LAC DU FLAMBEAU CHIPPEWA HOUSING AUTHORITY TRIP REPORT
Assessment of Mold and Moisture Conditions

Final Report

Date:
September 8 - 10, 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

Part I  Lac du Flambeau Chippewa Housing Authority Trip Report

Attachment I: Measuring Problem Regarding Mold

Part II  Lac du Flambeau Chippewa HA Technical Housing Assessment Report

Appendix A  Summary Site Visit Report

Appendix B  Housing Assessment Results
Part I
Lac du Flambeau Trip Report
September 8-10, 2004

Introduction

An investigation of mold and moisture conditions was originally conducted on November 3-6, 2002, by Kate Brown of the Building Research Council at the University of Illinois and Paul Knight of Domus Plus. A report detailing finding and recommendations from that site visit was prepared in December 2002. The Executive Director of the Lac du Flambeau Chippewa Housing Authority (LDFCHA) and Environmental Health Officer at Indian Health Services requested a follow-up visit to further assess the mold and moisture conditions in their housing units.

On September 8-10, 2004, Paul Knight and Robert Nemeth of Magna Systems, Inc. conducted a follow-up site visit to assess mold and moisture conditions. Technical assistance was provided by the Building Research Council. Eighteen existing homes and two homes under construction were investigated. The investigators divided into two teams given the number of homes pre-selected by the LDFCHA. A member of the LDFCHA staff escorted each inspection team.

This is a summary report of activities and issues identified while on site. A detailed analysis of the findings and recommendations is found in the attached report, titled: Technical Housing Assessment Report: Examining Mold and Moisture Conditions of HUD Homes on the Lac du Flambeau Reservation.

Background Information

The Lac du Flambeau Reservation is located in northern Wisconsin. There are approximately 1,830 Native Americans residing on the reservation. The reservation is located in Iron, Oneida, and Vilas counties. Northern Wisconsin’s winter climate consists of cold temperatures and heavy snowfall. The geography of the area has many lakes, streams, and rivers along with wetlands and marshes. Tribal staff reported high water tables. This type of topography can contribute to mold and moisture conditions.

Currently, there are 311 Low Rent and Mutual Help homes (192 Low Rental Units, 118 Mutual Help Units and 1 Turnkey Unit) and about 200 tribal homes on the reservation.

Reports of mold conditions began in July 2001. The LDFCHA in conjunction with the Lac du Flambeau Chippewa Indian Tribal Council and Lac du Flambeau Peter Christensen Health Center conducted a survey assessing mold and moisture conditions in housing on the reservation. The survey was mailed to all tribal households. About 60 surveys were returned. In some cases, the surveys indicated the mold problems were such that occupants with health conditions identified as high risk were relocated.
Day 1: Tuesday, September 7, 2004

Tuesday was a travel day to the reservation.

Day 2: Wednesday, September 8, 2004

On Wednesday morning, the assessment team met with the Housing Authority staff and Indian Health Service officials to discuss the mold situation on the reservation and to address any of the Tribe’s concerns. Also present were William Crump and Teresa Gallagher, both with Indian Health Service.

Two teams were formed to conduct the site investigations at 18 homes selected by LDFCHA. Teams were escorted by LDFCHA staff. Mr. Crump accompanied one team and Ms. Gallagher accompanied the second team. On-site assessments began that morning.

The selection of the properties was not random. Digital photographs were taken at each site to record conditions. Comprehensive assessments were conducted at each site. The inspection process involved visual assessment of both interior and exterior conditions, air flow measurements of bathroom ventilation systems, and discussion with residents when available.

A total of 12 homes were inspected this day.

Day 2: Thursday, September 9, 2004

Both teams continued the inspections in the morning. A total of six homes were inspected prior to lunch. It came to the attention of the teams that mold had been found in the crawl spaces of the new homes being built by LDFCHA. The new homes were inspected after lunch rather than existing homes that had been planned. Following the inspection of the new homes, the teams assembled along with Nick Chapman (Construction Manager, LDFCHA), Sandra Supinski (Tribal Sanitarian) and Bill Green (Renovation/Construction Manager, LDFCHA) to discuss the new homes. It was decided to meet with the builder of the new homes on Friday morning at the site to discuss appropriate action.

Due to a previous commitment, Mr. Knight left for Chicago following the afternoon meeting.

Day 4: Friday, September 10, 2004

In the morning, Mr. Nemeth met with housing authority staff and the builder to review the mold situation at the new homes. Mr. Nemeth traveled home on Friday afternoon.

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

Two sets of findings; first related to the existing homes and second to the units under construction, follow:

Existing Homes

1. Site drainage was poor at thirteen of the eighteen inspected homes. Plans to correct the site drainage issue at three of the five remaining homes have already been made. Site drainage work at the other two homes had been completed and appeared to be successful.

2. All but one of the eighteen inspected homes had gutter problems. Plans to install or repair the gutter systems have been made for three homes. Gutter problems ranged from damage caused by ice dams to no gutter systems at all.

3. All of the bathroom fans appeared to be original and functioned poorly. Five kitchen fans were re-circulating. Plans had been made to vent one of the kitchen fans to the outside. Bathroom and kitchen fans usually vented to the ridge vent causing mold growth on the underside of the roof sheathing.

4. Mold growth was found on the insulation dam around the attic hatch in ten of the inspected homes.

5. A crawl space with a history of being wet was successfully remediated by LDFCHA with the addition of foundation wall insulation, a continuous and sealed ground cover and sealed crawl space vents.

6. Four of the eighteen homes had mold growth at the juncture of the exterior wall and ceiling drywall.

7. A supply-only ventilation system installed in a home built in 1998 was never connected.

New Construction

1. Mold growth on the underside of the flooring sheathing above the crawl spaces were caused by poor site drainage and not protecting the crawl space from rain during construction.

2. The effectiveness of bathroom and kitchen exhaust fans as well as the clothes dryers was questionable given their location within the units and vent distances to the outside.
Recommendations

Recommendations relating to the technical issues are summarized below. For more detailed discussion, see the *Lac du Flambeau Chippewa Housing Authority Technical Housing Assessment Report* for additional information.

1. Site Drainage
   Efforts are needed to divert rainwater/snow melt away from the house foundation.

2. Rainwater/Snow Melt Management
   The installation of gutters, downspouts, leaders and splashblocks to drain water away from the house would help with the site drainage problems. Getting this water away from the house reduces the negative impact that the current site drainage has on wet foundations.

3. Bathroom and Kitchen Exhaust Fans
   Large amounts of moisture can be generated in bathrooms and kitchens given their function. Properly operating exhaust fans are key to removing moisture from these spaces.

4. Air Seal Attic Hatches
   Mold was found growing on the insulation dam at the attic hatch in about three fourths of the homes. Though all of the inspected hatches were insulated, they were not air sealed.

5. Crawl Space Design
   The crawl space foundation walls form the thermal boundary in the LDFCHA homes. Crawl space remediation work such as found in one home should continue as budgets permit.

6. Exterior Wall/Ceiling Juncture
   Although not a significant problem in LDFCHA housing, localized mold growth at this juncture was found. Recommendations are made with respect to controlling indoor moisture levels and improving the insulation over the top plates.

7. Supply-only Ventilation System
   A number of recommendations are made with respect to supply air ventilation systems installation, maintenance and controls.

Programmatic Recommendations:

A service-delivery system to effectively address mold and moisture conditions is recommended. 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 are:
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 and gutter maintenance 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. By having the resident complete the survey, it 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.
Attachment 1
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 (α = 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 $y \pm z$ (α= 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) * (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

LAC DU FLAMBEAU CHIPPEWA HOUSING AUTHORITY

TECHNICAL HOUSING ASSESSMENT REPORT

EXAMINING MOLD AND MOISTURE CONDITIONS IN HOMES OF THE LAC DU FLAMBEAU CHIPPEWA HOUSING AUTHORITY

Executive Summary

Introduction

Section 1: Methodology

Section 2: Lac du Flambeau 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

Paul Knight and Robert Nemeth of Magna Systems, Inc. inspected eighteen existing units and two buildings under construction for mold and moisture problems for the Lac du Flambeau Chippewa Housing Authority (LDFCHA) between September 8th and 10th, 2004. The exterior and interior inspection process of the eighteen existing homes involved visual assessment of both interior and exterior conditions, air flow measurement of bathroom exhaust fans and resident interviews where possible. Inspections at the units under construction focused primarily on the crawl spaces.

LDFCHA reported the following moisture problems in their homes:

- Damp basements and crawl spaces.
- Mold on the underside of roof sheathing.
- Questionable ventilation from exhaust fans.
- Mold growth on the underside of floor sheathing over crawl spaces in units currently under construction.

Existing Homes

Mold was found in fifteen existing homes. No mold was found in one home that was recently rehabbed specifically to solve mold and moisture issues. Mold was found in seven bathrooms (three bathrooms were not inspected). Mold was found on the underside of roof sheathing and/or on the insulation dam around the attic hatch in eleven homes (two attics were not inspected). Poor site drainage was found at thirteen homes.

All the measured bathroom exhaust fans were performing below their rated capacities. Most of the bathroom exhaust fans vented to an attic vent. Three bathroom fans were non-operational. Kitchen exhaust fans also vented to an attic vent.

Most of the inspected homes were constructed in the early to late 1980's. All but one home was 2” x 4” sidewall construction. The remaining home was 2” x 6” sidewall construction and was built in the late 1990’s. Seventeen homes were built over basements – one home was built over a crawl space.

New Construction

Severe mold growth was found on the floor sheathing above the crawl spaces in units currently under construction. The growth was caused by very damp crawl spaces resulting from poor site drainage and leaving the crawl spaces unprotected from the weather during construction. Many other moisture issues related to the design and construction of the new units were identified.
Principal findings include:

Two sets of findings; the first related to the existing homes and the second to the units currently under construction, follow:

A. Findings for the Existing Homes:

1. Site drainage was poor at thirteen inspected homes. Plans to correct the site drainage issue at three of the five remaining homes have already been made. Site drainage work at the other two homes had been completed and appeared to be successful.

2. Seventeen inspected homes had gutter problems. Plans to install or repair the gutter systems have been made for three homes. Gutter problems ranged from damage caused by ice dams to no gutter systems.

3. All of the bathroom fans appeared to be original and functioned poorly. Five kitchen fans were re-circulating. Plans had been made to vent one kitchen fan to the outside. Bathroom and kitchen fans were usually vented to the ridge vent causing mold growth on the underside of the roof sheathing.

4. Mold growth was found on the insulation dam around the attic hatch in ten homes.

5. A crawl space with a history of being wet was successfully remediated by LDFCHA with the addition of foundation wall insulation, a continuous and sealed ground cover, and sealed crawl space vents.

6. Four homes had mold growth at the juncture of the exterior wall and ceiling drywall.

7. A supply-only ventilation system installed in a home built in 1998 was never connected.

B. Findings for the New Construction:

1. Mold growth on the underside of the flooring sheathing above the crawl spaces were caused by poor site drainage and not protecting the crawl space from rain during construction.

2. The effectiveness of bathroom and kitchen exhaust fans as well as the clothes dryers was questionable given their location within the units and vent distances to the outside.

The report provides technical recommendations and discussions focusing on these items. Appendix A includes a summary of findings at each inspected unit. Appendix B provides observations and recommendations for each unit, including the units under construction.
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 on the Lac du Flambeau reservation. An investigation of mold and moisture conditions was originally conducted on November 3 – 6, 2002, by Kate Brown (Building Research Council) and Paul Knight (Magna Systems). A report detailing findings and recommendations from that site visit was prepared in December 2002.

Paul Knight and Robert Nemeth, both of Magna Systems, conducted a second site visit on September 8th - 10th, 2004, to provide a follow-up assessment with respect to mold and moisture conditions. The investigators divided into two teams given the number of homes pre-selected by the Lac du Flambeau Chippewa Housing Authority (LDFCHA). A member of the LDFCHA staff escorted each inspection team.

While the team was on site, a mold issue was discovered in some new housing units under construction by LDFCHA, so two of these homes were also inspected.

Principal findings from the November 2002 site visit included:

- Poor site drainage around the homes.
- Lack of gutter systems.
- Damp crawl spaces.
- Poorly functioning and improperly vented exhaust fans.

