SEMINOLE TRIBE TRIP REPORT
Assessment of Mold and Moisture Conditions

Final Report

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Office of Native American Programs

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BACKGROUND INFORMATION

The Seminole Reservation and Trust Land is located in parts of Broward, Collier, Charlotte, Okeechobee, Clay, Collier, Columbia, and Miami-Dade counties in the State of Florida. The reservation and trust lands are comprised of six main sites: Hollywood reservation, Big Cypress Reservation, Immokalee Reservation, Brighton Reservation, and Trust Land in Temple and Fort Pierce. The average annual precipitation is 63.6 inches. The average annual snowfall is 0 inches. The average annual maximum temperature is 90.7°F and the average annual minimum temperature is 57.8°F. Approximately 5,678 Native Americans reside on the Seminole Reservation and Trust Land. The housing authority maintains 409 homes for the Tribe, of which 154 are Low Rent and 255 are Mutual Help. Thirty-five units remain in the development stage under the 1977 Housing Act Program.

The assessment team responded to a request from the Eastern Woodlands Office of Native American Programs to assess site and housing conditions contributing to mold and moisture problems at the Seminole Reservation. The Executive Director of the Housing Authority requested technical assistance to address mold and moisture conditions and mold testing. The assessment team visited seven homes, including three conveyed homes, three newly constructed homeownership homes, and one manufactured home. All three conveyed homes were unoccupied. The family living in the manufactured home had been relocated until a new replacement home could be built. This family was relocated because of mold and moisture problems and health complaints. Except for the manufactured home, all the homes were slab on grade with concrete block walls and central air-conditioning. The homes ranged in age from newly constructed to approximately thirty years old. All the homes were a ranch style design.
PART I

SEMINOLE TRIBAL HOUSING AUTHORITY TRIP REPORT

INTRODUCTION

Kate Brown from the Building Research Council (BRC) at the University of Illinois Urbana-Champaign and Paul Knight from Magna Systems, Inc. conducted a site visit at the Seminole Tribal Housing Authority on October 26-30, 2003. The Seminole Tribal Housing Authority administers the housing program for the Seminole Tribe of Florida. The site visit provided technical assistance to the housing authority 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: Seminole Tribal Housing Authority Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes on the Seminole Reservation and Trust Lands.

BACKGROUND INFORMATION

The Seminole Reservation and Trust Land is located in parts of Broward, Calhoun, Charlotte, Citrus, Clay, Collier, Columbia, and Miami-Dade counties in the State of Florida. The reservation and trust lands are comprised of six main sites: Hollywood Reservation, Big Cypress Reservation, Immokalee Reservation, Brighton Reservation, and Trust Land in Tampa and Fort Pierce. The average annual precipitation is 63.6 inches. The average annual snowfall is 0 inches. The average annual maximum temperature is 90.3 °F and the average annual minimum temperature is 57.8 °F. Approximately 5,678 Native Americans reside on the Seminole Reservation and Trust Land. The housing authority maintains 409 homes for the Tribe, of which 154 are Low Rent and 220 are Mutual Help. Thirty-five units remain in the development stage under the 1937 Housing Act Program.

The assessment team responded to a request from the Eastern/Woodlands Office of Native American Programs to assess site and housing conditions contributing to mold and moisture problems at the Seminole Reservation. The Executive Director of the Housing Authority requested technical assistance to address mold and moisture conditions and mold testing. The assessment team visited seven homes, including three conveyed homes, three newly constructed homeownership homes, and one manufactured home. All three conveyed homes were unoccupied. The family living in the manufactured home had been relocated until a new replacement home could be built. This family was relocated because of mold and moisture problems and health complaints. Except for the manufactured home, all the homes were slab on grade with concrete block walls and central air conditioning. The homes ranged in age from newly constructed to approximately thirty years old. All the homes were a ranch style design.

Day 1: Sunday, October 26, 2003

Sunday was a travel day.
Day 2: Monday, October 27, 2003

The assessment team arrived at the Seminole Tribal Office in Hollywood, Florida on Monday morning. The team met with Peggie Reynolds, Assistant Director of Housing, Dorian Lang, Administrative Secretary, and Aaron Billie, Construction Manager to discuss the day’s activities, outline the team’s role while on the reservation, and address the housing authority’s concerns regarding the site visit. The housing staff presented the specific mold and moisture issues that the housing authority had been handling. Of specific concern were the issues of new construction, whether or not to test for mold, and handling occupants practices. Of the seven homes investigated, one household had been relocated because of mold and moisture conditions and health complaints by the occupants.

The Seminole Tribal Housing Authority selected the properties to be inspected and Aaron Billie coordinated the logistics for the site visit. Following the meeting, the assessment team guided by Aaron Billie, construction manager; Bob Green, Hollywood construction supervisor; Steve Simonton, plumber; Anthony Castrenze, electrician; Darren Kolensky, acting maintenance supervisor; Jackie Jones, construction secretary; Dorian Lang, administrative secretary; Jeremy Bowers, carpenter; and Renee Santiago, painter inspected three homes on the Hollywood Reservation.

Day 2: Tuesday, October 28, 2003

On Tuesday morning, the assessment team accompanied by Aaron Billie, Ray Collier, Brighton, Steve Simonton, Anthony Castrenze, Frank Thomas, Jackie Jones, and Dorian Lang, inspected four homes on the Brighton Reservation.

