RESEARCH REPORT

CMHC Dehumidifier Field Study

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CMHC Dehumidifier Field Study

Final Report

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The project team is indebted to the thirty participants and particularly the 21 who completed the study. Without their ongoing efforts at monitoring temperatures and moisture content, sending back the HOBO meters and emptying and measuring their dehumidifiers over the two years, we would not have been able to complete the study.

We would also like to acknowledge the contribution of Dr. Virginia Salares in guiding this study and encouraging the participants to keep at it.

Summary

This study was conducted to determine the usefulness of dehumidifiers in Canadian houses. Air temperature and relative humidity were continuously recorded in the basement and upper floor of twenty-one houses located in three main climatic regions in Canada. The homeowners recorded wood moisture content and surface temperatures over a two-year period and also measured the amount of water collected by a dehumidifier during the second year. The measurements showed lower moisture content of the basement air compared to outside air and reduced moisture content of wood in the basement when the dehumidifiers were running during the warm summer months.

In all regions of Canada, the operation of a dehumidifier reduces dampness indoors. In the milder and coastal regions, operation of a dehumidifier throughout the year is recommended.

RESEARCH HIGHLIGHT

May 2009

Technical Series 09-106

Effectiveness of Dehumidifiers in Controlling Moisture in Houses

INTRODUCTION

Houses are exposed to numerous moisture sources including precipitation, surface water, moisture in the ground around the foundation and moisture in the air from both indoor and outdoor sources. To prevent moisture from accumulating to the point where condensation, water damage and mold growth can occur, a variety of strategies can be used to deflect, drain and dry outdoor moisture and to control indoor moisture sources.

One method to control indoor moisture conditions involves the use of dehumidifiers. Dehumidifiers are often used as temporary solutions to high indoor humidity conditions that may occur throughout the year. However, year round operation of dehumidifiers may offer improved moisture control but the extent to which this is the case had not been fully explored.

In 2004, a CMHC pilot study examined the effectiveness of a typical residential dehumidifier in reducing moisture levels in basements of new houses. The results of the three-month study indicated that the relative humidity (RH) and moisture content of wood in the dehumidified basements were reduced compared to control houses with similar conditions. This *Research Highlight* reports on a subsequent field study that measured the effectiveness of dehumidifiers in controlling general moisture conditions in houses of varying ages in different regions of Canada. The purpose of this study was to determine if year round operation of dehumidifiers could improve moisture conditions and reduce opportunities for moisture related problems.

RESEARCH OBJECTIVES

The objectives were

1. To develop a practical and cost-effective method for assessing the effectiveness of dehumidifiers in the control of moisture in houses.
2. To determine the usefulness of dehumidifiers to control general moisture conditions in houses in different regions of Canada.

METHODOLOGY

The study examined moisture conditions within houses across Canada with and without dehumidifiers installed. The study was designed to monitor a group of houses over a period of two years. Baseline characteristics (moisture conditions) of each house without dehumidifiers were monitored the first year. Dehumidifiers were installed in the houses and moisture conditions were monitored for another year.

Thirty houses—10 from Ontario and Quebec, 10 from B.C. and the Atlantic and 10 from the Prairies were located for the study. To be eligible to participate in the study, the houses:

- did not have dehumidifiers or air conditioning systems
- had not experienced previous flooding in the year before; and
- no home renovations or move were anticipated in the next two years.

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Temperature and RH measurements were automatically recorded with two data loggers placed by the participants in the basement and the main floor. The data loggers were pre-calibrated and set to take measurements every hour. Participants were asked to return the data loggers periodically to the project coordinator throughout the study so that data could be downloaded and to ensure the devices were working properly.

Wood moisture content was measured by the participants with a moisture meter at five pre-determined locations in the basements and two locations on the upper floors. An infrared thermometer was used to measure surface temperatures in five basement and seven main and upper floor locations. Participants were provided log sheets for recording the measurements on a monthly basis.

During year two, when the dehumidifiers were operating, the participants also measured and recorded the volume of water extracted by the dehumidifier. The dehumidifier chosen for the study was a heavy duty model with a moisture-removal capacity of 31L (8.19 gal.) per day and a 10 L (2.64 gal.) reservoir for the removed water. It had an RH sensor that automatically stopped operation when the ambient air reached a pre-set RH of 50 per cent and started again when the RH of the air exceeded 50 per cent. The dehumidifier stopped operating when the reservoir was full. Calibration marks on the reservoir helped participants determine how much water had been extracted by the dehumidifier when they emptied the reservoir.

RESULTS

At the end of year one, 22 of the original 30 participants agreed to continue with the study and installed dehumidifiers. Useful results were obtained from 21 households. Eighteen participants—seven from Quebec and Ontario, four from Alberta and Saskatchewan, five from B.C. and two from the Atlantic—returned reasonably complete data that could be displayed graphically.

