch
Foundation: Concrete block crawl space
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired boiler
Bedrooms: 3
Occupancy: 4
Age: 3

Mold and Moisture Conditions: There was no mold in this home, however, several conditions were identified that may eventually lead to mold problems.

Site Drainage and Rainwater Management: A well installed metal gutter system that drained onto splash blocks was present.

Foundation Conditions: The home rested on a concrete block foundation wall above a crawl space. Access to the crawl space was through a hatch in the cluttered mechanical room. The crawl space was not inspected.

Exterior Conditions: Several minor problems were identified on the exterior of the building. Soffit material was loose (Figure 2), one of the wall caps was not tight to the wall (Figure 3) and one flashing boot around a plumbing stack was not secured to the roofing material (Figure 4).

Bathroom: A high quality bath fan was present and extra care had been taken in securing and sealing the perimeter of the sheet good materials covering the floor.

Kitchen: The electric stove had a range hood that exhausted to the exterior. Everything was in good condition.

Interior Conditions: The homeowner complained that one bedroom window was very drafty. There was a trickle vent at the base of a dusty window (Figures 5 & 6). The interior of the unit was in good condition.
**Attic:** There was approximately ten to twelve inches of fiberglass insulation in the attic. The laundry exhaust had an insulated duct connected to the fan housing that rose vertically approximately two feet and then turned back down to the top of the insulation and transitioned to a smooth metal duct (Figure 7). The metal duct was uncovered for approximately five feet and then covered with fiberglass insulation the rest of its length. In several locations, top plates were exposed where electrical cables dropped into the walls (Figure 8). There were also a few places where insulation was missing (Figure 9). Roof sheathing looked good.

**Occupant Notes:** Two adults (one smoker) and two children lived in the home. Both children had asthma and one had allergies.

**Discussion/Recommendations:**

On the Exterior:

1. Refasten loose soffit material.
2. Reattach loose wall exhaust cap.
3. Investigate why the plumbing boot is wrinkled. The concern is that wind driven rain could be blown beneath the boot and migrate into the roof structure.
4. The vinyl siding details at the head of the windows potentially could leak into the wall (Figure 10). Water draining down the siding could migrate behind the siding. Vinyl siding is not known for its water tightness. Flashing details behind the siding become very important in situations such as this.

On the Interior:

1. Cover the exposed metal duct in the attic with insulation.
2. Foam all electrical penetrations through the top plates in the attic and then cover with insulation making sure to eliminate all voids.
3. Insulate areas missing insulation in the attic.
4. The drafty window that the resident mentioned was inspected but nothing obvious was amiss. To simulate different pressures between the inside and outside, use a blower door and inspect the window when the house is depressurized. Using a smoke stick on the outside should disclose where the leaks are. Repair as necessary.

5. Inspect the crawl space. Make sure the band joist is well insulated. One area of concern is around the crawl space vents. Based on the elevation of the vent on the exterior, it appears that the vent is through the band joist (Figure 11). Make sure the sub-floor above the crawl space vent has rigid insulation attached to it to keep the floor warm.

Figure 11: Crawl space vent
Inspection Number: 1-2
Address: Glacier Village
Model Type: Ranch
Foundation: ICF crawl space
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired boiler
Bedrooms: 3
Occupancy: Vacant
Age: New

Mold and Moisture Conditions: There was no mold in this new vacant home.

Site Drainage and Rainwater Management: A metal gutter system that drained onto splash blocks was present. At the rear of the duplex one gutter emptied into another lower gutter presenting a potential problem (Figure 2).

Foundation Conditions: The home rested on an Insulated Concrete Form (ICF) block foundation wall above a crawl space. Access to the crawl space was through a hatch in the mechanical room (Figure 3). The crawl space had an exceptionally well installed vapor barrier and contained an exhaust and fresh air supply ventilation system (Figure 4).

Exterior Conditions: The fuel oil tank for the residence was at the rear of the structure (Figure 5). The fuel oil lines connecting the tank to the residence were exposed and susceptible to damage (Figure 6).