Day 3: Wednesday, October 29, 2003

On Wednesday morning, the assessment team met with Peggie Reynolds and Dorian Lang to discuss findings from the housing inspections, occupant issues, and preparation for the training session. A training session was presented to staff. The team used a power point presentation to address specific issues identified on the Hollywood and Brighton Reservations. The topics included:

- What is Mold and What it Needs to Grow
- Definition of Moisture Loads and Identification of Sources of Moisture
- Impact of Building Construction and Design on Moisture Sources
- Discuss the Findings on the Reservation and Problem Solving Strategies
- Mold Remediation
- Occupant Issues
- Mold Testing Issues

Day 4: Thursday, October 30, 2003

Thursday was a travel day.
Digital photographs were taken to record conditions in all seven homes. The inspection process also involved visual assessments of both interior and exterior conditions. *PART II: Seminole Tribal Housing Authority Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes on the Seminole Reservation and Trust Land* provides a detailed analysis of findings and recommendations for the homes investigated at the Hollywood and Brighton Reservations.

**Mold Testing**

The housing authority questioned when to test for mold and balancing occupant health and safety given the high cost of mold testing. The assessment team's answer was; if there is mold inside a building, it needs to be cleaned up. Normally, it is not necessary to identify the species of mold growing in a residence. There is no baseline of acceptable or unacceptable mold concentrations in a home. This message is consistent 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* position on testing is:

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:* American College of Occupational and Environmental Medicine, states that to successfully remediate mold and moisture conditions, the water and moisture sources must be identified and corrected.

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

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

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

Mold testing is often expensive. If testing is unnecessary or done poorly, the money will not be 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**


The Housing Authority Actions

The Housing Authority used excellent housing management and maintenance practices. The staff was very organized and helpful during our site visit.

FINDINGS

An overview of findings and recommendations for the site visit follows. PART II: Seminole Tribal Housing Authority Technical Housing Assessment Report provides a more detailed discussion and analysis of the findings.

Seminole Reservation

Principal findings from the site inspections include:

1. New homes are being constructed so that mold and moisture should not be a problem. Attic insulation installation can be improved for better thermal performance.

2. Mold is not a chronic problem in STHA housing. There are isolated mold incidents and the reasons for it are generally apparent.

3. Site drainage can be improved at the inspected existing homes. Site drainage appeared to be good at the new construction sites.

4. Gutter systems appeared to be optional. When present on existing homes, gutter systems could be improved.

5. Bathroom and kitchen exhaust ventilation can be improved in both existing and new homes.

PROGRAMMATIC RECOMMENDATIONS

A particular challenge to all housing authorities is the development of a prompt and effective service delivery system to address mold and moisture conditions. This requires a partnership between the housing authority and residents with a system that includes training for the maintenance staff on how to implement the technical recommendations and training for residents on their roles and responsibilities as homeowners and tenants. The housing authority has already taken excellent action steps to create a partnership.
Additional steps to supplement their program could include formalized methods for addressing mold problems and maintenance issues as they occur. For example:

1. Mandatory attendance at annual homeowner/tenant clinics as part of the annual recertification process. At these clinics, provide instruction on home maintenance issues, such as identifying and repairing leaks, using exhaust fans and maintaining gutters.

2. During the annual recertification process, ask occupants to complete a survey based on Housing Quality Standards (HQS) with additional questions on mold and moisture conditions in their homes. Completing the survey further engages residents in their own home maintenance. Furthermore, the survey responses provide additional information to the housing authority on unreported problems, especially leaks and inoperable fans that might contribute to an unsafe, unhealthy home environment.
Attachment 1

SEMINOLE TRIBAL HOUSING AUTHORITY

TECHNICAL HOUSING ASSESSMENT REPORT

EXAMINING MOLD AND MOISTURE CONDITIONS IN HOUSING ON THE SEMINOLE RESERVATION AND TRUST LAND

Executive Summary

Introduction

Section 1: Methodology

Section 2: Seminole Indian Reservation Housing

Section 3: Findings

Section 4: Technical Discussion and Recommendations

Appendix A: Housing Survey Summary Site Visit Report

Appendix B: Housing Assessment Results
PART II
SEMINOLE TRIBAL HOUSING AUTHORITY
TECHNICAL HOUSING ASSESSMENT REPORT
EXAMINING MOLD AND MOISTURE CONDITIONS IN HOMES ON THE SEMINOLE RESERVATION AND TRUST LAND

Executive Summary

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Section 4: Technical Discussion and Recommendations

Appendix A: Housing Survey Summary Site Visit Report

Appendix B: Housing Assessment Results
EXECUTIVE SUMMARY

Seven homes were inspected for mold and moisture problems for the Seminole Tribal Housing Authority (STHA). The STHA administers the housing program for the Seminole Indian Tribe. The investigation was conducted from October 27th through October 30th, 2003, by Kate Brown (Building Research Council) and Paul Knight (Magna Systems). A training session regarding mold and findings from the seven homes was also provided by the team to STHA staff.

STHA administers 409 housing units at six main sites: Hollywood Reservation, Big Cypress Reservation, Immokalee Reservation, Brighton Reservation, and Trust Land in Tampa and Fort Pierce. The team visited existing and new homes under construction on the Hollywood and Brighton reservations.

STHA had two objectives for requesting this site visit. First, STHA was interested in knowing if potential mold and moisture problems were being created as a result of their new construction practices. Secondly, STHA was interested in having mold in their existing housing assessed.

Three new homes under construction and four existing homes were visited. The floor slab had been poured in one new home, the building was closed-in at the second home and finishing work was being done in the third home.

One of the four existing homes was undergoing a total rehab at the time of the site visit; mold was not an issue in the home. Two of the existing homes were vacant as a result of severe mold. The fourth home, a manufactured home, was also vacated due to mold, but was not as severe as the other two homes. Occupants were not available for interviews at any of the homes.

New home construction methods as well as rehab construction practices used should prevent mold problems.

The severe mold problems in two inspected homes resulted from plumbing leaks. The mold in the manufactured home appeared to be related to the ductwork located in the roof cavity.