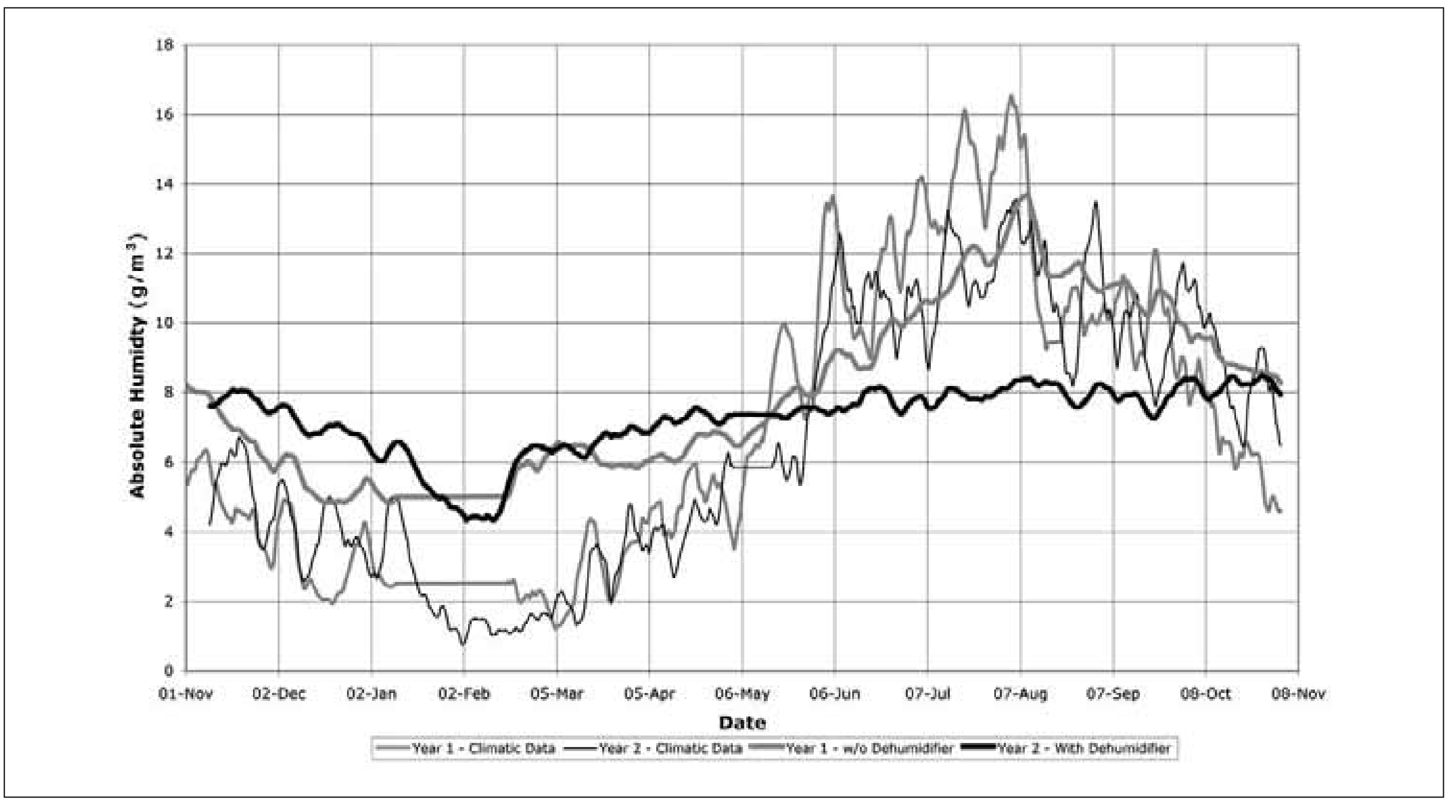

Figure 1 Comparison of Year 1 and Year 2 indoor basement and outdoor absolute humidity

Although there were gaps in moisture meter measurements and volume of water reported due to reporting lapses on the part of the occupants or absences, the overall quality of the data from the 18 houses was sufficient for analysis. A few individuals gave meticulously recorded data with very few gaps. In particular, data from House 22 was consistent throughout the study and the results will be used as an example to illustrate the type of information that was obtained. Figure 1 (House 22) presents a comparison of the absolute humidity (moisture content) of the basement air in Year 1 (without a dehumidifier) and Year 2 (with a dehumidifier) together with climatic data retrieved from Environment Canada for the location of the house for both years. In year 1, the indoor absolute humidity during the winter months was higher than that for outdoor air. During warm months of year 1, from May to the beginning of October, indoor absolute humidity resembled that of outside air, with a peak in early August. In Year 2, when the dehumidifier was running, indoor absolute humidity remained nearly constant and lower than the outdoor absolute humidity during the warm months from May to October.

On the main floor, which is typically open to the outdoors during the warm months, there was no reduction of indoor air moisture levels during the second year when the dehumidifier was operating. Generally, moisture levels in basement air were less than moisture levels in outdoor air during the spring, summer and fall months when the dehumidifier was operating.

Figure 2 shows the moisture removal rate vs. time graph for Year 2 for House 22. The moisture removal rate was calculated from the volume of water collected by the dehumidifier over time. Water was extracted from the air for a month in November (start of year 2) and from May until the end of October. No water was collected during the winter months. Figure 2 demonstrates how closely the moisture removal rate tracked the changes in outdoor absolute humidity.