The progress made in addressing these issues includes:

- Even though site drainage was poor at thirteen of the eighteen inspected homes, plans to improve site drainage have been made for three of the five remaining homes. Site drainage remediation work was completed at two homes and appeared to be successful.

- Seventeen inspected homes had gutter problems. Plans to install or repair the gutter systems have been made for three of the homes.

- A crawl space with a history of being wet was successfully remediated by the LDFCHA with the addition of foundation wall insulation, a continuous and sealed ground cover and sealed crawl space vents.

- Bathroom and kitchen exhaust fans continue to be a problem with respect to proper operation and venting.
SECTION 1 – METHODOLOGY

Visual inspection was used to assess mold and moisture conditions in the homes. Actual ventilation rates of bathroom exhaust fans were also measured when possible.

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. Findings and recommendations for each individual home, including the units under construction, are presented in Appendix B.

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. All rooms were examined for water damage and evidence of mold. Assessment of kitchens, bathrooms, basements, 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 homes were inspected for rainwater/snow melt management, including site grading, roof condition and gutter system.

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

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

Measurements

Actual ventilation rates of bathroom fans were measured with an exhaust fan flow meter (Figure 1). The flow meter consists of a gasketed pan that is placed tightly over an operating exhaust fan. The pan has a variable orifice and a connection for a digital manometer. The manometer measures the pressure difference between the pan and the home during fan operation. Based on the setting of the variable orifice and the measured pressure difference at the fan, the cubic feet of air per minute (CFM) exhaust by the fan is calculated.
SECTION 2 – HOME DESCRIPTIONS

Eighteen existing homes were inspected. One duplex and one five-plex apartment building under construction were also inspected. Homes were inspected over the three-day site visit.

Existing Homes

One home was in excess of 50 years old and two homes were about 6 years old. The remaining fifteen homes ranged in age from 20 years to 30 years in age.

Seventeen homes were built over basements and one home was built over a crawl space. Poured concrete and concrete block were used for the foundation walls. Most basement walls had 1 inch exterior rigid foam insulation. The crawl space was insulated on the interior with 1 inch rigid foam insulation.

Seventeen homes were 2 inch x 4 inch sidewall construction, which could not be inspected and was assumed to be R11 fiberglass batts. Sidewall construction in one 6-year old home was 2” x 6” framing and was assumed to be insulated with R19 batt insulation. Attic insulation ranged from R30 to R38 with fiberglass batts, blown fiberglass or blown cellulose insulation. Soffit and ridge vents were the common attic ventilation strategy.

Propane-fired forced air heating systems were generally found in the homes. One home was heated with a propane-fired boiler. On occasion, wood stoves were attached to the furnaces. The wood stoves usually served as the primary heating source with the propane furnaces serving as backup. A central return system was used in the homes and was located in the hallway. A fresh air intake duct attached to the low-pressure end of the return duct was found in one 6-year old home; however, it was never connected. Water heaters were propane-fired natural draft. A few power vented water heaters were found in the homes.

New Construction

New duplexes (Figure 2) and multi-unit apartment buildings were under construction during the site visit. Sidewalls were 2” x 6” framing with batt insulation. Homes were built over crawl spaces. Foundation walls were poured concrete with 1 inch exterior foam insulation. Slabs were being poured in the crawl spaces, accessed from the interior of the units.
Units will be heated with forced air furnaces. Both the furnaces and water heaters will be located in the crawl spaces. Servicing and maintaining the furnaces and water heaters may be an issue in the future given their location.

Windows were Energy Star rated with a U-value of 0.29. Proper window flashing was being used for the window installation. Raised-heel trusses were used in the attic allowing for full cavity insulation over the top plates (Figure 3).

The effectiveness of bathroom and kitchen exhaust fans as well as the clothes dryers was questionable given their location within the units and vent distances to the outside. See Appendix B for a detailed description of units under construction, findings and recommendations.

SECTION 3 – FINDINGS

3.1 Site Drainage

Site drainage was poor at thirteen homes, either flat or pitched toward the foundations. One home had water coming in at the base of the basement wall where the site was fairly flat (Figure 4). This home was being rehabbed at the time of the site visit.

Another home had poor drainage in the back of the home, but plans had been made to re-grade this area (Figure 5). One other home had chronic basement flooding issues. Site drainage work was ongoing at this home that included draining the gutters through underground drain lines to daylight off-site (Figure 6).
3.2 Rainwater/Snow Melt Management

Seventeen inspected homes had gutter problems. Gutter systems were missing on fifteen homes but rehabilitation plans called for the installation of gutters on two homes. Two gutters system had ice dam damage. Two recently installed gutter systems included underground drain lines to daylight (Figure 7).

3.3 Bathroom & Kitchen Exhaust Fans; Clothes Dryer

Properly operating and vented exhaust fans and clothes dryers remove moisture from bathrooms and homes. All inspected homes had bathroom exhaust fans.

An exhaust fan flow meter was used to measure actual cubic feet per minute (CFM) exhausted by operable bathroom fans (the fan flow meter doesn't fit over kitchen exhaust fans). The measured exhaust ranged between 0 CFM and 38 CFM. In addition, bathroom fans were quite noisy. Occupants tend not to use fans that are loud. The bathroom exhaust fan in home 1.7a was controlled by a dehumidistat. However, the fan was disconnected by the occupants due to its noise.

Measured CFM flow of bathroom fans is shown in Table 1. The fan in one home was reconnected for purpose of measuring its flow rate.

<table>
<thead>
<tr>
<th>Inspection number</th>
<th>Bath Fan CFM Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1</td>
<td>no power to home; fan could not be tested</td>
</tr>
<tr>
<td>1-2</td>
<td>25</td>
</tr>
<tr>
<td>1-3a</td>
<td>0</td>
</tr>
<tr>
<td>1-4a</td>
<td>21</td>
</tr>
<tr>
<td>1-5a</td>
<td>28</td>
</tr>
<tr>
<td>1-6a</td>
<td>17 (basement bath), 21 (main level bath)</td>
</tr>
<tr>
<td>1-7a</td>
<td>27</td>
</tr>
<tr>
<td>2-1a</td>
<td>36 (main bath), 38 (second bath)</td>
</tr>
<tr>
<td>2-2a</td>
<td>14 (half bath), non-operable in main bath</td>
</tr>
</tbody>
</table>

At a minimum, bathroom exhaust fans should provide a ventilation rate of 70 CFM. None of the bathroom exhaust fans were operating at their rated CFM. This was not unique to the housing stock at Lac du Flambeau and is commonly seen in all housing types, regardless of economic strata.
Two bathroom fans vented to the outside. The remaining fans were vented to the underside of roof vents. This practice can cause mold to grow on the underside of the roof sheathing (Figure 8).

Five kitchen fans were re-circulating with rehab plans calling for the venting of one of these fans. Non-recirculating kitchen fans vented to the underside of ridge vents.

Dryer vents were found disconnected (Figure 9).

3.4 Attic Hatch

None of the attic hatches were air-sealed. Mold was growing on the insulation dam in ten homes (Figure 10). An insulation dam is a plywood box constructed around the hatch to keep attic insulation from falling into the home when the hatch is opened. The hatch is not air-tight when closed. Warm moist air moves up into the attic around the perimeter of the hatch. Moisture condenses on the cool surface of the insulation dam causing mold growth.

3.5 Crawl Spaces

The previous site visit in November 2002 identified crawl spaces as being a significant problem with respect to moisture, energy efficiency and sanitary conditions.

Crawl space issues identified in that site visit included:

- thermal boundary
- ground covers
- ductwork and plumbing

- Thermal Boundary
The thermal boundary is the building section that separates conditioned space from outside conditions. Generally, the foundation walls form the thermal boundary. Insulate foundation walls and seal crawl space vents.
Ground Covers
A continuous and sealed ground cover prevents ground water from moving up into the crawl space. Crawl space moisture can be a significant source of moisture in a home.

Ductwork/Plumbing
Most ductwork and plumbing found in crawl space homes during the November 2002 visit were not insulated. Although not a moisture issue, energy was being lost due to the vented crawl spaces. Uninsulated plumbing could also freeze in vented crawl spaces.

The crawl space in one home had a history of being wet. Remediation work was done in the crawl space two years ago. Vents were sealed, foundation walls were insulated, a ground cover was installed and sealed at the joints and to the foundation wall and the occupant was keeping the crawl space clean (Figure 11). The crawl space was clean and dry. Ducts and plumbing lines were uninsulated, but are no longer an issue as the crawl space is now conditioned space.

Crawl Space Remediation
One crawl space was very similar to the crawl spaces inspected during the November 2002 site visit. One concern about these crawl spaces is the proximity of the crawl space vents to the ground. In some cases, the vents were at grade. In such cases, rain-water and snow melt can get into the crawl space. Re-grading to keep water away from these vents is highly recommended for all crawl spaces, regardless if crawl space remediation work is planned.

3.6 Exterior Wall/Ceiling Juncture
High indoor relative humidity during the winter combined with a cool interior surface can result in condensation based mold growth on the cool surface. This commonly occurs at the exterior wall/ceiling juncture, particularly on wood frame structures with low-sloped roof pitches. This building condition restricts careful placement of ceiling insulation (reducing R-value) and is affected by cold winds through the soffit vents (Figure 12). Four homes had this problem. The attics were very similar to other attics in homes without this problem. Insulation is installed over the top plate and eave chutes are used to direct air over the insulation (Figure 13).
Though there were some localized wind-washing through the insulation contributing to the problem, it is presumed that the indoor humidity levels were high in these homes. The kitchen fan in one home was re-circulating and the bathroom fan was exhausting only 28 CFM.

### 3.7 Supply-only Ventilation System

In one six-year old home the supply-only ventilation system was included as part of the heating system, providing a fresh air intake duct to the return side of the furnace. Whenever the air handler is operating, fresh air is drawn into the system. A damper is often included on the fresh air intake duct to control the amount of air being drawn into the system and to close when the air handler is not operating.

The exhaust fan flow meter was used to determine the amount of air being drawn into the system. Measured flow was 0 CFM. At this point, the duct was disconnected at the damper. It was discovered that the connection from the fresh air intake duct was never made to the furnace return duct (Figure 14).

Another home had had a supply-only ventilation system which had been removed with only the fresh air intake duct connection remaining on the furnace return duct (Figure 15).

### SECTION 4: TECHNICAL RECOMMENDATIONS

The recommendations are based on the findings identified during the 2002 site visit:

#### 4.1 Site Drainage

Poor site drainage continues to be the principal finding. Efforts to divert rainwater/snow melt away from foundations were recommended. Recommendations included:

- Overall site grading to prevent water from flowing toward the homes. Constructing swales and French drains may be helpful in some cases.
- Grading directly at the foundation to ensure a soil pitch away from the foundations.
• Sealing crawl space vents on asphalt drives in a water-tight fashion. Install asphalt curbs against foundation to drain water away from home.

Improving site drainage is still a principal recommendation. Site drainage issues were being addressed and were successful.

• Continue to improve site drainage work at other homes identified with poor site drainage as budgets permit.

• Include site drainage work on all homes to receive major rehabilitation work (new roof, new windows, and interior finish work).

• Site drainage issues must be addressed where crawl space remediation work is planned. Crawl space remediation work includes foundation wall insulation, installation of a ground cover and sealing crawl space vents.

• Site drainage must be improved at the buildings under construction to prevent future crawl space moisture problems.

4.2 Rainwater/Snow Melt Management

Drip lines from rainwater and snow melt were visible around homes without gutter systems. Given poor site drainage, water collects around the home perimeter and drains along the foundation walls.

• Install gutters, downspouts, leaders and splash blocks to drain water away from the home, reducing the negative impact that poor site drainage.

• Continue to include gutter system installation as part of rehab work.

• As conditions and budgets permit, continue to drain gutter systems off-site through underground drain lines.

4.3 Bathroom & Kitchen Exhaust Fans; Clothes Dryers

No significant changes were found with respect to bathroom and kitchen exhaust fans since 2002. Properly operating exhaust fans are essential in removing moisture from bathrooms and kitchens. Fans must operate effectively at their rated capacity to remove moisture. Furthermore, the fans must vent all the way to the outside and not to the underside of attic vents.

• Replace inoperable exhaust fans with new fans with sone ratings no higher than 1.5. Low-sone fans include Broan Solitaire and Panasonic WhisperCeiling and WhisperLite series. Low-sone fans generally cost between $75 and $100.
• In some cases, a through the wall exhaust fan may be appropriate. One such fan is the Panasonic WhisperWall unit (70 CFM, 1.1 sones).