Principal findings include:

1. New homes are being constructed in such a manner that reduces or prevents mold and moisture problems. However, increased sidewall and attic insulation installation would provide better thermal performance and reduce the potential for condensation. STHA may want to consider the benefits of non-vented attics in new homes.

2. Mold is not a chronic problem in STHA housing. Causes of the isolated mold incidents are generally apparent.
3. Site drainage can be improved at the inspected existing homes. Site drainage appeared to be good at the new construction sites.

4. Gutter systems appeared to be optional on new construction. When present on existing homes, gutter systems could be improved.

5. Bathroom and kitchen exhaust ventilation can be improved in both existing and new homes.

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

The Building Research Council (BRC) responded to a request from the Eastern/Woodlands Office of Native American Programs to assess site and structural conditions contributing to mold and moisture problems for the Seminole Tribal Housing Authority (STHA). The investigation was conducted on October 27-30, 2003, by Kate Brown (Building Research Council) and Paul Knight (Magna Systems). The houses were pre-selected by the Housing Authority.

Seven homes were inspected. Three new homes under construction and four existing homes were visited. One of the existing homes was totally rehabbed for reasons other than mold.

Building practices could be observed in the homes under construction and in the home being rehabbed. The practices used were sound and appropriate for the Florida climate thus should prevent mold and moisture problems. Two of the three existing homes had severe mold problems directly related to undetected plumbing leaks. A relatively minor mold problem was found in the third home that appeared to be caused by condensation on the main duct located in the roof cavity.

Recommendations to improve the thermal integrity of the wall and attic insulation, include non-vented attics, drying potential of sidewalls, bathroom and kitchen exhaust ventilation and site drainage.

SECTION 1 – METHODOLOGY

Visual inspection was used to assess mold and moisture conditions in the homes.

Visual Inspection

Housing inspections consisted of visual assessment of mold and moisture conditions. Assessment forms developed for the Chicago Mold and Moisture Project (a HUD Healthy Homes Program) were used to record information. The assessment forms are organized for a room-by-room inspection. Rooms were examined for water damage and evidence of mold. Assessment of kitchens, bathrooms, crawl spaces, utility rooms and attics included additional inspection relating to plumbing, localized ventilation, water entry and other moisture source issues.

The exterior of the houses were inspected for rain water management, including site grading, roof condition and gutter system.
Whenever possible, residents are interviewed to gather history on moisture problems, plumbing leaks, condensation, health issues, number of occupants and other useful information. However, none of the homes’ occupants were available.

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

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

SECTION 2 – HOUSE DESCRIPTIONS

STHA manages 409 homes. The homes are located on Seminole Reservation and Trust Land located in parts of Broward, Calhoun, Charlotte, Citrus, Clay, Collier, Columbia, and Miami-Dade Counties. The reservation and trust lands are comprised of six main sites: Hollywood Reservation, Big Cypress Reservation, Immokalee Reservation, Brighton Reservation, and Trust Land in Tampa and Fort Pierce. Homes at the Hollywood and Brighton sites were inspected.

New Construction

New homes were built on concrete slabs with spread footings (Figure 1). Slabs were poured over continuous 6 mil polyethylene ground covers that extend under the footings. The ground cover provided a capillary break and prevents ground water from moving up into the concrete.

Sidewalls were concrete masonry units (CMU’s). A drainage channel was created in the slab when it was poured. The channel allows water that penetrated the sidewall to drain and not remain trapped in the wall (Figure 2). A stucco finish was applied directly to the exterior face of the CMU’s and also was applied below grade to the slab edge to provide a capillary break.

The interior of the walls were furred-in with 1” x 2” furring strips. Foil-faced polyisocyanurate insulation was installed between the furring strips (Figure 3).
Pressure treated 1" x 3" lumber was installed horizontally at the base of the wall to provide a capillary break and support for the base of the gypsum board (Figure 4). Interior gypsum board installed over the furring strips with a ½" gap maintained between the bottom of the gypsum board and slab provided another capillary break.

Roof trusses were placed 24" on center (o.c.). Furring strips were installed perpendicular to bottom of the trusses at 16" o.c. Ceiling gypsum board (5/8") was installed onto the furring strips, since the ceiling gypsum board installers indicated that the gypsum board will sag if installed directly to the trusses at 24" o.c. Attics were insulated to R30 with fiberglass batts, but not particularly well with significant voids and gaps left between batts (Figure 5).

Attics were well vented with soffit and ridge vents.

High-pitched roofs were used, permitting full cavity attic insulation over the exterior walls and reducing the potential of condensation occurring at the wall/ceiling joint (Figure 6).

Space heating was usually not provided. Central air conditioning was standard. An air handler with a central return was located in a closet or laundry room. Supply air was ducted to the rooms through the attic. Ducts were sealed with mastic (Figure 7) and insulated.
Existing Construction

Construction techniques used in the existing site built homes were very similar to that seen in the new construction with the following exceptions:

- No insulation was used between the furring strips on the sidewall (Figure 8).
- Dropped soffits were used in the attic above the central hall for the main supply trunk. The backside of interior partition walls was not insulated and the stud cavity was open to the attic (Figure 9). Condensation may occur on these uninsulated surfaces. Dropped soffits were not used in the new construction.

SECTION 3 – FINDINGS

3.1 New Construction

Building practices in the new construction use basically sound techniques for energy efficiency and moisture migration (Figure 10). A continuous ground cover was placed beneath slabs. A drainage channel was provided in the slab beneath the exterior CMU walls. Capillary breaks were provided at key junctions. The following actions would improve current practices.

3.1.1. Sidewall Construction
The installation of furring strips directly to the exterior walls provided a thermal bridge between the exterior and interior. Despite that fact that insulation was placed between the furring strips, the insulating value of the furring strips was quite low. Heat will move through the CMU and furring strips bypassing the insulation.