Bathroom: A high quality bath fan was present and extra care had been taken in securing and sealing the perimeter of the sheet good materials covering the floor.

Kitchen: The electric stove had a range hood that exhausted to the exterior.

Interior Conditions: The duplex was brand new.
Attic: The attic was not inspected.

Occupant Notes: Vacant unit.

Discussion/Recommendations:

On the Exterior:

1. Fasten a housing over the exposed fuel oil lines to prevent them from being damaged.

2. During a rainstorm, observe the questionable downspout at the rear of the structure to see if it functions adequately. If there is overflow on the lower gutter, provide a separate downspout for the upper gutter.

On the Interior:

1. This home was very well built. If properly maintained, it should serve residents well for many years. The custom ventilation system housed in the crawl space, the high quality fan in the bathroom, and the range hood that is exhausted to the exterior should all contribute to a dry and mold-free interior.

2. Locating the crawl space access hatch in the mechanical room, which is only accessible to maintenance staff, was a wise decision. The integrity of the mechanical systems and the vapor barrier will not be violated by residents using the crawl space as a storage space.
Inspection Number: 2-1
Address: Hoonah
Model Type: Ranch
Foundation: Piers w/Skirting
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired boiler
Bedrooms: 3
Occupancy: 4
Age: 29 years

Mold and Moisture Conditions: There was extensive mold in this home. The bathroom had mold on the walls and ceiling (Figure 2 & 3), the closets had mold in them (Figure 4), and there was significant mold at the perimeter wall to ceiling junction (Figure 5).

Site Drainage and Rainwater Management: There was no gutter system. The rear of the site sloped toward the home.

Foundation Conditions: The home was on piers with skirting around the perimeter.

Exterior Conditions: The exterior of the residence was in bad condition. The cracked vinyl siding was installed in 1997, and was loose at the corners (Figures 6 & 7). The skirting cap channeled water toward the home and was coming loose (Figure 8).

Bathroom: The bathroom ceiling above the tub was covered with mold. The base of the walls at both ends of the tub was water damaged and moldy, and the area surrounding the toilet had mold. Water was on the floor at the base of the toilet, and the toilet was not secure to the floor.

Kitchen: The electric stove had a range hood that exhausted to the exterior. The kitchen sink drain had an electrical tape repair. There was some water damage to the base of the cabinet.
**Interior Conditions:** There was mold in the closets and at the wall to ceiling junction. The dryer vent was clogged (Figure 9).

**Attic:** The attic had soffit and gable-end vents. Approximately ten inches of fiberglass batt insulation was in the attic, but was held back from the perimeter. Insulation baffles along the perimeter were not present.

**Occupant Notes:** Three adults and one child lived in this house. Two adults were smokers but smoked outside. Two individuals had asthma, and one also had respiratory problems and allergies.

**Discussion/Recommendations:**

**On the Exterior:**

1. The vinyl siding needed to be repaired and at several locations water could enter the wall system. The entry of bulk water through violations in the siding could lead to rot and deterioration of wall components.

2. The skirting needed to be removed and reinstalled properly.

3. Although the home is up on piers and somewhat decoupled from conditions at grade, having a wet environment beneath the structure is undesirable. Grading at the rear of the structure could be improved so that water sheds to the sides of the home.

4. The location of bath and laundry vents in the soffit next to the exterior wall and adjacent to the soffit vents is undesirable (Figure 10). Reorient the vents to blow outward and replace the perforated soffit material next to the vents with non-perforated soffit material to keep moist exhaust from migrating into the attic.

5. Clean the clogged dryer vent so that it closes properly.

6. The rust on the boiler flue is either from condensation or leakage from the exterior (Figure 11). Inspect the roof flashings around the flue. If the problem stems from condensation problems, it could be due to the type of vent system used. If it is an A-type (single wall) vent, replace it with a B-type (double wall) vent.

**On the Interior:**

1. Most of the bathroom drywall is beyond cleaning and will need removed. After it is removed, inspect, clean, and repair the walls as needed.
2. Replace the existing bath fan with a high quality fan operated with the light switch. Use an insulated duct to vent the fan.