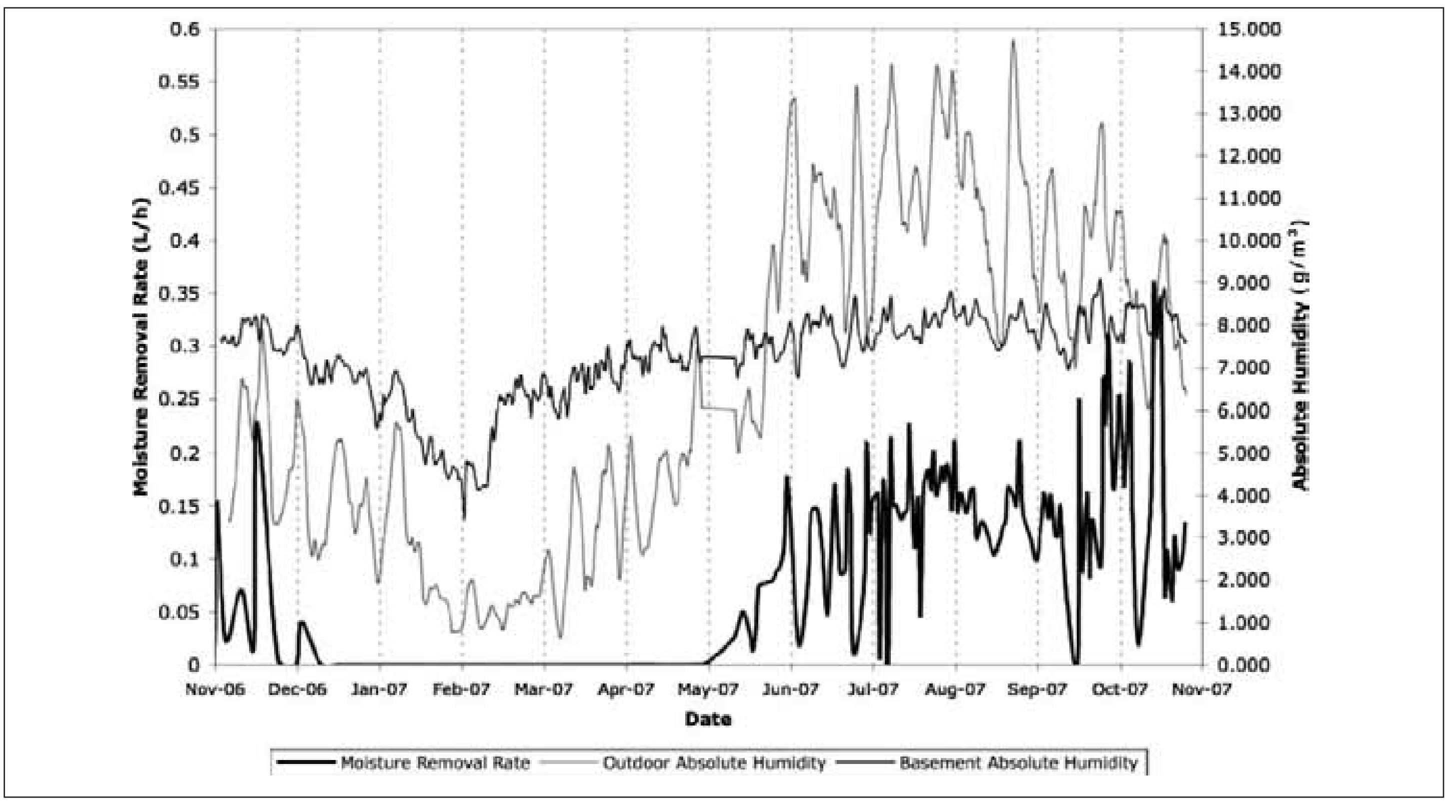

Figure 2 Moisture removal rate vs. time graph for Year 2

Figure 3 shows the moisture content of wood at various locations versus time over the two years for House 22. During Year 1, without dehumidification, the wood moisture content peaked at 10 per cent between June and October, while in Year 2, with dehumidification, the wood moisture content stayed around 7 to 8 per cent. There was no difference in moisture content of wood between the first and second year on the upper floor which is somewhat consistent with the previous observation concerning the limited impact of dehumidifier operation on main floor indoor air moisture levels. Dehumidification of the basement lowers the absolute indoor humidity and this is reflected in the wood moisture content in the basement.

Two houses gave results inconsistent with the above observations. House 13 had a higher indoor absolute humidity than the outdoors in winter and summer months even with dehumidification. The wood moisture content of this house was unchanged by the dehumidifier, which was removing an average of 0.60 L (0.16 gal.)/hr compared to 0.20 to 0.25 L (0.05 to 0.07 gal.)/hr in other houses. In House 9, absolute humidity was lower with dehumidification but wood moisture content was high, with 7 to 12 per cent moisture content in the summer and up to 24 per cent in the winter of both years. The moisture removal rate was as high as 0.75 L (0.20 gal.)/hr.

These anomalies can be explained by higher moisture sources in both houses. House 13 had an attached crawl space with a dirt floor next to the basement. House 9 had a preserved wood foundation. Dehumidifiers could not make a difference to the moisture loading through the dirt floor of House 13 and moisture may be diffusing through the wood foundation of House 9.

Overall, more than half of the houses showed a reduction in indoor humidity levels when dehumidifiers were installed relative to the corresponding climatic conditions of the regions where these houses were located. Seven houses showed some reduction in the wood moisture content while the rest did not show any reduction. All houses returning sufficient data showed at least some level of moisture removal, with 10 of 18 houses showing good levels of moisture removal.