**3.1.2 Sidewall Insulation**

Foil-faced polyisocyanurate was being installed between the furring strips. The foil-facing acted as a vapor diffusion retarder and reduced the drying potential of the wall. Moisture may be trapped between the CMU and insulation.

**3.1.3. Attic Insulation**

Batt insulation was installed in the new attics in a manner to greatly diminish the insulating value of the insulation. Numerous gaps and voids could be seen between the batts (Figure 11). In addition, the furring strips prevented the batts from making direct contact with the ceiling gypsum board. Consequently, an air space was created between the top of the gypsum board and the bottom of the batts reducing the effective R-value of the batts. As a result, condensation may occur on the gypsum board when warm humid attic air contacted the cool gypsum board.

**3.1.4 Attic Ventilation**

Attics were fully vented to remove heat from the attic. However, the dominant heat transfer mechanism in attics was through radiation. A vented attic provided only a 2 to 3 percent reduction in heat transfer through the ceiling to the living space. Thus, venting an attic has virtually no impact on cooling an attic or reducing the cooling load of the home.  

Similarly, venting attics brings a great deal of moisture into the structure in hot humid climates. Condensation can occur on cool surfaces, such as exposed ductwork or interior gypsum board.

Supply ducts were located in the attic. Although the ducts appear to be well sealed and insulated, some supply air leaked to the attic. Supply air leakage to the attic created two problems. First, conditioned air was lost to the attic causing an energy penalty to the occupant. A break in the duct insulation or damage to a duct joint can cause condensation on the duct. This problem with visible mold occurred in one house on the ceiling near the location of the supply air ductwork.

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1 *Unvented Attic Discussion*, Joseph Lstiburek, Building Science Corporation, February 2003
Secondly, the supply air leakages pressurized the attic and resulted in negative pressure in the living space of the home. The negative pressure may pull warm humid air in through the shell of the home. This action could cause condensation on cooler interior surfaces (Figure 12).

Eliminating attic vents and insulating the roof deck rather than the ceiling was recommended for warm humid climates. See Section 5.1.2, Attic Ventilation.

3.2 Mold

Mold does not appear to be a chronic problem in STHA homes. The source of the mold in two existing homes visited resulted from plumbing leaks. Mold at the third existing home resulted from condensation occurring on the heating duct in the attic. Conversations with STHA building and maintenance staff indicate that mold was not a significant or chronic problem in STHA homes.

3.3 Site Drainage

Site drainage was poor at the three existing homes. Site drainage was good at the new homes with the grade pitching away from the homes.

The ground was flat or pitched toward the three existing homes (Figure 13). Some localized depressions were found next to slabs. Such depressions can collect water and contribute to capillary action in the slab, especially if the stucco finish is damaged exposing the slab (Figure 14).

3.4 Gutter Systems

Gutter systems appeared to be optional on the new homes and were generally not used. When present on existing homes, gutter sections,
downspouts or leaders were missing (Figure 15).

3.5 Bathroom and Kitchen Exhaust Fans

Properly operating exhaust fans help remove moisture from bathroom and kitchens. All but one kitchen fan vented to the outside. The remaining recirculating fans did not remove moisture from the kitchen.

All but one home had bathroom exhaust fans. One home had two bathrooms with an exhaust fan in only one of the bathrooms. The second bathroom had no exhaust fan, but did have a hot tub.

Actual exhaust fan flow has been measured at various Native American homes. Bathroom fans had exhaust fan flow ratings of 50 cubic feet per minute (CFM) to 70 CFM. Actual flows usually ranged between 0 CFM (the fan made noise, but was not exhausting any air) to 35 CFM. Bathroom fans in the STHA homes are very similar to the ones previously measured thus actual flow rates are probably similar. That is, the fans were likely not operating at rated capacities.

All inspected dryers vented to the outside.

SECTION 4 – TECHNICAL RECOMMENDATIONS

The following recommendations are based on the site visit findings.

4.1 New Construction

The ambient air in southern Florida has significant levels of moisture most of the year. Air conditioning results in cold surfaces on interior walls and ceilings and ductwork. Condensation can occur on these cold surfaces. Controlling the infiltration of moisture-laden air into the building envelope and keeping moisture away from cold surfaces should be major goals of design and construction of new homes by the STHA.

4.1.1 Sidewall Insulation

- Install continuous sidewall insulation
- Use extruded or expanded polystyrene rather than foil-faced polyisocyanurate insulation
A continuous layer of insulation installed to the exterior wall provides a thermal break between the CMU and furring strips. Furring strips are attached to the CMU's through the insulation. Additional insulation can be placed between the furring strips or the air space can be maintained (Figure 16). The air space would permit any condensation that may occur on the insulation to dry.

The current wall system restricts the drying potential of the wall. The foil-facing on the polyisocyanurate acts as vapor retarder that can trap moisture and not allow the wall to dry. Either extruded or expanded polystyrene or non-faced polyisocyanurate should be used rather than foil-faced polyisocyanurate. Both extruded insulations are semi-permeable and allow moisture to pass through. Note that some extruded polystyrene insulation is shipped with a plastic film on it. The plastic film acts like a vapor retarder that should be stripped off before the insulation is installed.

4.1.2 Attic Insulation

Properly installed attic insulation will save energy and reduce the potential for condensation on the ceiling.

- Remove existing batt insulation.
- Insulate to R38 with blown insulation\(^2\). Blown insulation types include cellulose, rock wool or glass fiber. R38 is approximately 10” to 12” of insulation depending upon insulation type used.
- Fill all cavities created by ceiling furring strips with insulation.

4.1.3 Attic Ventilation

There are two alternatives for attic construction: vented and non-vented.

**Vented Attic**

The ceiling is the thermal boundary in a vented attic. The space below the ceiling is conditioned and the space above the ceiling is unconditioned. The ceiling should be well insulated with bypasses sealed. Ductwork located in an unconditioned attic should be air-tight and insulated.