3. Considering that the toilet is loose and the floor surrounding the toilet wet, the subfloor below the toilet has probably been compromised. Remove the sheet good flooring, inspect and repair the subfloor, and install new flooring as needed.

4. In the attic, install insulation baffles between trusses and fill the area between the baffle and top plate with insulation. While in the attic, seal and insulate all bypasses.

5. First clean with soap and water all the moldy closet walls and wall to ceiling junctions. If the drywall is not cleanable, remove the drywall, inspect, clean and repair the interior of the wall as necessary, and then reinstall drywall.

6. The dryer duct was concealed beneath cloths that had fallen behind the dryer. Inspect the dryer duct for its integrity and proper installation. Clean the exterior vent so that it can close properly.
Appendix B-Juneau and Hoonah Communities Technical Housing Assessment Report  August 23-24, 2004

Inspection Number: 2-2
Address: Hoonah
Model Type: Ranch
Foundation: Piers w/Skirting
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired boiler
Bedrooms: 3
Occupancy: 4
Age: 29 years

Mold and Moisture Conditions: There was extensive mold in this home. The bathroom had mold on the walls and ceiling (Figure 2 & 3), the closets had mold in them, and mold was at the perimeter wall to ceiling junction throughout the home (Figure 4).

Site Drainage and Rainwater Management:
There was no gutter system, thus the drainage around the home was poor.

Foundation Conditions: The home rested on piers with skirting around the perimeter.

Exterior Conditions: The exterior of the residence was clad in vinyl siding which had problems. Water could infiltrate the walls at areas where siding was missing (Figures 5 & 6). The home also had skirting problems (Figure 7). It appeared to be falling away from the structure and at several points created a ledge that drained water back toward the home.

Bathroom: The ceiling above the tub had mold and water spot stains from condensation. The area behind the toilet had mold.

Kitchen: The electric stove had a range hood that exhausted to the exterior. The kitchen sink drain had an electrical tape repair (Figure 8).
**Interior Conditions:** Several rooms had mold at the wall to ceiling junction. Water was on the floor between the boiler and hot water heater (Figure 9). The resident reported that the two year old windows were very drafty and that during the winter a lot of condensation formed on the window surface. The gasket that secures the glazing to the sash was old and cracked (Figure 10).

**Attic:** The attic had soffit and gable-end vents. There was approximately ten inches of fiberglass batt insulation in the attic, but in several locations the insulation was shoved tight to the roof sheathing along the perimeter and was not tight to the roof trusses. Insulation baffles along the perimeter were not present. There was some slight mold on the roof sheathing above the uninsulated access hatch.

**Occupant Notes:** Two adults and two children lived in this home. The two adults were smokers but smoked outside.

**Discussion/Recommendations:**

**On the Exterior:**

1. Repair the vinyl siding. At several locations water could enter the wall system. The entry of bulk water through violations in the siding could lead to rot and deterioration of wall components.

2. Remove and reinstall the skirting properly.

3. Although the house is up on piers and somewhat removed from conditions at grade, having a wet environment beneath the structure is undesirable. Grade should channel water away from the home, not below it.

4. The location of bath and laundry vents in the soffit next to the exterior wall and adjacent to the soffit vents is undesirable (Figure 11). Reorient the vents to blow outward and replace the perforated soffit material next to the vents with non-perforated soffit material to keep moist exhaust from migrating into the attic.

**On the Interior:**

1. Clean the drywall in the bathroom which may not need removal. Replace the existing bath fan with a high quality fan operated with the light switch. Use an insulated duct to vent the fan.
2. Install insulation baffles along the perimeter of the attic and tuck the insulation tight to the trusses. While in the attic, seal and insulate all bypasses. Insulate the attic hatch and have an air seal along the perimeter.

3. The mold at the wall to ceiling junction will be difficult to clean because of the popcorn finish on the ceiling. Scrape off the popcorn finish of the ceiling which will remove most of the mold in the process. Clean the remaining mold with soap and water. Insulating the perimeter of the attic as well as possible, along with controlling interior humidity, should mitigate the wall to ceiling mold problems.