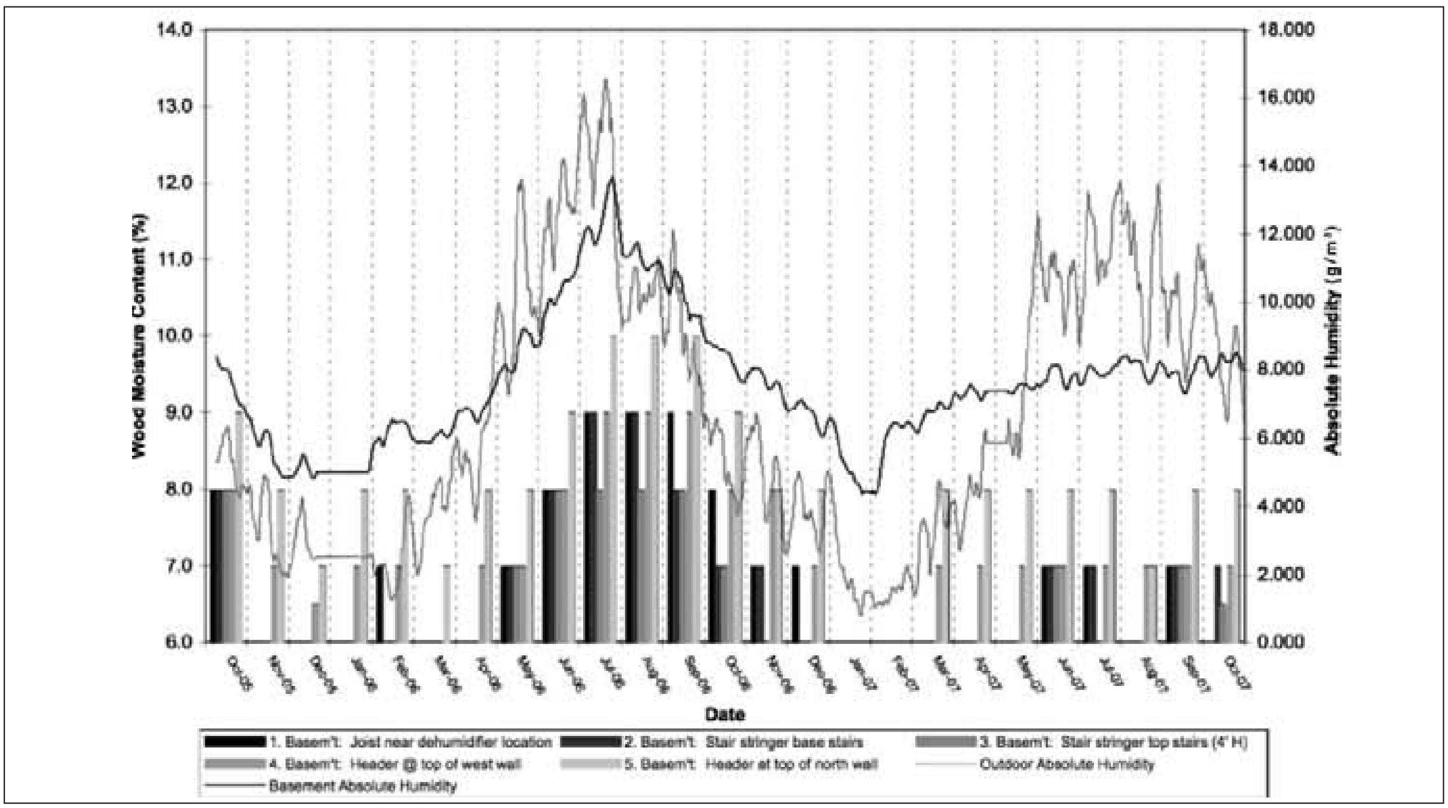

Figure 3 Basement wood moisture content for House 22 in Year 1 and Year 2

The highest moisture removal rates were in Atlantic Canada. The Prairies (considered 'dry' in the winter, not needing dehumidification) had high moisture removal rates during the summer. In central Canada, moisture removal rates were low to medium in the summer. In B.C., the moisture removal rate was low to medium year round.

CONCLUSION

This study confirmed that in the houses tested, dehumidifiers were effective in reducing indoor humidity during the warm months—May to November in most regions of Canada. Moisture levels in basement air were less than moisture levels in outdoor air when the dehumidifiers were operating. For the study, the dehumdifiers were placed in the basements of the homes and, in most cases, the benefit of the dehumidifier was primarily observed in the basement. Typically, the main floor humidity levels fluctuated with the outdoor levels during the second summer of dehumidification while the basement levels remained at a more constant level.

IMPLICATIONS FOR THE HOUSING INDUSTRY

The study demonstrates the benefits of dehumidifiers to control indoor moisture conditions in houses. In most regions of Canada, dehumidification is beneficial during the non-heating season while year round operation can be beneficial for houses located in milder coastal climates. Basements of newly constructed homes can be dehumidified, even before occupancy, to help remove moisture from construction materials. While this study demonstrates the benefits of mechanical dehumidification, moisture source control should be considered first where it is practical, and cost-effective, given the energy costs associated with the operation of dehumidification equipment.

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LE POINT EN RECHERCHE

Mai 2009 Série technique 09-106

Efficacité des déshumidificateurs à contrôler l'humidité dans les maisons

INTRODUCTION

Les maisons sont exposées à de nombreuses sources d'humidité, tant de sources intérieures qu'extérieures, y compris les précipitations, les eaux de ruissellement, l'humidité dans le sol au pourtour des fondations et l'humidité dans l'air. Pour empêcher l'humidité de s'accumuler à un point tel qu'il pourrait se produire de la condensation, des dommages causés par l'eau ou une croissance de moisissures, différentes stratégies peuvent être mises en œuvre pour dévier, évacuer et assécher l'humidité extérieure et pour contrôler les sources intérieures d'humidité.

Une des méthodes de contrôle de l'humidité intérieure consiste à utiliser un déshumidificateur, lequel sert souvent de solution temporaire pour contrôler des conditions d'humidité élevées pouvant se produire au cours de l'année. Le fonctionnement à longueur d'année d'un déshumidificateur pourrait offrir un contrôle amélioré de l'humidité, mais la mesure dans laquelle c'est le cas n'a pas été étudiée à fond.

En 2004, une étude commandée par la SCHL a examiné l'efficacité d'un déshumidificateur résidentiel à réduire le taux d'humidité dans les sous-sols de maisons neuves. Les résultats de cette étude d'une durée de 3 mois révèlent que l'humidité relative (HR) et la teneur en eau dans le bois dans les sous-sols déshumidifiés ont été réduites comparativement à des maisons de référence affichant les mêmes conditions. Le présent *Point en recherche* fait état de travaux de recherche subséquents sur le terrain au cours desquels on a mesuré l'efficacité des déshumidificateurs à contrôler les conditions générales d'humidité dans des maisons d'âges variés dans différentes régions du Canada. L'étude dont il question ici avait pour objectif de déterminer si le fonctionnement à longueur d'année d'un déshumidificateur pouvait améliorer les conditions d'humidité et réduire les possibilités de problèmes liés à l'humidité.

OBJECTIFS DE LA RECHERCHE

La recherche avait pour objectifs de :

1. mettre au point une méthode pratique et efficiente sur le plan des coûts pour évaluer l'efficacité des déshumidificateurs à contrôler l'humidité dans les maisons;
2. déterminer l'utilité des déshumidificateurs à contrôler les conditions d'humidité générales dans les maisons de différentes régions du Canada.

MÉTHODE

Les auteurs ont examiné les conditions d'humidité dans des maisons situées partout au Canada avec et sans déshumidificateur en place. L'étude a été conçue de manière à effectuer le suivi d'un groupe de maisons pendant deux ans. Les caractéristiques de référence (conditions d'humidité) de chaque maison sans déshumidificateur ont fait l'objet d'un suivi pendant un an. Des déshumidificateurs ont été installés dans les mêmes maisons et les conditions d'humidité ont fait l'objet de suivi pour une deuxième année.

On a sélectionné 30 maisons, dont 10 en Ontario et au Québec, 10 en C.-B. et en Atlantique et 10 dans les Prairies. Pour être admissibles à l'étude, les maisons ne devaient pas :

- avoir de déshumidificateur ou d'installation de climatisation;
- avoir subi d'inondation l'année précédente;
- faire l'objet de travaux de rénovation ou d'un déménagement de la part des occupants au cours des deux prochaines années.

Les mesures de température et d'HR ont été consignées automatiquement à l'aide de deux enregistreurs de données placés par les participants dans le sous-sol et au rez-de-chaussée. Les enregistreurs de données ont été calibrés au préalable et réglés de manière à prendre des lectures toutes les heures. On a demandé aux participants de retourner les enregistreurs de données périodiquement au coordonnateur du projet afin que ce dernier puisse télécharger les données et veiller au bon fonctionnement des appareils.

La teneur en eau du bois a été mesurée par les participants au moyen d'un humidimètre à cinq endroits déterminés à l'avance dans le sous-sol et à deux endroits aux étages. Un thermomètre à infrarouges a servi à mesurer les températures de surface à cinq endroits au sous-sol et à sept endroits au rez-de-chaussée et à l'étage. Les participants ont reçu des feuilles de contrôle pour y inscrire les mesures sur une base mensuelle.