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\(^2\) Department of Energy recommendation for attic insulation in existing homes for southern Florida
If STHA continues to use vented attics, the following recommendations are made:

- Insulate ceilings per section 4.1.2, "Attic Insulation".
- Duct system should be tested for air tightness. Duct leakage to the exterior should be limited to 5.0% of the total air handling system rated air flow at high speed (nominal 400 CFM per ton) determined by pressurization testing at 25 Pa. Two acceptable compliance mechanisms are (1) test duct leakage to outside at finish stage, or (2) test total duct leakage at duct rough-in stage.
- Ducts should be insulated to minimum R4.
- Duct system should be designed to supply airflow to all conditioned spaces and zones (bedrooms, hallways, basements) as well as to provide a return path from all conditioned spaces or zones. Interzonal air pressure differences, when doors are closed, should be limited to 3 Pa.

**Non-vented Attics**

The roof is the thermal boundary in a non-vented attic. The underside of the roof sheathing is insulated and air-sealed rather than the ceiling. Duct work does not have to be insulated. Leaks from the ductwork are not as critical with respect to energy use but could still impact comfort (sufficient airflow to rooms).

From a report titled *Vented and Sealed Attics in Hot Climates,*

Results showed that, when compared to typically vented attics with the air distribution ducts present, sealed "cathedralized" attics (i.e. sealed attic with the air barrier and thermal barrier [insulation] at the sloped roof plane) can be constructed without an associated energy penalty in hot climates.

The following information on attic venting in hot, humid climates is taken from the 2001 Edition of the ASHRAE Fundamentals Handbook (page 24.8).

**Attics and Cathedral Ceilings**

The commonly stated rules for attic and cathedral ceiling construction - ventilation and vapor retarder toward the inside - pertain to cold climates and not to warm, humid climates with indoor air conditioning. Common sense suggests that venting with relatively humid outdoor air means higher levels of moisture in the attic or cathedral ceiling. Higher moisture levels in vented attics in hot, humid climates do not lead to moisture damage in sheathing or framing. However, higher moisture levels in attic cavities may affect chilled surfaces of the ceiling and cold surfaces of mechanical equipment. When cooling ducts are located in the attic space, attic ventilation with humid outdoor air may increase the chance of condensation on the ducts.3

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3 Presented at the ASHRAE Symposium on Attics and Cathedral Ceilings, June 1997, by A. F. Rudd and Joseph Lstiburek
4.2 Mold

Mold does not appear to be a chronic problem in STHA housing with mold generally resulting from plumbing leaks.

- Instruct residents on the damage caused by plumbing leaks can. Recommend to occupants who intend to leave their homes for an extended period of time that they should provide a means by which their homes can be periodically inspected.
- Instruct residents to promptly report mold to the STHA for remediation and correcting the moisture problem causing the mold growth.

4.3 Site Drainage

Efforts that divert rain water away from the slabs on existing homes include:

- A number of holes and dips were found adjacent to foundations that should be filled-in. Damaged or missing stucco should be repaired to maintain a capillary break between the ground and slab.
- Overall site grading to prevent water from flowing toward the houses. Constructing swales may be helpful in some cases.
- Grade directly at the foundation to ensure a soil pitch away from the foundations.

4.4 Rainwater Management

Gutter systems appeared to be optional on the new homes. When present on existing homes, gutter sections, downspouts or leaders were missing. Rainwater management problems compound poor site drainage problems.

- Encourage or require gutter systems on new homes. Gutter systems coupled with good site drainage minimize the chance of slabs getting wet.
- Repair gutter systems on existing homes. Moving rain water away from the house reduces the negative impact that the current site drainage has on the potential for creating wet slabs (or crawl spaces, in the case of manufactured housing).

4.5 Bathroom and Kitchen Exhaust Fans

Bathrooms and kitchens generate large amounts of moisture. Properly operating exhaust fans are key to removing moisture from these spaces.

- Bathroom fans in existing homes should be replaced on an ongoing basis. Typical the flow rates for the type of bathroom fans found in STHA housing are probably far below their rated capacities. Bathroom exhaust fans should be replaced or installed in new homes that are rated for a minimum 70 CFM at 0.25” of static pressure.
- New bathroom fans should have sone ratings no higher than 1.5. Sone is a rating for sound – the lower the sone rating, the quieter the fan. Occupants tend not to
use noisy fans. Low-sone fans include Broan *Solitaire* and Panasonic *WhisperCeiling* and *WhisperLite* series. Low-sone fans generally cost between $75 and $100.

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

- A 60 minute timer switch may be used when the bathroom fan has a separate on/off switch. Timer switches cost between $15 and $50.

- Kitchen recirculating fans should be replaced with fans that vent to the outside. Kitchen exhaust fans should be rated at 150 CFM. Kitchen fans generally do not have sone ratings. However the *Broan Allure* series has sone ratings ranging from 0.4 to 1.5.

- Periodically inspect all bathroom and kitchen exhaust fan ducts. Ensure that exhaust ducts are properly attached and sealed to the exhaust fan housing. All ducts should terminate outside the house and not below roof vents.

- If exhaust venting is taken through the roof eaves, ensure that the ducts terminate and are sealed to a properly designed eave vent termination fitting.

- Periodically inspect dryer vents. The following conditions should be corrected when found:
  1. cramped dryer vents
  2. disconnected dryer vents
  3. venting to some space other than to the outside of the building
  4. replacing plastic ribbed dryer vents with smooth round metal ducts
SECTION 5 – DISCUSSION OF COMMON PROBLEMS

5.1 New Construction

5.1.1 Insulate Attics with Blown Insulation

Ensure that the following items have been done prior to installing attic insulation:

- Block top plates and install insulation chutes.
- Seal all attic bypasses.
- Insulate and air-seal attic access hatch.