• 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 $40.

• 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 home 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 design eave vent designed for exhaust fan termination.

• As rehabilitation work is done in laundry areas, re-install flex duct to minimize bends and elbows. Install a dryerbox with to help make the transition if the dryer is located in a laundry room (Figure 16). Cost is about $20 (www.drybox.com).

• Periodically inspect dryer vents and correct the following conditions when found:
  - Install a dryer vent when missing or damaged.
  - Replace crimped or cracked dryer vents.
  - Reconnect disconnected dryer vents.
  - Replace plastic ribbed dryer vents with smooth metal vents as space permits.

4.4 Attic Hatch

Mold growth on insulation dams around the attic hatch was commonly found during both site visits. Though attic hatches were insulated, they were not air sealed. Warm moist air moved into the attic around the perimeter of the hatch. The moisture condensed on the wall of the insulation dam.

• Air seal attic hatches with positive closure. Install foam weatherstripping along the perimeter of the hatch stop. Use sash locks, gate hooks or another type of latch to provide positive closure of the hatch to the hatch stops.

• Insulate hatches to a minimum R38.

Figure 16 – “Dryerbox”
4.5 Crawl Space Design

The crawl space foundation walls form the thermal boundary in the LDFCHA homes. Continue crawl space remediation work as budgets permit.

- Seal and make existing crawl space vents watertight.
- Inspect and replace missing crawl foundation wall and rim joist insulation.
- Cover the soil surface in the crawl spaces with a continuous and sealed ground cover such as a concrete slab, polyethylene sheet of other vapor-proof material.
- Encourage occupants to keep their crawl spaces free of clutter.

4.6 Exterior Wall/Ceiling Juncture

Although not a significant problem in LDFCHA housing, localized mold growth at this juncture was found. Recommendations are made with respect to controlling indoor moisture levels and improving the insulation over the top plates.

- Carefully check previous recommendations with respect to site drainage, exhaust ventilation and crawl space ground covers in homes with this condition.
- Remove the existing fiberglass insulation over the top plates and beneath the ventilation chutes. Air seal between top plate and insulation baffle with two-part spray polyurethane foam (Figure 18). Replace fiberglass insulation.

Spray polyurethane foam has an R-value of 6 per inch. It is also impermeable to air flow. The foam should provide the necessary insulation and air seal to elevate the interior surface temperature of the wall/ceiling juncture.

4.7 Supply-only Ventilation System

The following recommendations are made for the supply air ventilation systems:

- Inspect fresh air intake ducts to ensure that they are connected to the furnace return duct.
- Inspect all fresh air intake grilles on the exterior of town homes. Clean grilles of dirt and debris and inspect at least twice a year.
- Consider installation of a timer, such as the *AirCycler*, to provide air circulation when the furnace or air conditioner is not being used (See Section 5.7).
SECTION 5 – DISCUSSION OF COMMON PROBLEMS

5.1 Site Drainage

Design and build the roof so water lands on the roof, moves to the edge, some percolates downward through the soil, more in sandy soils and less in clay soils and other moves along the soil surface following the slope, out to the downhill edge of the site. This is the best way to prevent mold and moisture problems in homes. The homes that have problems are the homes that allow water to accumulate in the soil that is in contact with the foundation. The soil that is in contact with the foundation should, in a well-managed property, be the driest soil on the site following a rainstorm. Homes with dry foundations (basements, crawl spaces and slabs) are usually dry houses. To keep the foundation dry, keep the soil dry that is next to the foundation.

Keeping the soil that touches the foundation dry involves a few 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 act like funnels that collect water from the edge of the roof and concentrate it in the downspout. On the land, valleys and swales act like collectors or funnels that concentrate the water on the site. If the water management design makes use of funnels (such as valleys, gutters or swales) then they require maintenance to make sure they work as they are intended. Damage is worst where a valley, gutter or swale is blocked.

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. 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 and fill with dirt. Tamp the fill material to prevent future settling. Provide sufficient fill material such that drainage occurs away from the foundation.

- If the house has no gutters, then the base of the soil around the house has to serve as a gutter. It should have a surface that helps prevent splash back onto the siding of the
house. 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. Soil at the outside corners of the foundation, where the downspouts are usually found, can always be tamped because the corner will never collapse inward.

- 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.

5.2 Rainwater/Snow Melt Management

Collect and distribute rainwater and snow melt from the roof away from the foundation with a gutter system. Make flashings around chimneys and vents watertight.

- Include waterproofing underlayment at the eaves and in valleys as part of re-roofing to help prevent water damage caused by ice dams.

- Gutters can be an effective rainwater/snow 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. Ensure the gutters hangers are solid so that they keep the gutter from sagging.

- Secure downspouts to the home. 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, the water has to be directed away from the foundation of the building. It should be directed out past the backfill onto the undisturbed soil, which may be 3' to 5' out from the edge of the house. If it is allowed to dump water close to the foundation, into the backfill, it will concentrate the water next to the foundation—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 (Figure 1). Instead, use a notched section of downspout that is hinged to the elbow at the base of the downspout. 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.

- Keeping gutters clean in wooded areas can be a maintenance issue. A gutter guard system can help 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) (Figure 19).

5.3 The Bathroom & Kitchen Exhaust Fans; Clothes Dryers

Several rooms in a house are natural moisture sources simply by the nature of their function. Showers result in 100% humidity in the bathroom. Kitchens use water for cooking and cleaning. In laundry rooms, clothes dryers 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 home until most of the moisture has been removed to the outside.

Vent bathroom exhaust fans, kitchen exhaust fans and clothes dryers to the outside rather than into the living space. Venting to the basement, crawl space and attic can lead to moisture problems occurring in these areas. 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 inoperable and recirculating kitchen exhaust fans should be replaced whenever possible with venting to the outside mandatory. The fans should have a minimum exhaust capacity of 150 CFM. Under no circumstances should recirculating fans be installed in place of the kitchen exhaust fans.

Use smooth-surfaced rigid duct or non-combustible flexible metal duct approved for dryer venting on dryer vents. Place duct joints in the direction of air flow. Do not fasten ducts with screws or fasteners that extend into the duct. Minimize the length of the duct run, especially with flexible metal duct. Install flexible metal duct without dips or sags. Insulate dryer vents extending through non-conditioned spaces.

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

Dryer vent caps should have a backdraft damper that closes when the dryer is not being used. Do not install insect screens or small wire cages over the vent cap.

### 5.4 Attic Hatches

Warm air rises during the winter due to the stack effect. Any penetration through the ceiling that is not air sealed will allow the air to pass through it. Moisture is also carried with the air that can condense on cold attic surfaces. Although the attic hatches were insulated, the perimeter of the hatches was not air sealed and mold was visible on the insulation dams in most of the inspected homes.

Air seal the hatches as shown in Figure 19. Install latches 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 20). 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.

5.5 Crawl Space Design

The thermal boundary is the building section that separates conditioned space from outside conditions. A clear distinction should be made as to 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. Crawl space vents indicate that the floor above the crawl space is the thermal boundary.

Both of the above conditions were found in the LDFCHA homes during the November 2002 site visit. The crawl space walls were insulated with 1" extruded polystyrene foam (R5) indicating the foundation walls form the thermal boundary. However, the crawl spaces were vented (analogous to opening a window in a heated room). If the crawl spaces are to be vented, then the floors above the crawl spaces should be insulated and air sealed with all mechanicals (ductwork, plumbing) above the insulation.

The mechanicals are currently exposed in the crawl spaces. Depending upon where the thermal boundary is located, one of two strategies may be employed. It is our recommendation that the crawl space foundation walls be the thermal boundary given the current conditions found in the homes.

- **Crawl Space Walls are the Thermal Boundary**

The crawl space is unvented (see Figure 21). It shows an exterior insulation system that allows a shallower frost wall, although the foundation wall may be insulated down to the

![Figure 21 - Crawl space walls are thermal boundary](image-url)
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.

In essence, the crawl space is designed as a short basement that is conditioned as a result of ductwork, and in some cases, with furnaces being located there. As unvented crawl spaces are not yet allowed by most codes, it may be necessary to add closeable vents to obtain a building permit.

The following points relate to crawl spaces in general, regardless of thermal boundary:

- Crawl spaces should have easy access and good lighting so as to enable regular inspections.
- Water in crawl spaces typically comes from poor rainwater management outdoors, plumbing leaks, air conditioner condensate or water softener discharge.
- Cover the ground surface 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. All joints and seams must also be sealed. The ground cover must also be sealed to foundation piers interior to the crawl space.

5.6 Exterior Wall/Ceiling Juncture

High relative humidity and cold surfaces can lead to mold growth. If a surface approaches the dew point temperature\(^1\) 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 often occurs at the wall/ceiling junction on exterior walls.

There are at least three reasons why the exterior wall/ceiling juncture gets cold:

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 over the plate.
3. The geometry of the corner usually means that slow-moving currents of warm air may not be able to reach into the corners (Figure 22).

\(^1\) Dew point temperature is the warmest temperature of a surface where water condensation from the surrounding air would form on that surface. If the surface temperature is increased, the dew point temperature also increases which decreases the potential for condensation to occur.
The dark spots occur where the interior surfaces are the coldest. They occur there because that is the hardest place to insulate effectively. Anyone who has tried to insulate an attic knows that it is difficult to carefully insulate the exterior edge of the attic, especially in homes with low-pitch roofs. With batt insulation, special pusher sticks may be used to get the insulation out to the edge. With loose fill insulation, the outside edge should be prepared correctly so that it is packed with insulation.

Many individuals and organizations (including 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 of the major drawbacks. Designs without attic ventilation may improve the performance of the eave area, and most designs without ventilation rely on verified airtightness of the ceiling plane for good moisture performance. For more information about the benefits and drawbacks of attic ventilation see “Venting of Attics and Cathedral Ceilings”.

5.7 Supply-only Ventilation System

The type of ventilation system found in the LDFCHA homes is a “supply only” type system. Supply only systems use a fan to force outside air into the building while air leaks out of the home through holes in the building shell. A simple “supply only” system uses the furnace air handler as the ventilation fan and the heating ducts as the distribution system. Ductwork is installed from the outside of the home to the return side of the furnace. Whenever the air handler operates, fresh air is drawn in from the outside and mixed with the return air. A balancing damper may be installed to control the amount of air being introduced to the home. The duct should be insulated to reduce condensation during the winter. A filter should also be installed between the duct and the return duct. A wall cap with insect screen should be installed on the outside of the wall.
The above system provides ventilation throughout the entire home, but only when the air handler is operating. The air handler is less likely to operate during the spring and fall (summer also if central air conditioning is not present). A timer control, such as the AirCycler, may be installed to assure ventilation year round.

The AirCycler is mounted on the furnace cabinet and wired to the air handler and tracks the operation of the air handler. If the air handler has not run for a certain period of time (20 minutes, for example), the AirCycler will turn the fan on for a period of time (10 minutes, for example). Both the “fan-off” and “fan-on” times are adjustable between 1 and 99 minutes. During periods of high heating or cooling, the air handler will probably run often and the AirCycler will not affect fan operation. Cost of the AirCycler controller is around $90.