Durant la deuxième année avec les déshumidificateurs en marche, les participants ont également mesuré et enregistré le volume d'eau extrait par le déshumidificateur. Le déshumidificateur qui a servi pour l'étude était un modèle robuste ayant une capacité d'extraction d'humidité de 31 L (8,19 gal) par jour, doté d'un réservoir de 10 L (2,64 gal) pour stocker l'eau extraite. Il comportait un capteur d'HR qui arrêtait automatiquement l'appareil lorsque l'HR de l'air ambiant atteignait 50 % et redémarrait lorsque l'HR excédait 50 %. Le déshumidificateur cessait de fonctionner lorsque le réservoir était plein. Des marques de calibration sur le réservoir ont permis aux participants de déterminer quelle quantité d'eau avait été extraite par le déshumidificateur lorsqu'ils vidangeaient le réservoir.

RÉSULTATS

À la fin de la première année, 22 des 30 participants d'origine ont convenu de poursuivre l'étude et d'installer un déshumidificateur. Des résultats utiles ont été obtenus de 21 ménages. Dix-huit participants, dont sept du Québec et de l'Ontario, quatre de l'Alberta et de la Saskatchewan, cinq de la C.-B. et deux de l'Atlantique, ont retourné des données raisonnablement complètes qui ont été affichées graphiquement.

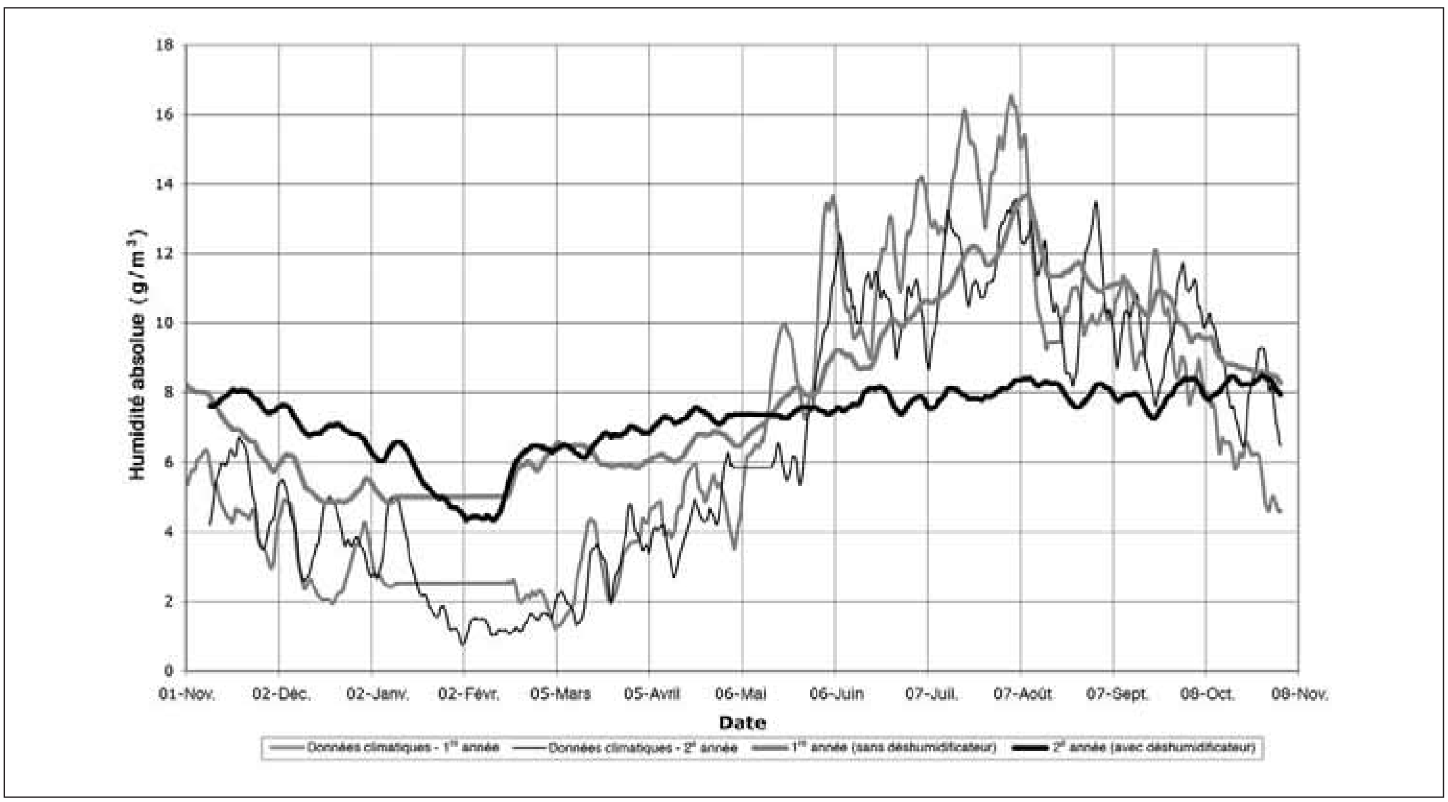

Figure 1 Comparaison de l'humidité absolue au sous-sol par rapport à celle de l'extérieur au cours de la première et deuxième année

Bien qu'il se soit produit des lacunes dans les mesures de l'humidimètre et des quantités d'eau rapportées en raison de défauts de rapport ou de l'absence des occupants, la qualité d'ensemble des données provenant des 18 maisons était suffisante pour en permettre l'analyse. Quelques personnes ont rendu des données méticuleusement enregistrées avec peu de lacunes. En particulier, les données de la maison 22 ont été uniformes au cours de l'étude et ces résultats serviront d'exemple pour illustrer le type d'information obtenu. La figure 1 (maison 22) montre une comparaison de l'humidité absolue (teneur en humidité) de l'air du sous-sol au cours de la première année (sans déshumidificateur) et au cours de la deuxième année (avec déshumidificateur), en plus des données climatiques des différentes localités tirées d'Environnement Canada pour les deux années. Pendant la première année, l'humidité intérieure absolue durant les mois d'hiver était plus élevée que celle de l'air extérieur. Au cours des mois chauds de la première année, de mai au début d'octobre, l'humidité intérieure absolue était semblable à celle à l'air extérieur, avec une pointe tôt en août. Pendant la deuxième année, lorsque le déshumidificateur était en marche, l'humidité intérieure absolue est demeurée presque constante et inférieure à l'humidité extérieure absolue durant les mois chauds de mai à octobre.