Install blown cellulose or rock wool to 3.25 to 3.75 lbs/ft³ or blown fiberglass to 1.6 lb/ft³. Install the insulation to a uniform depth according to manufacturers’ specifications for proper coverage (bags per square foot ratio) to attain the desired R-value at settled density as listed on the insulation bag.

Include attic insulation measuring sticks in the insulation showing insulation depth (Figure 17). Note that insulation will settle over time. Therefore, insulation should be blown to “installed density”, not to settled density.

5.1.2 Insulation baffles

Place insulation baffles over the exterior wall to keep loose fill insulation from falling into the soffit and ensure that the area can be packed with insulation, maximizing insulation value over the exterior wall.

This measure keeps blown insulation from falling into the soffit ensuring proper insulation coverage over the exterior walls and preventing warm moist air from contacting cooler ceiling surfaces. Cool surfaces can cause condensation to occur on top of the ceiling gypsum board.

High relative humidity and cool surfaces can lead to mold growth. If a surface approaches the dew point temperature based on the relative humidity, water will condense, be quickly absorbed by the material, and raise the moisture content of the surface. At some point, the moisture content can be sufficient to promote mold growth. This process can occur at the wall/ceiling junction on exterior walls.

There are at least two reasons why the exterior wall/ceiling juncture may promote growth in a southern climate:

1. Warm moist air 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 over the ceiling gypsum board at the exterior wall.

5.1.3 Attic Bypass Sealing

Attic bypasses are holes or gaps in the top floor ceiling that expose cooler ceiling and wall surfaces. Negative pressure in the living space caused by the air handler and exhaust fans can pull warm humid air down into interior wall cavities. Condensation on the backside of interior surfaces may result.

Strong air-barrier materials like plywood, gypsum board or foam insulation board can be used to seal attic bypasses. These materials should be attached with mechanical and/or adhesive bonds.

The following are some examples of attic bypasses and how to seal them.

- Soil stacks, plumbing vents, open plumbing walls: Seal joints with expanding foam or caulk. If joint is too large, stuff with fiberglass insulation and foam over the top. Large openings may also be sealed with insulated foam board or scrap gypsum board (Figure 18).
- Housing of exhaust fans and recessed lights: Caulk joints where housing comes in contact with ceiling.
- Box around recessed light fixtures to prevent overheating and/or fire. Use gypsum board to construct the box. Provide a minimum 3” clearance between the box and the sides of the fixture. The box should be constructed to a height that will be 4” above the installed insulation. Cover the box with gypsum board and seal to the sides of the box. Do not cover the box with insulation. If there is insufficient clearance to install a box 4” higher than the insulation, do not cover the box and use an appropriate barrier to keep the insulation 3” away from the fixture.
- Wiring and conduit penetrations: Seal joint with caulk or low expanding foam.
5.1.4 Insulate & Air Seal Attic Hatches

A non-air sealed attic hatch is another type of bypass. Moisture can condense and mold can grow on access hatch blocking if not air sealed (Figure 19).

Air seal the hatches with weatherstripping or gasket as shown in the Figure 20. Latches should be installed to lock the hatches in place and provide positive closure.

Insulate attic hatches to a minimum of R38 but no less than R19. A lightweight attic hatch may be cut from damaged insulated foam core doors (Figure 21). The door has an R-value around 7. Batt insulation may be attached to the back of the door panel to achieve the desired R-value. The door panel is pre-finished, light-weight and requires no additional painting.

5.1.5 Attic Ventilation

The current STHA new home construction practice included vented attics with supply ducts. Although required by some building codes, vented attics do little to remove excess heat from the attic space. The following measures should be incorporated in vented attics.

- Properly installed attic insulation (see 5.1.1, Insulate Attics with Blown Insulation).
- Seal and test all duct joints for air tightness.
- Properly installed duct insulation.

Non-vented attics provide a number of benefits over vented attics. Insulation and air sealing are done on the bottom side of the roof sheathing (Figure 22). Spray foam insulation, such as Icynene, is recommended as it provides both insulation and air sealing. Batt insulation is not recommended as it provides no air-sealing benefits (air sealing is critical to avoid condensation on the underside of the roof sheathing. Additional information regarding vented and non-vented attics in hot humid climates can be found at http://www.buildingscience.com/. In particular, see Roof and Attic Ventilation Issues in Hot-
Humid Climates by Armin Rudd for the South Florida Building Officials Association (May 14, 2003). The following benefits of non-vented attics are taken from that article.

**Benefits of Unvented Attic with Spray Foam Insulation**

- Increases building air tightness.
- Greatly reduces air infiltration which causes comfort problems and high space conditioning energy bills.
- Eliminates the difficult problem of building the ceiling air tight (i.e. changing ceiling heights, soffits, coffered ceilings, dropped ceilings, and mechanical chases.
- Eliminates moisture carried in by outside air.
- Eliminate condensation on cool duct and ceiling drywall surfaces (attic dew point temperature can be up to 85°F).
- Eliminate moist air pulled down interstitial wall cavities by mechanical depressurization, which often results in mold on drywall.
- Improves indoor air quality.
- Reduces the amount of dust, dirt, and pollen entering the house.
- Creates a less hospitable environment for bugs and insects who like the moisture.
- Increases energy efficiency.
- Allows a complete air distribution system within the conditioned space.
- Reduces the uncontrolled air exchange.

5.2 Mold

Mold is not a chronic problem in STHA homes however resident lifestyles can have an impact on mold. Instructional information for residents should include the following:

- Undetected and unrepaired damage caused by plumbing leaks.
- Importance of promptly reporting mold to the STHA for remediation.
- The difference between plumbing leaks and sweaty pipes and fixtures; wipe-up moisture from sweaty pipes and fixtures.
- Importance of using outside venting bathroom and kitchen exhaust fans during and after bathing and cooking activities to remove excess moisture.