A schematic of a supply only ventilation system with the AirCycler is shown in Figure 23.
### SUMMARY SITE VISIT REPORT

**Appendix A: Lac du Flambeau Chippewa Housing Authority**

**Inspection Number** | **Address** | **HUD Program** | **Building Age** | **Occupancy** | **Foundation Type** | **Model and Framing Type** | **Heat Type** | **Site Drainage Problems** | **Gutter System Problems** | **Leaks from Exterior** | **Wet Basement or Crawlspace** | **Plumbing Problems** | **Bathroom Problems** | **Exterior Wall/Ceiling Problems** | **Attic Problems** | **Visible Mold** | **CFM**
1.1 | 15505 Indian Village Road | Owner | 16 years | 7 | Basement - Concrete Block | Ranch | F.A. Propane | Yes | Yes | No | No | No | No | No | No | No | No | No | see note 1
1.2 | 3055 Artshon Lane | Owner | 50 years | 3 | Basement - Concrete Block | Ranch | F.A. Propane | Yes | Yes | No | Yes | Yes | No | No | Yes | No | Yes | 13 | 25
1.3a | 215 Makwa | LR | 22 | 4 | Basement - Poured Concrete | Ranch | F.A. Propane | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes | 14, 16 | 0
1.3b | 319 Makwa | MH | 22 years | 3 | Basement - Poured Concrete | Ranch | F.A. Propane | No | Yes | Yes | Yes | No | Yes | No | Yes | No | Yes | 14, 16 | 21
1.3c | 230 Makwa | LR | 22 years | 4 | Basement - Poured Concrete | Ranch | F.A. Propane | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | Yes | 14, 15, 16 | 28
1.6a | 408 Chippewa | LR | 30 years | 6 | Basement - Poured Concrete | 2-story | F.A. Propane | Yes | Yes | Yes | No | No | No | No | No | Yes | 11, 16 | 17/21
1.7a | 208 Chippewa | LR | 25 years | 6 | Crawl Space - Poured Concrete | Ranch | F.A. Propane | No | Yes | No | No | No | Yes | No | Yes | No | Yes | 14, 16 | 27
1.3b | 911 Old Abe Road | Owner | 6 years | 4 | Basement - Concrete Block | Ranch | F.A. Gas | Yes | Yes | No | Yes | No | No | Ni | Yes | 12, 16 | NT
1.4b | 1708 Thunderbird Lane | Owner | Est. 30 years | Unknown | Basement - Concrete Block | Ranch | Boiler, Propane | Yes | Yes | No | Yes | Yes | Ni | Ni | Ni | Ni | Yes | 12 | NT
1.5b | 520 Chicag | Owner | Est. 22 years | 4 | Basement - Concrete Block | Ranch | F.A. Gas | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | 12, 13, 16 | Non-operable
1.6b | 2810 Little Pine | Unknown | 20 | Unknown | Basement - Poured Concrete | Ranch | F.A. Propane | Yes | Yes | Yes | No | Yes | Ni | Ni | Ni | No | No | NT
1.7b | 265 Industrial Park | Owner | 19 | Unoccupied | Basement - Concrete Block | Ranch | F.A. Propane | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | 12, 14, 15, 16 | NT
2.1a | 4091 Little Tree | LR | 6 years | 5 | Basement - Poured Concrete | Ranch | F.A. Propane | No | No | No | Yes | No | No | No | Yes | 17 | 36/38
2.2a | 215 Chicag | LR | 30 years | 5 | Basement - Poured Concrete | Ranch | F.A. Propane | Yes | Yes | Yes | No | No | Yes | No | Yes | No | Yes | 14, 16 | 14 & non-operable
2.1b | 14180 Longs Point | LR | 30 | 11 | Basement - Concrete Block | 2-story | F.A. Propane | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | Yes | 14, 15, 16 | NT
2.2b | 414 Chicag | LR | 25 | 3 | Basement - Concrete Block | Ranch | F.A. Propane | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes | 16 | NT
2.3b | 213 Makwa | Owner | 22 | 3 | Basement - Poured Concrete | Ranch | F.A. Propane | Yes | Yes | No | No | No | Yes | No | Yes | No | Yes | No | NT
2.4b | 513 Chicag | Owner | Ext. 20 Years | Unknown | Basement - Poured Concrete | 2-story | F.A. Propane | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | 11, 13, 15 | Non-operable

1 = mutual help  
TK = Turnkey/Rent to Own  
LR = Low Rent  
Ni = Not Inspected  
NT = Not Tested

- **Note 1**: - power, could not measure exhaust fan flow  
- **Note 2**: leakage around new windows
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assistance Trip Report

Inspection Number: 1-1a
Address: 15505 Indian Village Road
Age: 16
House Type: Mutual help
Condition: Currently vacant
Bedrooms: 2
Foundation: Concrete block
Heat Type: FA Furnace (propane)
Construction: Stick-built, 2” x 4”

Mold and Moisture Conditions: A 2003 total rehabilitation was a result of basement flooding and reported high level of mold spores and occupant health issues. It included new exterior siding, roof and attic insulation, windows, interior gypsum board, and appliances. The interior basement walls and bandjoist were painted with a mold resistant paint. Occupants refused to move back into the home claiming it still had adverse health effects on the children.

No mold was found. However, a number of minor items related to moisture were identified which LDFCHA already had plans to address.

Rainwater Management: Site drainage was fairly good, except for the back yard, where the site pitched down near the back basement windows (Figure 2). The owner wanted to add bedrooms near this location. There was no gutter system on the home. LDFCHA had plans to re-grade the rear portion of the yard and install a gutter system.

Basement: The basement was very dry. The walls and bandjoist were painted with a mold resistant paint. The dryer vented to the outside through a flexible metallic duct. The exterior of the foundation wall was insulated with 1 inch foam board.

Bathroom/Kitchen: The bathroom exhaust fan could not be measured since power was turned-off to the home. The bathroom fan vented to the outside, however the tape connection to the roof outlet appeared to be failing (Figure 3). The kitchen fan was a re-circulating model.

Attic: The attic was insulated with approximately 10 inches of blown fiberglass insulation (Figure 4). No mold
was found in the attic.

**Heating System:** The house was heated with an 80% efficient forced air furnace. A central return system was used. The water heater was natural draft. At one point, a supply-only duct brought fresh air from the outside to the return side of the furnace (Figure 5). The duct was missing and the fresh air intake on the exterior of the home was removed.

**Occupant Notes:** Two adults and five children have lived in the home since 1988. The children reportedly have been tested positive for mold allergies.

**Recommendations:**

- Consider re-connecting fresh air duct to return side of furnace.
- Replace the re-circulating kitchen fan with one vented to the outside.
- Correct the grading problem in the back of the home.
- Install a gutter system on the home.
- Check the bathroom exhaust fan duct connection to the roof outlet to assure a tight connection and that the fan vents all the way through the roof.
- Replace the bathroom exhaust fan on/off switch with a mechanical timer or switch operated on relative humidity.
- Air-seal the attic hatch.
Appendix B: Lac du Flambeau Chippewa Housing Authority Technical Assistance Trip Report

September 8-10, 2004

Inspection Number: 1-2a
Address: 3055 Artishon Lane
Age: 50 +
House Type: Owner
Condition: Occupied
Bedrooms: 2
Foundation: Concrete block
Heat Type: FA furnace (propane)
Construction: Stick-built, 2" x 4"

Mold and Moisture Conditions: This house was a one-story with a walk-out basement finished as living space, including a bedroom and a bathroom. At one point, a new roof had been added over the existing roof.

Current rehabilitation included, installation of new windows, replacement of vinyl siding with fiber-cement siding, installation of a new metal roofing, site grading work at the front yard, and replacement of the gutter system.

The basement smelled musty. Some mold was found on the backside of gypsum board in the basement bathroom. The basement carpet was wet, but no mold was found under the carpet or on the basement wall gypsum board. Ice dams have been a problem over the deck. No mold was found on the main level of the home.

Rainwater Management: This home was built into a side of hill overlooking a lake. Site drainage in the front yard was flat (Figure 2). At this location water was found in the basement. Site drainage along both the sides and back of the home appeared to be good. Ice dams had damaged a gutter over the deck (Figure 3).

Basement: The basement was finished as living space including a bedroom and bathroom. Mold was found on the backside of the bathroom near the tub location (Figure 4). The carpet was also very wet at the back wall (Figure 5). No mold was found either
under the carpet or on the gypsum board. The exterior basement wall was insulated with 1 inch foam board.

**Bathrooms/Kitchen:** The basement bathroom had no exhaust fan. The bath fan on the main level measured 25 CFM. The kitchen fan vented outside, as did the dryer vent.

**Attic:** Two roof cavities were inspected. An attic over the back of the home was insulated with about 10 inches of cellulose. At the back of the home was a cathedral ceiling. Fascia was removed above the deck to inspect the roof cavity (Figure 6). Insulation was compressed over the top plate (Figure 7). There was no air barrier above eave soffit at the top plate (Figure 8). No mold was found on the roof sheathing.

**Heating System:** The house was heated with a forced air furnace. The water heater was power vented. Combustion gases were vented through plastic ribbed duct that appeared to be against code (Figure 9).

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

**Recommendations:**

- Correct the site drainage in the back yard and install a gutter system; follow-up to determine if the basement water leakage was solved by these two measures.
- Install low-sone bathroom exhaust fans with mechanical timers in both bathrooms.
- Check the compliance of the water heater vent; replace with the correct vent material, if necessary.
- Air-seal above the eave soffit with rigid material, such as 1 inch foam board or plywood.
- Fill the rafter cavity above the cathedral ceiling with dense-pack cellulose; eliminate all ventilation from the underside of the new roof deck.
- Air-seal attic hatch.
Appendix B: Lac du Flambeau Chippewa Housing Authority Technical Assistance Trip Report

Inspection Number: 1-3a
Address: 215 Makwa
Age: 22 years
House Type: Low rent
Condition: Occupied
Bedrooms: 4
Foundation: Poured concrete
Heat Type: FA furnace (propane)
Construction: Site built, 2" x 4"

Mold and Moisture Conditions: The home had a history of basement flooding. Excavation was done in 2001 and new drain tile were installed. The basement walls were damp, particularly in the corners. The dryer vent was disconnected. The bathroom ceiling was moldy and the bathroom exhaust fan measured 0 CFM. Mold was found on the roof sheathing near the end of the bathroom exhaust fan duct.

Rainwater Management: Site drainage was fairly flat. A gutter system and sump pump discharge drained away from home (Figure 2). A gutter on the rear of the home was damaged, possibly due to ice dams.

Basement: The basement corners were damp (Figure 3). The dryer vent was disconnected (Figure 4). Occupant indicated that the dryer was not being used until the vent was replaced.

Bathroom/Kitchen: The bathroom fan measured 0 CFM and was controlled by a separate switch. The ceiling was moldy (Figure 5). The kitchen fan was re-circulating.

Attic: The attic was insulated with about 10 inches of blown fiberglass. A common bypass
was well sealed around the masonry chimney (Figure 6). The bathroom exhaust fan duct had a tortuous path and terminated under the ridge vent where mold was found (Figures 7 & 8). An insulation dam around the attic hatch was moldy (Figure 9).

**Heating System:** A forced air furnace was used as the heating system. A wood stove was used as a secondary heating system. The water heater was natural draft.

**Occupant Notes:** One adult and three children lived in the home.

**Recommendations:**

- Install low-sone bathroom exhaust fan mechanical timer.
- Re-duct bathroom exhaust fan with smooth metal duct; insulate duct and vent all the way through the roof.
- Use smooth metal duct for the clothes dryer.
- Install kitchen exhaust fan vented to the outside.
- Repair gutter on rear of home.
- Air-seal attic hatch.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assistance Trip Report

September 8-10, 2004

Inspection Number: 1-4a
Address: 319 Makwa
Age: 22 years
House Type: Mutual help
Condition: Occupied
Bedrooms: 3
Foundation: Poured concrete
Heat Type: FA furnace (propane)
Construction: Site built, 2” x 4”

Mold and Moisture Conditions: The basement smelled musty. Water was reported entering into the basement around a rear basement window. Mold was found in the roof sheathing near the termination of the bathroom exhaust fan duct. Minor mold was found in the bathroom above the tub.

Rainwater Management: Site drainage was fairly flat. The basement window wells were covered with plastic enclosures (Figure 2). There was no gutter system on the home.

Basement: The basement smelled musty, but no signs of water were found. Occupant indicated that water would come into the basement around the rear basement window (Figure 3). This same window had a plastic enclosure. The dryer was vented to the outside.

Bathroom/Kitchen: The bathroom fan measured 21 CFM and was controlled by a separate switch. A small amount of mold was found on the bathroom ceiling. The kitchen fan was re-circulating.

Attic: The attic was insulated with about 10 inches of blown fiberglass. The bathroom exhaust fan duct terminated under the ridge vent and mold was present on the sheathing. Sharp bends and elbows found on the bathroom exhaust fan duct reduced the exhaust capacity of the fan (Figure 4).

Heating System: A forced air furnace was used as the heating system. The water heater was natural draft.
Occupant Notes: One adult and two children lived in the home.