Au rez-de-chaussée, qui est habituellement ouvert à l'extérieur durant les mois chauds, il n'y a eu aucune diminution des taux d'humidité de l'air intérieur durant la 2^e^ année avec le déshumidificateur en marche. En règle générale, les niveaux d'humidité dans l'air du sous-sol étaient inférieurs à ceux dans l'air extérieur le printemps, l'été et l'automne avec le déshumidificateur en marche.

La figure 2 montre le taux d'extraction d'humidité en fonction du temps au cours de la deuxième année pour la maison 22. Le taux d'extraction d'humidité a été calculé à partir du volume d'eau recueilli par le déshumidificateur au fil du temps. L'eau a été extraite de l'air pendant le mois de novembre (début de la 2^e^ année), puis de mai jusqu'à la fin octobre par la suite. Aucune eau n'a été recueillie durant les mois d'hiver. La figure 2 révèle la précision avec laquelle les taux d'extraction d'humidité suivaient les changements d'humidité absolue à l'extérieur.

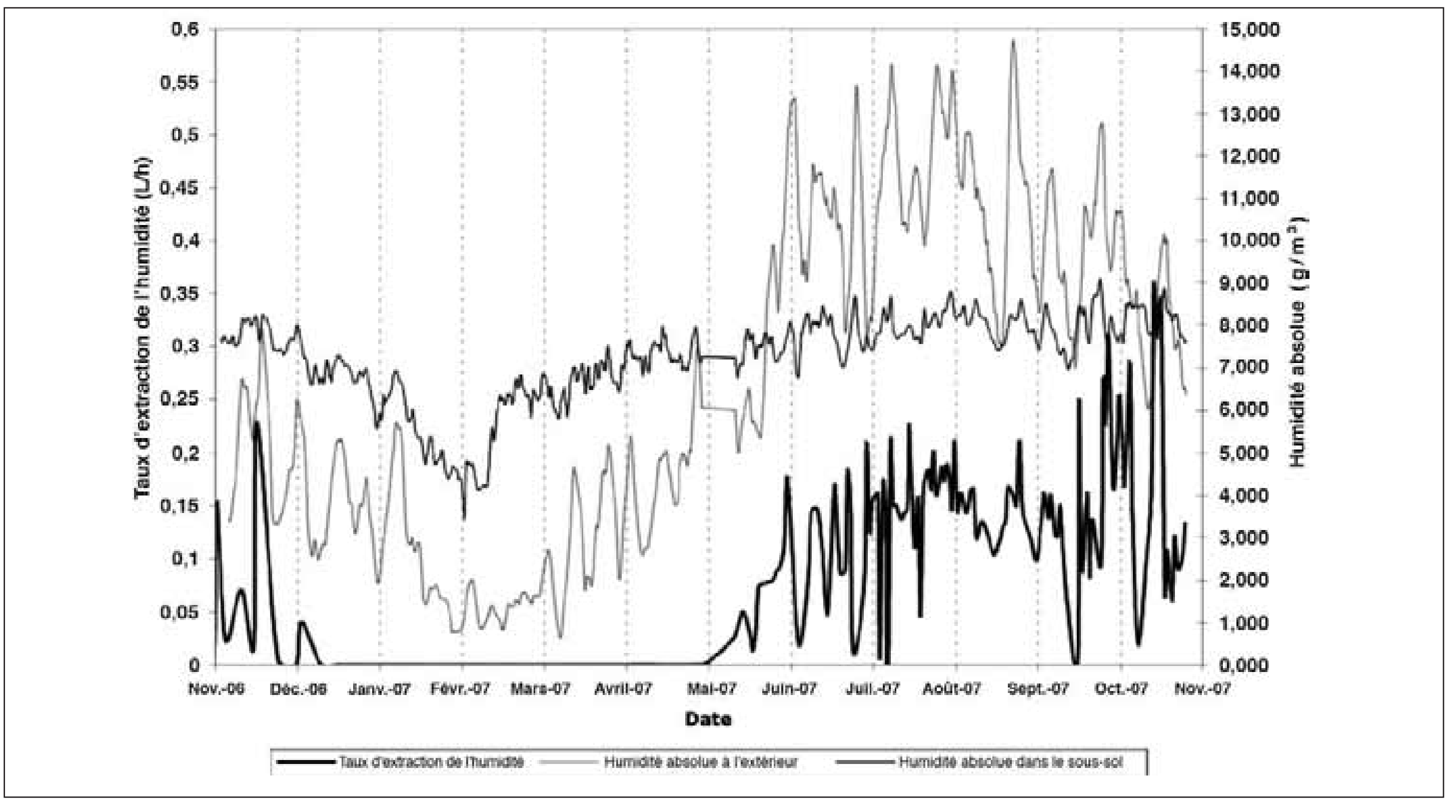

Figure 2 Graphique du taux d'extraction de l'humidité en fonction du temps au cours de la 2^e^ année

La figure 3 donne la teneur en eau du bois à différents endroits en fonction du temps pendant la première et deuxième année pour la maison 22. Durant la première année, sans déshumidificateur, la teneur en eau du bois a atteint un sommet de 10 % entre juin et octobre, tandis que dans la deuxième année, avec déshumidificateur, la teneur en eau du bois est demeurée stable à environ 7 ou 8 %. Il n'y avait aucune différence dans la teneur en eau du bois entre la première et la deuxième année à l'étage, ce qui concorde assez bien avec l'observation antérieure concernant l'impact limité du déshumidificateur sur les taux d'humidité intérieur dans l'air du rez-de-chaussée. La déshumidification du sous-sol abaisse l'humidité intérieure absolue, ce que confirme la teneur en eau du bois au sous-sol.