5.3 Site Drainage

When rain falls on a building site, where should the water go? The roof should be designed and built so that the water that lands on the roof is moved out to the edge of the roof. When rain falls on a soil surface, some percolates down through the soil - more in sandy soils and less in clayey soils. The water that does not percolate downward moves along the soil surface following the slope, out to the downhill edge of the site. 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. Houses that have problems are houses that have allowed water to accumulate in the soil touching the foundation. The soil in contact with the foundation should be the driest soil on the site. Houses with dry foundations (basements, crawl spaces and slabs) are usually dry houses.
Keeping the foundation dry is the key to a good indoor environment in most houses. To keep the foundation dry, keep the soil next to the foundation dry.

Keeping the soil that touches the slab dry involves two general rules, together with some specific guidelines.

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

The second general rule is the “ground-roof” rule - treat the soil surface as if it were a low-slope roof surface. Pitch the surface away from the house - the steeper the pitch, the better the drainage. Imagine all the water moving to the low edge of the site, and imagine how best to get it there. Avoid areas near the building that can act as water collectors.

Specific site drainage guidelines include:

- The house should be built on a crown, not in a hole. If there is sufficient exposed foundation, site grading at the house can be improved.
- Identify localized dips and holes immediately adjacent to the foundation and fill with dirt. Tamp the fill material to prevent future settling. Provide sufficient fill material such that drainage occurs away from the slab.
- If the house has no gutters, then the base of the soil around the house has to serve as a gutter itself. It should have a surface that helps prevent splash back onto the exterior finish of the house, especially if the exterior finish is wood siding. It should be designed with pitch so that it effectively moves water away from the house.
- Good tamping or compaction of the backfill is very helpful because it helps keep water up on the surface where it can be managed by slope.
- Bushes and other plantings may be very helpful, especially if their root balls soak up a lot of water. Also they can be planted strategically near downspouts so that the downspout extenders are less likely to be kicked off or removed during lawn mowing.

5.4 Rain Water Management

Collect rain water from the roof and distribute it away from the slab with a gutter system. Ensure the flashings around vents are watertight.

- Gutters can be an effective rain water management system. Pitch the gutters to the downspout. Short gutters may be hung level. In hip roof houses, consider using downspouts only on the downhill side not on the uphill side. In areas with a moderate amount of trees, consider large gutters and downspouts where leaves and debris can be flushed more easily. Make sure the gutters hangers are solid to ensure the gutter from sagging.
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- Secure downspouts to the house. They should never be undersized, and some oversizing never hurts. Fasten elbows and straight sections together with pop rivets—screws that project into the downspout can lead to clogging.

- At the base of the downspout, direct the water past the backfill onto the undisturbed soil, which may be 3' to 5' out from the edge of the house. If allowed to dump water close to the slab and into the backfill, it will concentrate the water next to the slab—precisely the wrong place for the water to be. The traditional way to discharge the water away from the house involves using downspout extenders (sections of straight downspout) or splash blocks. Both of these are often disturbed when lawns get mowed. A notched section of downspout that is hinged to the elbow at the base of the downspout can solve this problem. The soil at the base of the downspout should be sloped away from the house at a minimum of 5% slope. Six inches of fall in the first 10' away from the house gives a 5% slope.

- Keep gutters clean in wooded areas can be a maintenance issue, so use a gutter guard system to keep debris out of the gutter, thus minimizing maintenance, while allowing water to drain into the gutter. Two such gutter guard systems are the PermFlow Gutter Guard System and the WaterFall Gutter Guard System. These systems cost about $4.50 per 3' section and are designed for a 5” K style gutter (8’ sections are sold to contractors).

5.5 Bathroom & Kitchen Exhaust Fans/Dryer Vents

Several rooms in a house are natural moisture sources simply by 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. Exhaust ventilation dilutes the moisture and places the room in a negative pressure, thus limiting the spread of moisture to the rest of the house until most of the moisture has been removed to the outside.

Vent bathroom exhaust fans, kitchen exhaust fans and clothes dryers to the outside rather than into the living space or attic. Venting to the attic can lead to moisture problems in the attic. For this reason, localized exhaust ventilation requires ductwork.

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

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

Replace range hoods whenever possible with venting to the outside mandatory. The hoods should have a minimum exhaust capacity of 150 CFM.

Dryer vents should be smooth-surfaced rigid duct. Non-combustible flexible metal duct approved for dryer venting may also be used. Duct joints should be in the direction of air flow. Ducts should not be fastened with screws or fasteners that extend into the duct. Length of the duct run should be minimized, especially with flexible metal duct. Flexible metal duct should be installed without dips or sags.

Minimum duct diameter should be 4” and length should not exceed 25’ from the dryer outlet to the termination point. If duct length is greater than 25’, use a 5” diameter duct.

Dryer vent caps should have a backdraft damper that closes when the dryer is not being used. Insect screens or small wire cages should not be installed over the vent cap.
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*Discussion of new construction and rehabilitation of existing homes is found in Section 2, New Construction pages 12-14 and Existing Construction.
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**Inspection Number:** 1-1  
**Address:** 6520 James E. Billie Dr.  
**Age:** 17 years  
**House Type:** Conveyed  
**Occupancy:** Vacant  
**Bedrooms:** 4  
**Foundation:** Slab-on-grade  
**Heat Type:** No heat - central air only  
**Construction:** Ranch, concrete block

**Mold and Moisture Conditions:** The water line to the refrigerator was not turned off when the refrigerator was removed (Figure 2). The home flooded and caused severe mold growth throughout the home (Figures 3 and 4). Plans for gutting the home and rebuilding the interior have been made.
Rainwater Management: Site drainage around the home was flat. Depressions were found near the slab. Some gutters and downspouts were missing. One downspout drained immediately adjacent to the slab (Figure 5).