Recommendations:

- Do additional grading around the windows wells to ensure drainage away from home.
- Install a gutter system on the home.
- Install low-sone bathroom exhaust fan with a mechanical timer.
- Re-duct bathroom exhaust fan with smooth metal duct; insulate duct and vent all the way through the roof.
- Install kitchen exhaust fan vented to the outside.
- Air-seal the attic hatch.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assistance Trip Report

Inspection Number: 1-5a
Address: 230 Makwa
Age: 22 years
House Type: Low rent
Condition: Occupied
Bedrooms: 3
Foundation: Poured concrete
Heat Type: FA furnace (propane)
Construction: Site built, 2” x 4”

Mold and Moisture Conditions: Mold was visible at the top plate on the exterior walls, on the window in the back bedroom, on the roof sheathing around the bathroom exhaust fan duct, and at the insulation dam around the attic hatch.

Rainwater Management: Site drainage was fairly flat. There was no gutter system on the home. Drip lines were visible at the front and back of the home (Figure 2).

Basement: The basement was dry. The dryer vented to the outside. The sump pump appeared functional.

Bathroom/Kitchen: The bathroom fan measured 28 CFM and was controlled by a separate switch. Some mold was found on the bathroom ceiling. The kitchen fan was re-circulating.

Mold was visible at the juncture of the exterior wall and ceiling along the top plate (Figure 3). Mold was also visible on the back bedroom window sash.

Attic: The attic was insulated with about 10 inches of blown fiberglass. The bathroom exhaust fan duct terminated under the ridge vent and mold was present on the sheathing. Sharp bends and elbows found on the bathroom exhaust fan duct reduced the exhaust capacity of the fan. Mold was growing on the insulation dam around the attic hatch.

The top plates were insulated. The presence of mold would indicate high indoor humidity levels and/or wind-washing through the insulation from the soffit vents. Given that this
home is very similar to the previous two inspected homes and that the top plate insulation in this home was very similar to the previously inspected attics (Figure 4), it is presumed that the indoor humidity levels are high.

**Heating System:** A forced air furnace was used as the heating system. A wood stove was used as back-up heating. The water heater was natural draft.

**Occupant Notes:** Two adults and two children lived in the home.

**Recommendations:**

- Install gutter system on home.
- Install low-sone bathroom exhaust fan mechanical timer.
- Re-duct bathroom exhaust fan with smooth metal duct; insulate duct and vent all the way through the roof.
- Install kitchen exhaust fan vented to the outside.
- Air-seal attic hatch.
- If mold over top plates persist, remove 12 inch of insulation back from top plate and insulate with two-part spray polyurethane foam to a depth of 4".
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assistance Trip Report

September 8-10, 2004

**Inspection Number:** 1-6a  
**Address:** 408 Chippewa  
**Age:** 30 years  
**House Type:** Low rent  
**Condition:** Occupied  
**Bedrooms:** 4  
**Foundation:** Poured concrete  
**Heat Type:** FA furnace (propane)  
**Construction:** Site built, 2” x 4”

**Mold and Moisture Conditions:** Occupant indicated that water enters at the base of the wall in the unfinished basement section. New windows were installed in the spring of 2003 and the occupant has reported condensation problems on the windows.

No significant signs of moisture were found on the basement walls. Some windows were covered with heavy fabrics restricting airflow across the window and causing condensation problems. Some interior window trim had been removed and the resulting rough opening cavity was not air-sealed.

Mold was also present on the roof sheathing around the bathroom exhaust fan ducts and the insulation dam around the attic hatch.

**Rainwater Management:** Site drainage was fairly flat, especially near the report basement leakage area (Figure 2). There was no gutter system on the home.

**Basement:** The basement was dry. The dryer vented to the outside. Windows in both basement bedrooms had condensation problems. One window was covered with a heavy fabric (Figure 3).

**Bathroom/Kitchen:** The lower level bathroom fan measured 17 CFM. The upper level bathroom fan measured 21 CFM. Both fans were wired to the ceiling light even though there was a separate switch for the fans. The kitchen fan vented to the outside.

**Attic:** The attic was insulated with about 12 inches of blown fiberglass. The roof sheathing was moldy (Figure 4). A large bypass was found next to the...
furnace flue (Figure 5). Such a bypass can cause basement moisture to rise into the attic during the winter and condense on the roof sheathing.

**Heating System:** A forced air furnace was used as the heating system. Supply air registers to the basement bedrooms were located in the center of the ceiling. There was insufficient airflow to both bedrooms, so both were cooler which further lowered the dew point temperature on the windows.

**Occupant Notes:** Two adults and four children lived in the home.

**Recommendations:**

- Install a gutter system on the home.
- Check the grading at the front basement wall; increase the pitch away from the home, if possible.
- Install low-sone bathroom exhaust fans in both bathrooms with either mechanical timers or fan-delay switches.
- Re-duct all exhaust fans with smooth metal duct; insulate duct and vent all the way through the roof.
- Air-seal the attic bypass around the furnace flue with flashing and high temperature caulk.
- Air-seal the attic hatch.
- If possible, replace the heavy fabrics with blinds on the windows.
- Measure airflow to both basement bedrooms; re-balance system to increase the airflow.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assistance Trip Report

Inspection Number: 1-7a
Address: 208 Chippewa
Age: 25 years
House Type: Low rent
Condition: Occupied
Bedrooms: 3
Foundation: Poured concrete
Heat Type: FA furnace (propane)
Construction: 2" x 4", modular

Mold and Moisture Conditions: Some mold was found on the bedroom windows, the roof sheathing above bathroom, and on the insulation dam around the attic hatch. The bathroom exhaust fan was disconnected.

The crawl space work was completed two years ago. Walls were insulated with 1 inch foam, the crawl space vents were sealed, and a new ground cover was installed. The crawl space was very dry.

Rainwater Management: The site drainage was fairly flat. The crawl space vents were located near grade (Figure 2). Even though vents were sealed, water entry was a possibility. There was no gutter system on the home.

Crawl Space: The crawl space was dry. The foundation insulation and ground cover were installed very well with all of the joints in the ground cover being sealed (Figure 3).

Bathroom/Kitchen: The bathroom exhaust fan was controlled by a humidistat located in the hallway, however the fan was disconnected. The fan measured 27 CFM when it was reconnected and was very loud. The fan vented to the outside, as did the kitchen fan. The dryer vent was disconnected (Figure 4).

Attic: The attic was insulated with about 12 inches of fiberglass batt insulation. The roof sheathing was moldy above the bathroom. Mold was also found around the attic hatch.
Heating System: A forced air furnace was used as the heating system. A central supply was used and the filter was very dirty (Figure 5). The water heater was a direct vent sealed combustion model (Figure 6).

Occupant Notes: Two adults and four children lived in the home.

Recommendations:

- Install a gutter system on the home.
- Install low-sone bathroom exhaust fans in both bathrooms; check the operation with a humidistat.
- Inspect the bathroom exhaust fan duct; if flex duct, replace with a smooth metal duct and ensure that it vents all the way through the roof.
- Vent the dryer with a smooth metal duct.
- Encourage the occupant to change the filter on a monthly basis.
- Air-seal attic hatch.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assistance Trip Report

<table>
<thead>
<tr>
<th>Inspection Number: 2-1a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address: 4091 Little Tree</td>
</tr>
<tr>
<td>Age: 6 years</td>
</tr>
<tr>
<td>House Type: Low rent</td>
</tr>
<tr>
<td>Condition: Occupied</td>
</tr>
<tr>
<td>Bedrooms: 3</td>
</tr>
<tr>
<td>Foundation: Poured concrete</td>
</tr>
<tr>
<td>Heat Type: FA furnace (propane)</td>
</tr>
<tr>
<td>Construction: 2” x 6”, modular</td>
</tr>
</tbody>
</table>

Mold and Moisture Conditions: The basement had been flooding. Gutters have been installed which have helped. Site grading was done to drain water away from the home. Mold was found on the insulation dam around the attic access hatch and on the kitchen windows. The fresh air supply to the furnace was never connected.

Rainwater Management: The house was built too low to the ground. Re-grading was done to direct water away from the home (Figure 2). A gutter system was installed. Rainwater was drained away from the home through buried plastic drain lines.

Basement: The basement was wet around the water softener (Figure 3). The dryer was vented to the outside.

Bathroom/Kitchen: The main bathroom fan measured 36 CFM. The fan in the master bedroom bath measured 38 CFM. Both fans were rated for 70 CFM, controlled by a separate on/off switch, and vented to the outside. The kitchen fan was recirculating.

Attic: The attic was insulated with about 12 inches of blown fiberglass insulation. Mold was found around the attic hatch insulation dam (Figure 4).

Heating System: The furnace was direct vent sealed combustion. The water heater was natural draft. A supply-only ventilation was installed to provide outside air to the return side of the furnace (Figure 5). However, the supply-only duct was never connected to the return duct. That is, a hole was never cut into
the return duct (Figure 6). As a result, no fresh air was being brought into the home.

**Occupant Notes:** Two adults and three children lived in the home.

**Recommendations:**

- Connect supply-air only system to return duct.
- Install low-sone bathroom exhaust fans in both bathrooms.
- Control fans with mechanical timers.
- Inspect bathroom exhaust fan ducts; if flex duct, replace with smooth metal duct, and ensure that ducts vent all the way through the roof.
- Vent the dryer with a smooth metal duct.
- Air-seal the attic hatch.
Appendix B: Lac du Flambeau Chippewa Housing Authority  
Technical Assistance Trip Report  
September 8-10, 2004

**Inspection Number:** 2-2a  
**Address:** 215 Chicag  
**Age:** 30 years  
**House Type:** Low rent  
**Condition:** Occupied  
**Bedrooms:** 3  
**Foundation:** Poured concrete  
**Heat Type:** FA furnace (propane)  
**Construction:** 2” x 4”, modular

**Mold and Moisture Conditions:** Mold was found on the roof sheathing. Exhaust fans vented to the underside of the roof vents. Minor mold growth was found on the ceiling above the bathtub.

Rehabilitation work was just beginning on the home. Work would include new windows, new roof (including sheathing), gutters, and re-grading.

**Rainwater Management:** The house was built very low to the ground. A hole had opened-up under the back door stoop (Figure 2) adjacent to the basement wall. Re-grading would be done to direct water away from the home. A gutter system would be installed.

**Basement:** The basement was dry. Part of the basement was finished as a sleeping area that included a rug. Due to furniture placement, the rug could not be pulled back for inspection. The dryer was vented to the outside.

**Bathroom/Kitchen:** The main bathroom exhaust fan did not work. Minor mold growth was found on the ceiling (Figure 3). The fan vented to the underside of a roof turbine vent (Figure 4). The fan in the half-bathroom measured 14 CFM. Both fans were controlled by a separate on/off switch. The kitchen fan vented to the attic.

**Attic:** The attic was insulated with about 12 inches of fiberglass batt insulation. Mold was found on the roof sheathing.
**Heating System:** A return grille was cut into the return air plenum at the furnace (Figure 5). The furnace filter was also very dirty. A wood stove was used for supplemental heat. The water heater was natural draft.

The return air grille was probably cut into the plenum to provide air circulation to the sleeping area. However, this return may be short-circuiting the return air in the main body of the home. That is, the main body of the home may be receiving insufficient air flow. Furthermore, the return grille acted to pull basement pollutants into the air distribution system that may cause an indoor air quality problem. Should the house become too-tight as a result of the rehabilitation work, backdrafting the water may become an issue.

**Occupant Notes:** Three adults and two children lived in the home.

**Recommendations:**

- Seal the return air grille on the plenum; should the grille not be sealed, conduct a house depressurization test following the rehabilitation to assure proper draft of the water heater.

- Encourage the occupants to change filters on a monthly basis.

- Install low-sone bathroom exhaust fans in both bathrooms.

- Control the fans with mechanical timers.

- Vent the bathroom exhaust fans with smooth metal duct and ensure that the ducts vent all the way through the roof.

- Vent the kitchen fan with a smooth metal duct and vent all the way through the roof.

- Air-seal the attic hatch.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assessment Report

September 8-10, 2004

Inspection Number: 1-3l
Address: 911 Old Abe Road
Age: 6 years
Model Type: Ranch
Bedrooms: 3
Foundation: Concrete block
Heat Type: NG Forced-air
Construction: 2 x 4 Wood Frame

Figure 1: 911 Old Abe Road; Front elevation

Mold and Moisture Conditions: This home had moisture leaking through the basement walls (Figures 2-4).