Deux maisons ont produit des résultats qui ne concordent pas avec les observations ci-dessus. La maison 13 affichait une humidité absolue intérieure plus élevée qu'à l'extérieur durant les mois d'hiver et d'été, même avec déshumidificateur. La teneur en eau du bois dans cette maison est demeurée inchangée par l'action du déshumidificateur, qui éliminait en moyenne 0,60 L/h (0,16 gal/h) comparativement à 0,20 à 0,25 L/h (0,05 à 0,07 gal/h) dans d'autres maisons. Dans la maison 9, l'humidité absolue était plus faible avec la déshumidification, mais la teneur en eau du bois était élevée, avec une teneur en eau de 7 à 12 % en été, et jusqu'à 24 % en hiver pour les deux années. Le taux d'extraction d'humidité y était aussi élevé que 0,75 L/h (0,20 gal/h). Ces écarts s'expliquent par des sources d'humidité plus importantes dans ces deux maisons. La maison 13 comportait un vide sanitaire attenant au sous-sol et dont le plancher est en terre battue. La maison 9 est établie sur des fondations en bois traité. Le déshumidificateur ne parvenait pas à modifier la charge d'humidité provenant du plancher en terre battue de la maison 13 et il est possible que l'humidité se diffuse à travers les fondations en bois traité de la maison 9.

Dans l'ensemble, plus de la moitié des maisons ont affiché une réduction des niveaux d'humidité après avoir été dotées d'un déshumidificateur, compte tenu des conditions climatiques correspondantes des régions où étaient situées les maisons. Sept maisons ont affiché une certaine diminution de la teneur en eau du bois, tandis que le reste n'affichait aucune réduction. Toutes les maisons qui ont produit suffisamment de données affichaient au moins un certain niveau d'élimination d'humidité : 10 maisons sur 18 ont produit des niveaux convenables d'élimination d'humidité.

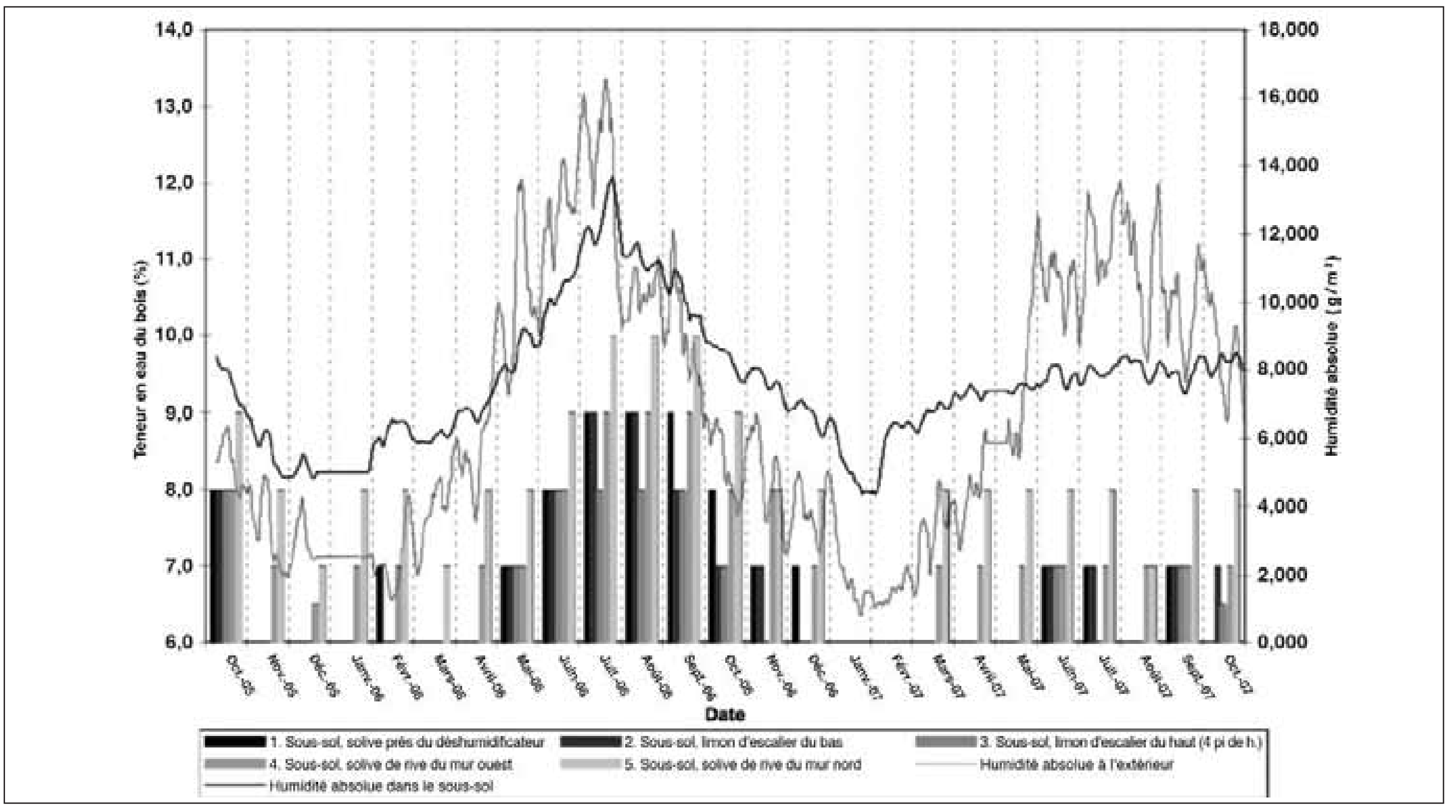

Figure 3 Teneur en eau du bois au sous-sol dans la maison 22, 1re et 2e années

Le taux le plus élevé d'élimination d'humidité s'est produit dans le Canada atlantique. La région des Prairies, que l'on considère comme région « sèche » en hiver qui n'exige pas de déshumidification, a affiché des taux élevés d'extraction d'humidité durant l'été. Dans le centre du Canada, les taux d'extraction d'humidité se sont avérés faibles à moyens en été. En C.-B., le taux d'extraction d'humidité était de faible à moyen toute l'année.

CONCLUSION

L'étude dont il est question ici confirme que dans les maisons mises à l'essai, les déshumidificateurs se sont avérés efficaces pour amenuiser l'humidité intérieure au cours des mois chauds, c'est-à-dire de mai à novembre dans la plupart des régions du Canada. Les niveaux d'humidité dans l'air des sous-sols étaient inférieurs aux niveaux d'humidité de l'air extérieur lorsque les déshumidificateurs étaient en marche. Pour réaliser l'étude, les déshumidificateurs ont été placés dans le sous-sol des maisons et, dans la plupart des cas, les avantages procurés par le déshumidificateur se sont fait sentir surtout dans les sous-sols. Dans la plupart des cas, les niveaux d'humidité au rez-de-chaussée ont fluctué avec les niveaux d'humidité extérieurs durant le deuxième été de déshumidification, alors que les niveaux d'humidité dans le sous-sol demeuraient à des niveaux presque constants.