4. Repair the plumbing leak in the mechanical room. This leak contributes to interior humidity problems.

5. Repair the kitchen sink waste piping.

6. Investigate the drafty windows. Using a blower door to create pressure differentials on the inside of the window to the outside should help disclose what, and how much, is leaking. Although only two years old, the seals along the perimeter of the window appear very old and dried out.
Inspection Number: 2-3
Address: Hoonah
Model Type: Ranch
Foundation: Piers w/Skirting
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired boiler
Bedrooms: Unknown
Occupancy: Unknown
Age: 29

Mold and Moisture Conditions: The occupant was not present, therefore the interior was not inspected.

Site Drainage and Rainwater Management: A partial gutter system above the front door steps did not have a downspout (Figure 2). The home was built on a slope and the hillside at the rear of the home drained toward the home (Figure 3).

Foundation Conditions: The home rested on piers (Figure 4) with skirting around the perimeter.

Exterior Conditions: The exterior of the residence was clad in vinyl siding which was in good condition.

Bathroom: Not inspected
Kitchen: Not inspected
Interior Conditions: Not inspected.
Attic: Not inspected.

Occupant Notes: Not interviewed

Discussion/Recommendations:

1. Grade at the rear of the structure so water sheds to the sides of the home.

2. Extend the gutter to the end of the roof and install a downspout. Install a gutter on the rear high-side of the property to reduce the amount of moisture currently draining beneath the structure.
Inspection Number: 2-4
Address: Hoonah
Model Type: Ranch
Foundation: Piers with Skirting
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired boiler
Bedrooms: 3
Occupancy: 3
Age: 31 years old

Mold and Moisture Conditions:
This home had minor mold. The bathroom tub surround had mold on some seams (Figure 2). There was wall to ceiling mold along the home perimeter kept in check by the homeowners’ cleanliness.

Site Drainage and Rainwater Management:
The partial plastic gutter system was missing a downspout (Figure 3). The grade at the front of the home shed water toward the home, passed it beneath, and on beyond the home.

Foundation Conditions:
The home rested on piers with skirting around the perimeter.

Exterior Conditions:
The exterior of the residence was clad in vinyl siding. One small section of soffit material was missing (Figure 4).

Bathroom:
Some seams of the tub surround and behind the toilet had mold. The vanity waste was connected with a flexible waste pipe (Figure 5). The fan functioned ineffectively. The fan grill was clogged with lint.

Kitchen:
The electric stove had a range hood that exhausted to the exterior. The kitchen sink had a flexible waste pipe connection (Figure 6).

Interior Conditions:
Wall to ceiling mold was along the perimeter of the home, but was kept in check by the homeowners’ cleanliness. Ghosting, darkened lines along rafters on the master bedroom ceiling (Figure 7), probably due to storing personal possessions in the attic (Figure 8), compromised the insulation’s effectiveness.
Attic: The attic had soffit and gable-end vents. Approximately ten inches of fiberglass batt insulation was in the attic, but was compromised in several areas due to boxes and other clutter resting on top of it. The attic hatch was not insulated.

Occupant Notes: Two adults and one child lived in this home.

Discussion/Recommendations:

On the Exterior:

1. Repair the gutter system.

2. Replace the section of missing soffit material.

On the Interior:

1. Clean the bath fan grill and test the fan for its effectiveness.

2. Remove the tub surround, inspect and repair the walls as needed, and install a new tub surround.

3. There were no insulation baffles along the attic perimeter and the insulation did not extend all the way to the top plates (Figure 9). Install insulation baffles and push insulation tight to the baffle. Properly insulating this area and controlling interior humidity should mitigate wall to ceiling mold.

4. Replace the flex pipe waste beneath the vanity and kitchen sink with standard PVC waste pipe. The flex pipe is much more prone to clogging and more vulnerable to damage than standard PVC pipe.

5. Advise the residents that if they use the attic as a storage area, construct a platform above the insulation to prevent compression and compromise.

6. Insulate the attic hatch and provide an air seal along the perimeter.