Site Drainage and Rainwater Management: No guttering system was present. The grade at the front of the home was flat and at the rear of the home the grade dropped down toward a lake. Numerous depressions were along the perimeter of the home and next to window wells (Figure 3). There was a particularly bad drainage problem on the front side of the home where the garage butted up to the home (Figure 4). The garage roof drained into a depression next to the foundation and saturated the ground at this area.

Foundation Conditions: The basement had masonry block foundation walls and smelled musty. At several locations the masonry was wet (Figures 5) and some were growing mold.

Exterior Conditions: The exterior of the home was in good condition. The windows and doors had been replaced approximately two years ago.

Bathroom: The bathroom was not inspected because it was in use.

Kitchen: No plumbing problems were found and the gas range had a range hood that was vented to the exterior.

Interior Conditions: The occupants primarily wanted the basement inspected, therefore much of the first floor habitable spaces were not. What was observed was in good condition, other than missing carpet.

Attic: The attic was vented with soffit vents and a ridge vent, was very well insulated, had ventilation baffles along the perimeter, and the duct connecting the bath fan to the...
roof cap was insulated. The roof sheathing was in good condition. The attic hatch was not air-sealed and the OSB insulation dam had mold growth due to an air bypass (Figure 7).

**Occupant Notes:** Two adults and two children lived in this home and the mother was expecting.

**Discussion/Recommendations:** Problems in this home were primarily moisture infiltration through the basement walls due to poor rainwater management and possibly groundwater, since the home was situated between two lakes.

**On the Exterior:**

1. Install metal gutters to manage rainwater. Drain the gutters away from the structure preferably through an underground conduit to daylight at the rear of the site. Managing rainwater will help keep the site surrounding the home drier than it currently is.

2. Ensure drainage moves away from the foundation. Fill all or the depressions near the foundation and window wells.

3. The sump discharged immediately next to the foundation (Figure 8). Extend the discharge to deposit water at least three feet away from the home, preferably further. The grade at the rear of the home dropped off toward the lake so the discharge could be run underground to daylight further away from the house.

4. The dryer exhaust blew into a window well. Move the vent so the warm moist air does not blow into the well where it can condense and concentrate moisture next to the basement windows.

**On the Interior:**

1. The basement had clutter on the floor (Figure 9). Cardboard boxes and clothes can all serve as a host and a food source for mold to grow on, so store on shelving off the floor.

2. Scrub basement walls with soap and water and use a dehumidifier to dry the basement thoroughly. Once dry, paint the walls with a wall disinfectant (such as Foster 40-80), and then finish coat the walls with a fungicidal protective coating (such as Foster 40-20).
3. If managing rainwater, filling depressions around the house, and discharging the water away from the house do not resolve moisture problems, the moisture source is from groundwater. A dehumidifier would be very beneficial to help keep the basement dry and the dehumidifier could be drained into the sump pit so that residents do not have to constantly empty it.

4. Air-seal the attic hatch with weatherstripping or a gasket to eliminate air bypass around the perimeter of the hatch.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assessment Report

Inspection Number: 1-4b
Address: 1708 Thunderbird Lane
Age: ~30 years
Model Type: Ranch
Bedrooms: 3
Foundation: Concrete block
Heat Type: Boiler w/baseboard heat (propane)
Construction: 2 x 4 Wood Frame

Mold and Moisture Conditions: The basement of this home was inspected and mold was found in one corner on the walls, floor and on equipment for the water supply system (Figure 2). It appeared that the equipment was leaking and there was substantial moisture in this area.

Site Drainage and Rainwater Management: No guttering system was present. The grade at the front of the home was flat and the grade at the rear sloped toward the foundation (Figure 3).

Foundation Conditions: The basement had masonry block foundation walls. The basement appeared dry except around the pressure tank.

Exterior Conditions: The exterior of the home was in good condition although the roof would need replacement in the next few years.

Bathroom: The bathroom was not inspected.

Kitchen: The gas range had a range hood that was vented to the exterior.

Interior Conditions: The basement had the previously mentioned leak problems with the water system. The washing machine emptied into a laundry sink (Figure 4) which then drained into an open sump pit (Figure 5) from where the effluent was pumped into the sewage system. There was an open pipe to the sewage system (Figure 6).

Attic: The attic was not inspected but from the exterior, soffit vents, gable end vents and a turbine were present to ventilate the attic space.
Discussion/Recommendations:

On the Exterior:

1. Install metal gutters to manage rainwater. Drain the gutters away from the structure preferably through an underground conduit to daylight at the rear of the site. Managing rainwater will help keep the site surrounding the home drier than it currently is.

2. Ensure positive drainage away from the foundation. Fill all of the depressions near the foundation and window wells.

On the Interior:

3. Store boxes, preferably plastic containers, on shelving off the floor.

4. Fix the leak in the water system.

5. In the back corner of the basement where the leaking water system is, scrub basement walls with soap and water and use a dehumidifier to dry the basement thoroughly. Once dry, paint the walls with a wall disinfectant (such as Foster 40-80), and then finish coat the walls with a fungicidal protective coating (such as Foster 40-20).

6. Cap the open waste pipe in the basement. The concern is that if the trap at the base of the pipe dries out, sewer gasses would be able to vent into the basement.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assessment Report

September 8-10, 2004

Inspection Number: 1-5b
Address: 520 Chicag
Age: ~22 years
Model Type: Ranch
Bedrooms: 3
Foundation: Concrete block
Heat Type: NG Forced-air
Construction: 2 x 4 Wood Frame

Mold and Moisture Conditions: Portions of the roof sheathing in this home were very moldy (Figure 2). The basement also had mold growing on the walls and the underside of the first floor sheathing due to numerous plumbing leaks (Figure 3). In the basement, the washing machine had overflowed and flooded the basement floor (Figure 4).

Site Drainage and Rainwater Management: No guttering system was present. The grade surrounding the house was flat. There were numerous depressions along the perimeter of the house and next to window wells.

Foundation Conditions: The basement had concrete walls that at certain locations had mold on them.

Exterior Conditions: The exterior of the building was clad with vinyl siding which was in poor condition due to several holes through the siding (Figure 5). The roof had three turbines, one of which was missing leaving a large hole into the attic (Figure 6). There were small trees growing out of the window wells (Figure 7). The sump discharged next to the foundation (Figure 8).

Bathroom: The toilet in the guest bath was not secure to the floor and the vinyl tile flooring surrounding it was partially missing, exposing soft, wet, and rotting subflooring (Figure 9). The bath fan did not work.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assessment Report

September 8-10, 2004

Kitchen: There was evidence of a leak beneath the kitchen sink (Figure 10). The gas range had a range hood that was vented to the exterior.

Interior Conditions: The flooded basement was a serious problem as were all of the plumbing leaks. The abundance of moisture has contributed to the deterioration of subflooring, cabinets, and finish surfaces.

Attic: The attic was vented with soffit vents and turbines. One of the turbines was missing which left a large hole in the roof allowing for the entry of rain. The attic was well insulated, but ventilation baffles along the perimeter were not evident. The bath fan ductwork was hung from the roof trusses and pointed toward a turbine (Figure 11). At certain locations, the roof sheathing had extensive mold on it. The attic hatch was not air sealed. From the exterior, the roof surface was very uneven and appeared to need attention.

Discussion/Recommendations:

On the Exterior:

1. The roof sheathing had been compromised by mold and moisture. Strip roof shingles and remove and replace all moldy sheathing. Reshingle the roof and install a ridge vent instead of the turbines. Install roof vents for both bath fans and the range hood at the same time.

2. Install metal gutters to manage rainwater. Drain the gutters away from the structure. Managing rainwater will help keep the site surrounding the home drier than it currently is.

3. Ensure positive drainage away from the foundation. Fill all of the depressions near the foundation and window wells and remove the trees from the window wells.

4. The sump discharges immediately next to the foundation. Extend the discharge so it deposits water at least three feet away from the home, preferably further.

On the Interior:

1. Fix whatever is causing the washing machine to flood the basement. This huge surface area of water imparts a huge moisture load on the home. After the leak is repaired, run a dehumidifier and drain it into the sump.
2. Scrub basement walls with soap and water and use a dehumidifier to dry the basement thoroughly. Once dry, paint the walls with a wall disinfectant (such as Foster 40-80), and then finish coat the walls with a fungicidal protective coating (such as Foster 40-20).

3. Fix kitchen plumbing leaks.

4. Gut the bathroom to properly repair. Remove all fixtures so the subfloor can be removed and replaced. Replace subfloor and replace flooring with sheet goods rather than tile. Sheet goods are more durable than vinyl tile and provide greater protection for the subfloor.

5. Properly vent the bath fans and kitchen range hood to the exterior through insulated ducts that are securely connected to roof vents.

6. Air-seal the attic hatch with weatherstripping or a gasket to eliminate air bypass around the perimeter of the hatch.
Inspection Number: 1-6b
Address: 2810 Little Pines Road
Age: ~20 Years
Model Type: Ranch
Bedrooms: 3
Foundation: ½ bsmt., ½ crawl
Heat Type: Propane Forced-air
Construction: 2 x 4 Wood Frame

Mold and Moisture Conditions: There was moisture in the basement around the floor drain (Figure 2) from furnace condensate and the waste pipe where it exited the house (Figure 3).

Site Drainage and Rainwater Management: No guttering system was present. The grade surrounding the house was flat. Concentrated roof drainage from a valley had caused damage to exterior insulation covering the foundation wall (Figure 4).

Foundation Conditions: The half-basement had concrete walls which were in good condition. The only cause for concern was leakage around the perimeter of the waste pipe where it penetrated the concrete wall.

Exterior Conditions: The exterior of the building was clad with vinyl siding which was in good condition. Exterior insulation covering the foundation was damaged due to uncontrolled and concentrated runoff from a roof valley (Figure 4).

Bathroom: The bathroom was not inspected. The bath exhaust was near the soffit vents outside

Kitchen: The kitchen was not inspected.

Interior Conditions: The interior was not inspected.

Attic: The attic was not inspected.
Discussion/Recommendations:

On the Exterior:

1. Install metal gutters to manage rainwater. Drain the gutters away from the structure. Managing rainwater will help keep the site surrounding the home drier than it currently is.

2. Relocate the bath exhaust vents to vent out the roof further away from the soffitt vents or eliminate the soffit vents.

On the Interior:

3. Resolve the leak around the waste pipe. Install gutters to solve this problem by drying the ground next to the structure.

4. Beneath the waste pipe penetration through the foundation, scrub the basement walls with soap and water and use a dehumidifier to dry the basement thoroughly.

5. Run the furnace condensate waste pipe so that it empties directly into the floor drain rather than onto the floor near the drain.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assessment Report

Inspection Number: 1-7b
Address: 265 Industrial Park
Age: 19
Model Type: Ranch
Bedrooms: 3
Foundation: Block wall
Heat Type: Propane Forced-air
Construction: 2 x 4 Wood Frame

Figure 2: Mold behind former upper cabinets
Figure 3: Corner behind former kitchen base cabinets
Figure 4: Mold at truss bearing points
Figure 5: Closet wall to ceiling mold
Figure 6: Mold at base of wall in exterior corner
Figure 7: Slight mold on window frames and sashes
Figure 8: Slight mold above tub area
Figure 9: Moldy base of walls in basement
Figure 10: Slope at the rear of the house has questionable drainage.

Mold and Moisture Conditions: There was moisture damage and mold throughout this home; behind former kitchen cabinets (Figure 2 & 3), at truss bearing points (Figure 4), at the wall to ceiling junction (Figure 5), at the base of walls in exterior corners (Figure 6), at windows (Figure 7), in the bathroom (Figure 8), and on basement walls (Figure 9).

Site Drainage and Rainwater Management: No guttering system was present. The front grade of the home was flat and the grade dropped away from the house toward the rear. A depression at the back of the home at the basement windows did not appear to have significant slope away from the structure (Figure 10).

Foundation Conditions: The basement had masonry block foundation walls with mold growth on and near the base of the walls.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assessment Report

Exterior Conditions: The exterior of the home was in relatively good condition except for a few locations where the vinyl siding had holes in it (Figure 11).

Bathroom: The bath had some mold on the walls and ceiling but it was not as severe as in the rest of the home. The bath fan functioned ineffectively. The toilet supply leaked (Figure 12).

Kitchen: Kitchen cabinets had been removed disclosing mold growth on the walls in the exterior corner. The former range hood was vented to the exterior.