Bathroom/Kitchen: The kitchen fan was recirculating. The bathroom fans vented to the outside and were rated around 50 CFM. From previous experience, actual exhaust flow from this type of fan (Figure 6) is usually less than 20 CFM.

Attic: The attic was insulated with 4 inches of loose rock wool. The main trunk line from the air handler was located in a dropped soffit over the hallway (Figure 7). Interior partition walls were open as a result of the soffit (Figure 8). Open partition walls allow warm moist air to be drawn down into the interior wall cavities potentially causing condensation problems. The duct sealing at joints and the quality of the duct insulation could not be inspected.

Occupant Notes: The house was vacant.

Recommendations: The STHA plans to gut and rebuild the interior of the home. The following recommendations are made with rehabilitation in mind. The first three recommendations are building practices currently being used by STHA in a home that was receiving a similar rehabilitation during the site visit.
1. Install rigid foam insulation between existing furring strips on exterior walls.

2. Provide a capillary break between the slab and furring strips/gypsum board.

3. Provide a minimum 1/2" gap between bottom gypsum board and slab on all walls.

4. Install a kitchen exhaust fan that vents to the outside.

5. Install low-sone bathroom exhaust fans vented to the outside. Provide appropriate fan control (see section 5.5, “Bathroom & Kitchen Exhaust Fans/Dryer Vents”).

6. Install/repair the gutter system. Install leaders to direct rain water away from slab.

7. Re-grade slab perimeter to drain water away from slab.

8. Install gypsum board over top of dropped soffit. Install insulation over top of new gypsum board.

9. Install new ductwork. Seal all joints with duct mastic (current building practice) and insulate ducts (current building practice).
Appendix B: Seminole Tribal Housing Authority Technical Assessment Report

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**Inspection Number:** 2-1  
**Address:** South Tucker Ridge Road  
**Age:** 17 years  
**House Type:** Conveyed  
**Occupancy:** Vacant  
**Bedrooms:** Unknown  
**Foundation:** Slab-on-grade  
**Heat Type:** No heat - central air only  
**Construction:** Ranch, concrete block walls

![Figure 1: South Tucker Ridge Road](image)

**Mold and Moisture Conditions:** This home was unoccupied. The water line to the water had sprung a leak during this period of time and flooded the home (the interior of the home could not be thoroughly inspected due to standing water). Mold could be seen everywhere in the home.

![Figure 2: Leak in water line](image)  
![Figure 3: Mold on living room wall](image)  
![Figure 4: Mold on kitchen walls](image)
**Rainwater Management:** Site drainage around the home was flat. The porch slab was flat and the exterior was water damaged (Figure 5). Depressions were found near the slab (Figure 6). A gutter system was not present.

**Bathroom/Kitchen:** The kitchen fan was recirculating. The bathroom ventilation could not be inspected.

**Attic:** The attic could not be inspected.

**Occupant Notes:** The house was vacant.

**Recommendations:** The STHA has plans to gut and rebuild the interior of the home. The following recommendations are made with rehabilitation in mind. The first three recommendations are building practices currently being used by STHA in a similar home.

1. Install rigid foam insulation between existing furring strips on exterior walls.
2. Provide a capillary break between the slab and furring strips/gypsum board.
3. Provide a minimum ½" gap between bottom gypsum board and slab on all walls.
4. Install a kitchen exhaust fan that vents to the outside.
5. Install low-sone bathroom exhaust fans vented to the outside. Provide appropriate fan control (see section 5.5, "Bathroom & Kitchen Exhaust Fans/Dryer Vents").
6. Install a gutter system. Install leaders to direct rain water away from slab.
7. Replace porch slab and pitch to drain water away from exterior wall.
9. Inspect, repair or replace ducts as necessary. Seal all joints with duct mastic and insulate ducts.
Mold and Moisture Conditions: The home was unoccupied during the site visit. Mold was visible on a bedroom ceiling at the joint where the double-wide manufactured home was connected (Figure 2). Ductwork was located about this joint, but could not be inspected.

Although the client was not at home, a relative indicated that the mold appeared after the home had been re-roofed. It is suspected that roof work may have damaged the duct insulation or duct joints causing condensation to occur.

Return air was drawn from the home and ducted through the crawl space to the air conditioning unit located on the side of the home (Figure 3). Supply was ducted back to the home and up a chase to the attic cavity. The main trunk extended the length of the home with branch ducts providing cooling to each room. The location of the mold was near point where the main trunk tied came out of the chase.

The supply air grilles were quite dirty indicating no filter or a leak in the return air system (Figure 4).
Rainwater Management: The site drained toward the home in the back (Figure 5). A gutter system on the home was not present, but a gutter was located on the attached porch.

Bathroom/Kitchen: The kitchen fan vented to the outside. The master bedroom bath has no bathroom fan, although a hot tub was present in the bathroom. The main bathroom fan vented outside.

Attic: The home had an inaccessible cathedral ceiling. The main duct was located in this cavity. It is suspected that condensation was occurring on the duct causing the mold on the bedroom ceiling, but this could not be confirmed.

Occupant Notes: Occupants of the home were not present.

Recommendations:

1. Remove and replace damaged ceiling. Inspect and repair supply air duct in roof cavity above damaged ceiling.

2. Install low-sone bathroom exhaust fans vented to the outside, especially in the bathroom with hot tub but no existing fan. Provide appropriate fan control (see section 5.5, “Bathroom & Kitchen Exhaust Fans/Dryer Vents”).

3. Re-grade around back and side of home to direct rainwater away from crawl space.

4. Install gutter system. Install leaders to direct rain water away from home.