Interior Conditions: Interior conditions were rough, since remodeling efforts had been initiated but then halted. There was the common mold at truss bearing points, in closets at exterior walls, and at the base of walls at exterior corners. Window frames and sashes had a slight film of mold near the base of the windows.

Attic: The attic was vented with soffit vents, gable end vents, and a ridge vent. The attic was not accessed, but the attic hatch was open disclosing water condensation on the attic hatch insulation dam (Figure 13). The visible roof sheathing appeared in good condition.

Occupant Notes: Although this home was vacant at inspection, five occupants had lived there previously.

Discussion/Recommendations:

Problems in this home were primarily due to insulation deficiencies.

On the Exterior:

1. Install metal gutters to manage rainwater. Drain the gutters away from the structure preferably through an underground conduit to daylight at the rear of the site. Managing rainwater will help keep the site surrounding the home drier.

2. Ensure positive drainage away from the foundation near the basement windows.

3. Repair all holes in the vinyl siding.
On the Interior:

4. Remove small areas of mold with soap and water. In areas of more severe mold, remove compromised drywall. Inspect the interior of the wall for mold damage and repair and/or clean as necessary. Ensure that everything is well insulated before installing a vapor barrier and new drywall.

5. Wash, lightly sand and refinish window frames and sash.

6. Repair the toilet supply plumbing leak.

7. Replace the existing bath fan with a high quality bath fan. To ensure it is used, either hard-wire the fan to the bath light so that it runs every time the light is turned on, or consider a programmable switch that keeps the fan running for a programmed period following bathroom use. (Available from Energy Federation Incorporated, www.efi.org, Fan/Light Time Delay Switch).

8. In the attic, install ventilation baffles between trusses at the perimeter of the house and install fiberglass tight to the bottom of the baffle. Make sure the insulation covers the top plates.

9. Inspect the attic to ensure sufficient insulation and no voids around plumbing vents, electrical wires, and the bath exhaust fan.

10. Air-seal the attic hatch with weatherstripping or a gasket to eliminate air bypass around the perimeter of the hatch.

11. Scrub the basement walls with soap and water and use a dehumidifier to dry the basement thoroughly. Once dry, paint the walls with a wall disinfectant (such as Foster 40-80), and then finish coat the walls with a fungicidal protective coating (such as Foster 40-20).

12. Make sure that at locations where the supply air ducts are adjacent to the bandjoist, there is a good thermal break between the duct and the bandjoist (Figure 14). Rigid insulation would be preferable at these particular locations.

13. Install a sill below the basement windows to cover the open concrete block cores (Figure 15). A substance other than wood would be preferable such as a strip of cultured marble or some other type of non-organic solid substance material.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assessment Report

Inspection Number: 2-1b
Address: 14180 Longs Point Lane
Age: ~30 Years
Model Type: 2-story
Bedrooms: 4
Foundation: Block wall basement
Heat Type: Propane Forced Air
Construction: 2 x 4 Wood Frame

Mold and Moisture Conditions:
There were several instances of moisture damage, but only a few instances of mold. There were a few wall to ceiling spots of mold (Figure 2).

Site Drainage and Rainwater Management: No gutter system was present. The grade surrounding the home was flat and there were several depressions next to the foundation (Figure 3).

Foundation Conditions: The basement had masonry block foundation walls which was dry. There was clutter in the basement.

Exterior Conditions: The exterior needed repair in several areas. The soffits were badly damaged (Figure 4), the siding had worked itself loose and the gable end vent was damaged (Figure 5). The sump discharged next to the foundation (Figure 6).

Bathroom: The bathroom was in marginally poor condition. There was missing floor tile (Figure 7) and the bath fan barely worked. The toilet flange had a leak that had been repaired (Figure 8).

Kitchen: The gas range had an exhaust that was vented to the exterior. The kitchen sink base had been repaired due to moisture damage from plumbing leaks (Figure 9).
**Interior Conditions:** The interior had holes through drywall, missing floor tile, damaged cabinets, and poorly working exhaust fans to be repaired (Figure 10).

**Attic:** The bath fans vented into the attic (Figure 11) with evidence of delamination of the roof sheathing. Minor mold was on the attic hatch insulation dams. The hatch itself was not insulated.

**Discussion/Recommendations:**

On the Exterior:

1. Install metal gutters to drain away from the home preferably through an underground conduit to daylight.

2. Ensure positive drainage away from the foundation. Fill all or the depressions near the foundation and window wells.

3. Fix broken and missing basement windows.

4. Fix the damaged soffit and gable end vent grill.

5. Refasten loose siding.

6. Extend the sump discharge to drain at least three feet away from the foundation.

On the Interior:

7. Store all these goods on shelving off the floor.

8. Replace bath fans with high quality units and properly vent them to the exterior.

9. Replace bath flooring with vinyl sheet materials. Vinyl sheet flooring does not have the seams that vinyl tile does.

11. Repair split dryer exhaust duct.

7. Insulate and air-seal the attic hatch.

8. Increase insulation in the attic at the locations of spots of mold. Since these were not recurring spots, this would seem to indicate isolated areas lacking sufficient insulation.

9. Replace drywall as needed.
Inspection Number: 2-2b
Address: 414 Chicag
Age: ~ 25 Years
Model Type: Ranch
Bedrooms: 3
Foundation: Block wall basement
Heat Type: Propane Forced Air
Construction: 2 x 4 Wood Frame

Mold and Moisture Conditions: Mold was found on roof sheathing close to where ducts exhausted into the attic (Figure 2).

Site Drainage and Rainwater Management: No gutter system was present. The grade had a gentle slope away from the home.

Foundation Conditions: The basement had masonry block foundation walls and appeared dry.

Exterior Conditions: The shingles badly weathered, needing replacement (Figure 3). One window frame was damaged (Figure 4).

Bathroom: One bathroom had a loose toilet and the other bathroom had discolored vinyl flooring next to the bathtub, which indicated a former or current moisture problem. Water spots were on the ceiling near one of the bath fans (Figure 5).

Kitchen: The gas range had a range hood that was vented to the exterior. The sink base looked fine.

Interior Conditions: The interior was well kept. The basement floor drain was covered with dirt carried up from beneath the slab by bugs (Figure 6).

Attic: The bath fans vented into the attic (probably the reason for the discoloration on the roof sheathing next to the duct termination). The attic was vented by soffit vents and turbines. Insulation along the perimeter was tight to the roof sheathing and there were no ventilation baffles (Figure 7).
and areas of missing insulation (Figure 8).

**Discussion/Recommendations:**

On the Exterior:

1. Install metal gutters to drain away from the house, preferably through an underground conduit to daylight.

2. Remove the existing shingles and inspect the roof sheathing. Repair sheathing as necessary, patch the turbine holes, and re-shingle the roof. Install a continuous ridge vent in place of the turbines.

3. Replace the damaged window frame.

On the Interior:

4. Remove the loose toilet and inspect the floor sheathing for damage. Repair as necessary and re-secure the toilet.

5. Install insulation baffles along the perimeter of the attic.

6. Insulate areas in the attic missing insulation and ensure holes for electrical and plumbing through the top plates are foamed shut and insulated.

7. Insulate the spots on the bathroom ceiling caused by missing insulation while correcting other attic deficiencies.

8. Properly secure the bath ducts to the roof exhaust housings.

9. Replace the furnace filter (Figure 9). Clogged furnace filters can severely restrict air flow which can contribute to increased energy consumption and poor heat distribution, thus mold.

10. Store goods on shelving off the floor.

11. Clean the basement floor drain and make sure it drains properly. The furnace condensate discharges into this drain.

12. The dryer exhaust is very close to grade and may be partially restricted by vegetation (Figure 10). Clean vegetation away from the dryer exhaust.
Appendix B: Lac du Flambeau Chippewa Housing Authority
Technical Assessment Report

September 8-10, 2004

**Inspection Number:** 2-3b  
**Address:** 318 Makwa  
**Age:** 22 Years  
**Model Type:** Ranch  
**Bedrooms:** 3  
**Foundation:** Concrete wall basement  
**Heat Type:** Propane Forced Air  
**Construction:** 2 x 4 Wood Frame

**Mold and Moisture Conditions:** This home had mildew on the vinyl siding, but there was no evidence of mold on the interior.

**Site Drainage and Rainwater Management:** No gutter system was present. The grade around the house was relatively flat.

**Foundation Conditions:** The basement had concrete foundation walls and appeared dry. One of the basement windows was missing.

**Exterior Conditions:** The vinyl siding was dirty and was damaged at one corner (Figure 2). The discharge for the sump was broken off at the face of the building (Figure 3). The soffits had some minor damage.

**Bathroom:** The bathroom had a bath fan but no switch to operate it (Figure 4). The junction between the bathtub and vinyl flooring was missing a trim-strip (Figure 5). One toilet had a leaky mechanism inside the tank.

**Kitchen:** The electric range had a range hood meant to be vented to the exterior, however there was no hole in the drywall behind the unit (Figure 6), thus the unit was unvented.

**Interior Conditions:** The interior was well kept but did need some repairs. The dryer duct was disconnected from the appliance (Figure 7). The furnace condensate was drained into a hole in the floor slab (Figure 8). The basement floor had a large area at the...
base of the chimney that was covered with what appeared to be creosote that had flowed out of the chimney (Figure 9). A large stack of firewood was in one basement corner (Figure 10).

**Attic:** The end of the bath fan duct was fastened to a truss and pointed toward the ridge vent (Figure 11). The duct was also pinched in several places where it had been wired to truss members (Figure 12). Several ventilation baffles along the attic perimeter were improperly installed (Figure 13). The insulation surrounding the chimney was discolored (Figure 14). The attic had approximately eight to ten inches of very fluffy loose-fill insulation.

**Discussion/Recommendations:**

**On the Exterior:**

1. Install metal gutters to drain water away from the home preferably through an underground conduit to daylight.

2. Fix the damaged sump discharge and drain it at least three feet away from the foundation.

3. Repair the damaged vinyl siding and soffit.

**On the Interior:**

4. Install a switch for the bath fan.

5. Reinstall a trim strip at the tub to floor junction. Seal thoroughly to keep water from gaining access to beneath the vinyl flooring.

6. Properly duct the range hood to the exterior.

7. Eliminate the wires that pinch the bath duct and vent the duct through a roof vent rather than directing it at the ridge vent.

8. Reinstall the insulation baffles along the perimeter of the attic and make sure the perimeter is well insulated.

9. Add more insulation to the attic.
10. Replace the missing basement window.

11. Reconnect the dryer duct to the dryer.

12. The furnace condensate was drained through a hole that was drilled through the floor slab. High-efficiency furnaces can produce a large quantity of water and draining this water to beneath the slab is undesirable. Water sitting beneath the slab can compromise the structural properties of the soil beneath the slab and eventually some of this water will migrate back through the slab and contribute to increased humidity levels inside. The condensate should be rerouted to drain to a floor drain or sump pit.

13. Although it is unadvisable to store large quantities of wood inside a residence because of the moisture it can release as it dries, there did not seem to be a problem with that in this residence.

14. The creosote flow over the basement floor seems to indicate that the chimney needs to be cleaned. The discolored attic insulation surrounding the chimney may be related to this but needs to be further researched. There was nothing obvious that would indicate why the insulation would be discolored.
Mold and Moisture Conditions: Above the garage door, the only section of gutter on the home drained against the home causing deterioration of the wall and mold on the interior (Figures 2–4). Other moisture problems were from plumbing leaks (Figures 5–8).

Site Drainage and Rainwater Management: Only the garage door had a gutter. The grade around the house was flat with poor drainage potential away from the home. There was a distinct drip line where the roof drained onto the ground.

Foundation Conditions: The basement had concrete foundation walls and was dry. There were water marks along the base of the wall that indicated prior water problems.

Exterior Conditions: The wood siding was in good condition except where the gutter drained against the wall.

Bathroom: Both the downstairs and upstairs bathroom fans did not function. A leak from the second floor bath was indicated by damage to the first floor bath ceiling (Figure 7 & 8). A leak from the first floor bath was evident from the basement and the discolored vinyl flooring around the toilet. The downstairs toilet was not secure to the floor.

Kitchen: The kitchen was not inspected
**Interior Conditions:** Several areas in this home needed repaired, the bathrooms in particular. The wall and window beneath the location where the gutter drained against the wall were deteriorated and had mold behind the baseboard. One basement corner was sectioned off to create a bedroom with hanging sheets.

**Attic:** A gap was in the roof sheathing at the ridge to allow for a ridge vent; however, the gap was covered with felt paper and shingles (Figure 9). Both bath fan ducts vented in the attic and were not fastened to a roof vent (Figure 10). The roof sheathing was delaminating (Figure 11). Although the soffits were perforated for ventilation, the blown-in insulation was tight to the roof sheathing along the perimeter (Figure 12).

**Discussion/Recommendations:**

**On the Exterior:**

1. Install metal gutters to drain away from the home. Slope the gutter above the garage door away from the home.

2. Fill depressions next to the foundation, compact and reseed.

3. Install a ridge vent.

**On the Interior:**

1. Replace both bath fans with high quality fans and properly vent them to the exterior.

2. Identify and repair all plumbing leaks in both bathrooms.

3. Install ventilation baffles along the perimeter of the attic.

4. Insulate and air-seal the attic hatch.

5. Add more insulation to the attic.

6. Open up and inspect the damaged living room wall, caused by the improperly drained gutter. Replace all the rotted wood; then reinsulate and replace the drywall.

10. Store containers on shelving off the floor.

11. Clothes were hung to dry in the basement. The moisture released by these clothes contributes a significant amount of water to interior humidity. Residents should either hang dry clothes outside or use the dryer.
12. Fix the leaking water meter (Figure 14).

13. In one of the corners of the basement, the upper portion of the foundation wall was discolored (Figure 15). This may or may not be mold. Scrub this area with soap and water and dry thoroughly. If it is mold, it could be due to poor drainage on the exterior of the structure and no insulation on the exterior of the concrete. Installing insulation on the upper portions of the exterior of the foundation wall would help keep the wall warmer and reduce the potential for condensation and mold growth on the concrete. It would also improve thermal comfort in the basement and reduce energy consumption.
Mold and Moisture Conditions: This duplex was one of several still under construction. There was much mold growth in the crawl space of several units. Figure 2 shows one area of white fuzzy mold suspended on the bottom side of the floor sheathing. Separating the units was a firewall consisting of two layers of $\frac{1}{4}$ inch gypsum board. Figure 3 shows extensive mold growth on the firewall separation and adjacent joist. The dirt floor in these units did not have a vapor barrier and the soil was very wet and soft in certain areas. There was liquid water on portions of the concrete stem wall.

Several sources for the moisture in the crawl space were: the uncovered ground (Figure 4), rains during construction that had drained through the structure before it was roofed, and poor rough grading around the perimeter of the foundation.

Site Drainage and Rainwater Management: These buildings were located in a fairly flat wooded area. Gutters and leaders to conduct the water away from the buildings will play an important roll in keeping water away from the foundation.

Several areas had large depressions around the perimeter of the foundation (Figure 5), contributing to the moisture problem in the crawl space by channeling water toward the foundation rather than away from it.
Appendix B: Lac du Flambeau Housing Authority
Technical Housing Assessment Report

Foundation Conditions: The crawl space walls were cast concrete. In a couple of the crawl spaces the grade still had tree roots sticking out of the ground and construction debris littering the floor, which was very uneven and not ready for a vapor barrier (Figure 6). The design called for the HVAC unit and the domestic water heater to be located in the crawl space, therefore, a hole had been excavated and a concrete pad cast in its base (Figure 7). The sides of several of these holes had already collapsed and the pads were covered with dirt.

Exterior Conditions: The lower portions of the home exterior are to be clad with HardiPlank, a cementitious clapboard, and the gable ends are to be covered with vinyl siding.

Bathroom: In a couple units the plumbing had been installed and there were no water hammer arrestors on most of the plumbing lines to the fixtures. One inspected unit was designed for handicapped accessibility.

Kitchen: It was not evident how the range hood would be vented.

Interior Conditions: The ground floor condition was better than the crawl space condition, however there was a strong musty smell emanating from the crawl space access hole.

Attic: The attic was to be vented by soffit and ridge vents.

Discussion/Recommendations:

On the Exterior:

1. The drainage from a valley located directly above the front entry to the unit could present problems (Figure 8). The quantity of water draining from this valley will undoubtedly overwhelm the gutter system at the base of the valley. Finishing the sidewalk and grade to slope away from the foundation will be critical to keep this area dry.

2. Based on the description by the Project Manager, the transition between the cementitious siding and the vinyl siding was going to be a flat board without
metal flashing above the board. No drawings were reviewed but the description of the transition from one material to another was questionable. LDFCHA would be better served by continuing the cementitious siding to the peak and eliminating the vinyl siding. If there is to be a transition, the transition needs to be properly flashed to keep water out of the walls.

3. Building materials were left out in the open and exposed to the elements. Left exposed, many building materials will absorb moisture and once incorporated into the structure will need to be dried before being covered with finishes. Furthermore, manufacturers specifically state that products such as engineered lumber should not be left exposed to weather.

On the Interior:

1. The crawl space problems should already have been addressed by the time this report is issued, however, lessons to be learned from this incident are:

   a. Clear out roots and construction debris and level the floor of the crawl space immediately after the foundation walls have been cast.

   b. Install a vapor barrier before setting the deck.

   c. Before the walls are set, cover the deck to keep rainwater from draining into the crawl space.

   d. After the stem walls have been cast, rough-grade the area surrounding the house so that it does not have large depressions that channel water toward the foundation.

   e. Because of the current situation, it would be advisable to monitor moisture levels in the crawl space. There are reasonably priced data loggers that could be placed in the crawl space from which the data could be downloaded every time the furnace filter is changed. The data could then be reviewed to make sure that humidity levels are below that needed for mold growth. If the data shows that humidity levels are too high, appropriate actions could be taken before mold growth becomes a serious issue. Following are two websites that sell reasonably priced data loggers.

   http://www.onsetcomp.com/

2. The washer and dryer are located just inside the entry from the attached garage. How and where the dryer was to be vented was unclear, since there was no location proximate to the dryer for the venting it. The dryer duct will have to run a long distance to vent to the exterior. This issue will need to be addressed properly so it does not become a problem. Use smooth insulated ductwork and maybe a booster form. See http://www.fantech.net/ for dryer booster fans.
3. The apparent lack of air chambers to eliminate water hammer could become an issue. See http://www.plumbingsupply.com/waterhammerarresters.html for information regarding this issue.

4. Locating the domestic water heater and HVAC unit in the crawl space is not adviseable. Access to the crawl space is in a closet and like most closets; they will get filled with personal items. Anytime the filters need to be changed or units need to be serviced, closets will need to be emptied to gain access to the hatch. Not only will this be inconvenient for the homeowner but also for the maintenance staff. The location of the water heater in a hole is also a concern. If the crawl space floods the water will go to the lowest spot. The water heater will be located in the lowest spot in the crawl space. If this is where the water heater will eventually reside, increase the size of the hole and incorporate a sump pit adjacent to the water heater so that if this area floods, the sump can keep the water heater from becoming submerged.

5. The location of the bathroom and kitchen are toward the center of the building. This caused long duct runs from the bath fan and range hood. Use smooth and insulated ductwork. Oversize both the bath fan and range hood slightly to overcome any pressure drop due to long duct runs.

6. The layout of the accessible bathroom met accessibility standards, but it appeared that a disabled person would have difficulty maneuvering around in the bathroom.
Mold and Moisture Conditions: This 5-plex was under construction and the crawl space was already consumed by mold. The crawl space floor had a poorly installed concrete slab that had several areas of standing water on top of it (Figure 2). The underside of the floor sheathing had extensive mold (Figure 3).

Site Drainage and Rainwater Management: Site drainage was poor. In the location where utilities were run to the building, the footing had been undermined and the excavation acted as a large funnel channeling water towards the foundation.

Foundation Conditions: The crawl space had concrete foundation walls. Standard lumber wood beams were set in beam pockets and rested on pressure treated bearing plates. However, in several instances, the ends of the beams were in direct contact with the concrete foundation walls (Figure 4).

Exterior Conditions: The frame of the building was still under construction.

Bathroom: The building was not far enough along, and the drawings were not available for review to comment upon.

Kitchen: The building was not far enough along, and the drawings were not available for review to comment upon.

Interior Conditions: The crawl space access hatch was located in an interior closet. The door and window headers were constructed out of solid lumber (Figure 5).
Attic: The building was not far enough along, and the drawings were not available for review to comment upon.

Discussion/Recommendations:

On the Exterior:

Building materials were left out in the open exposed to the elements. Left exposed, many building materials absorb moisture which will need to be dried out when the material is used in a structure and before being covered with finishes. Furthermore, manufacturers specifically state that products such as engineered lumber should not be left exposed to weather. Note the engineered wood joists lying in the dirt (Figure 6).

On the Interior:

1. The crawl space problems should already have been addressed by the time this report is issued, however, lessons to be learned from this incident are:
   a. With only a minor amount of additional effort, the slab in the crawl space could have been installed so that it was flat and sloped to a sump pit. The intent of installing a slab in the crawl space was sound. It was the execution of the installation that was lacking.
   b. Before the walls are set, cover the deck to keep rainwater from draining into the crawl space.
   c. After the stem walls have been cast, rough-grade the area surrounding the house so that it does not have large depressions that channel water towards the foundation.
   d. Because of the current situation, it would be advisable to monitor moisture levels in the crawl space. There are reasonably priced data loggers that could be placed in the crawl space from which the data could be downloaded every time the furnace filter is changed. The data could then be reviewed to make sure that humidity levels are below that needed for mold growth. If the data shows that humidity levels are too high, appropriate actions could be taken before mold growth becomes a serious issue. Following are two websites that sell reasonably priced data loggers.
   [http://www.onsetcomp.com/](http://www.onsetcomp.com/)

2. As in the duplexes, locating mechanicals in the crawl space will be problematic. Access for servicing, which at a minimum entails having to change air filters on a regular schedule will inconvenience the occupant and service provider.

3. Standard lumber in contact with concrete foundation walls does not meet most building codes. The wood beams that are in contact with the concrete foundation walls pose a problem. The outside face of the concrete walls at these locations
will be below grade. Moisture will migrate through the concrete and eventually precipitate the deterioration of the ends of the beams. A ½ inch air space should have been left between the end of the beams and the concrete. Following is an excerpt from the Oregon code which addresses this issue.

**APPLICABLE CODE SECTIONS**

1993 Oregon Structural Specialty Code (OSSC), Section 2516(c)3, 5, 7 and One and Two Family Dwelling Specialty Code (Dwelling Code), Section R-309.1.

Section 2516(c)3. Plates, sills and sleepers.

All foundation plates or sills and sleepers on a concrete or masonry slab, which are in direct contact with earth, and sills which rest on concrete or masonry foundations, shall be treated wood or foundation redwood, all marked or branded by an approved agency. Foundation cedar or No. 2 foundation redwood marked or branded by an approved agency may be used for sills in territories subject to moderate hazard, where termite damage is not frequent and when specifically approved by the building official. In territories where hazard of termite damage is slight, any species of wood permitted by this code may be used for sills when specifically approved by the building official.

Section 2516(c)5. Girders entering masonry or concrete walls.

Ends of wood girders entering masonry or concrete walls shall be provided with a 1/2-inch air space on tops, sides and ends unless approved wood of natural resistance to decay or treated wood is used.

Section 2516 (c)7. Wood and earth separation.

Protection of wood against deterioration as set forth in the previous paragraphs for specified applications is required. In addition, wood used in construction of permanent structures and located nearer than 6 inches to earth shall be treated wood or wood of natural resistance to decay, as defined in Section 2502(a). Where located on concrete slabs placed on earth, wood shall be treated wood or wood of natural resistance to decay. Where not subject to water splash or to exterior moisture and located on concrete having a minimum thickness of 3 inches with an impervious membrane installed between concrete and earth, the wood may be untreated and of any species.

However, there are similar codes that parallel the Oregon Code. Resolving this issue will not be simple. Gaining access to the area beyond the beam is practically impossible. Providing additional support for the beam outboard from the wall, so that there is support for the beam once the end rots away may be the simplest solution.

4. The window and door headers are constructed out of solid lumber. Walls constructed out of 2x6 framing members provide the opportunity to integrate insulation into the header, which was not done. In future projects, insulated headers should be specified for window and door headers.