CONSÉQUENCES POUR LE SECTEUR DE L'HABITATION

Les auteurs ont montré les avantages des déshumidificateurs pour contrôler les conditions d'humidité dans les maisons. Dans la plupart des régions du Canada, la déshumidification s'est avérée avantageuse durant la saison hors chauffage, tandis que le fonctionnement à longueur d'année pourrait profiter aux maisons situées dans les régions côtières aux conditions climatiques plus douces. Les sous-sols des maisons nouvellement construites peuvent être déshumidifiés, avant même l'occupation, afin d'aider à éliminer l'humidité des matériaux de construction. Bien que cette étude ait fait la démonstration des avantages de la déshumidification mécanique, il faut privilégier le contrôle à la source de l'humidité où cela s'avère pratique et efficient, compte tenu des coûts énergétiques associés au fonctionnement d'un déshumidificateur.

Directrice de projet à la SCHL : Virginia Salares

Consultants pour le projet de recherche :
Buchan, Lawton, Parent Ltd.

Recherche sur le logement à la SCHL

Aux termes de la partie IX de la *Loi nationale sur l'habitation*, le gouvernement du Canada verse des fonds à la SCHL afin de lui permettre de faire de la recherche sur les aspects socio-économiques et techniques du logement et des domaines connexes, et d'en publier et d'en diffuser les résultats.

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1.0 INTRODUCTION

Cold and damp basements are a common occurrence during the summer months in many Canadian homes. Although the cold may be welcome, the damp is not. It can contribute to moisture and indoor air quality problems, mold and rot. Dehumidifiers are one solution to reduce the high humidity levels and a variety of products are available.

In 2004, a Canada Mortgage and Housing Corporation pilot study examined the effectiveness of a typical residential dehumidifier at reducing moisture levels in a new basement. The results of the three-month study indicated the relative humidity (RH) and moisture content of wood in the dehumidified basement was reduced when compared to a non-dehumidified control house with similar conditions.

Based on the results of the pilot study, CMHC initiated this field study of the effectiveness of dehumidifiers in houses across the country. Originally comprised of ten houses from Ontario and Quebec, ten houses from BC and the Atlantic and ten houses from the Prairie region, at the study's completion, data was obtained from 21 houses over a two-year period. Prior to the study, the homes did not have air conditioners or dehumidifiers. During the first year of the study, the relevant characteristics of each house were measured and documented with the house in its original (not dehumidified) configuration. During the second year, the same parameters were measured with a dehumidifier operating when it was needed.

The study's participants were identified and confirmed by CMHC. For the most part, they were CMHC employees chosen with the expectation that employees would have more of a vested interest in completing the study than volunteers from the general population.

The Project Manager from CMHC was Dr. Virginia Salares. Buchan, Lawton, Parent Ltd provided project coordination, data manipulation and reporting.

2.0 METHODOLOGY

Task 1: Refine Monitoring Protocol and Prepare Instruction to Participants

The preliminary protocol was developed by CMHC. Buchan, Lawton, Parent Ltd, in conjunction with the CMHC Project Officer, refined the protocol. The monitoring protocol was developed to ensure a consistent data collection process in all the homes during the two-year study and to ensure useful results were obtained. This protocol included instructions to the participants and incorporated a combination of automatic and manual readings of temperature, relative humidity and moisture content.

Each house received two HOBO data loggers to automatically measure temperature (T) and relative humidity (RH) in the basement and in the upper floor on an hourly basis. As well, the homeowner participants were provided with a TimberCheck Moisture Meter to measure the moisture content of wood in five pre-determined locations in the basement and two locations in the upper floor and a Raytec infra-red thermometer to measure surface temperatures in five basement locations and seven main and upper floor locations.

In order to maintain a simple routine, participants were asked to take the manual measurements once a month at the same time and date throughout the two-year study period. During year two, when the dehumidifier was operating, the homeowners also measured and recorded the volume of water extracted by the dehumidifier.

The project presented several challenges:

- Devising a simple and fairly accurate method of determining the amount of moisture removed from the air by the dehumidifier. The simplest system was to provide each homeowner with a calibrated pail and ask them to measure how much water was removed each day. At the beginning and end of the higher humidity period, the frequency of measurement would likely be every few days, but during the summer, the dehumidifier was expected to require daily attention. This was a difficult request to make -- even from dedicated CMHC employees. Alternatives involving a fool-proof automated system, such as installing a flow meter in the condensate drain or a fill and drain counting system, were determined to be very expensive and difficult to accomplish.
- Developing a simple monitoring protocol that thirty different and possibly non-technical homeowners could execute. Each homeowner had to install the monitoring equipment and the dehumidifier and take all measurements in their individual homes. All troubleshooting was by telephone or e-mail. The goal was to create a simple protocol with clearly written instructions. However, in one instance, personnel from Buchan, Lawton, Parent Ltd had to visit a local study home to help set up the equipment.
- Maintaining participant motivation over the course of two years. Ongoing contact and monthly or bi-monthly data collection and feedback helped to encourage the homeowners to collect the data and also provided an indication of any problems.

A brief homeowner questionnaire was also prepared under Task 1. Many parameters were expected to affect the amount of humidity generated in a house and how it was removed. The information collected included:

- House size, type, age, construction, and exterior drainage
- Type of HVAC systems, furnace fan usage, ventilation fan locations & usage; was there an HRV?
- Foundation type; was there a drainage membrane, weeping tiles?
- Basement floor type; was it insulated and/or did it have a vapour barrier?
- Were there any water sources in basement? Shower? Sump pump? Cistern?
- Was moisture or mold a concern in the basement?
- Location and frequency of laundry and how clothes were dried
- Number of occupants, bathing habits – did they take long showers?

Task 2: Prepare Data Loggers, Instruments & Instructions and Ship to Participants

Once the Monitoring Protocol was confirmed, Buchan, Lawton, Parent Ltd created 30 packages containing the monitoring equipment, instrumentation and detailed instructions for the participants.

Task 3: Establish Contact and Monthly Co-ordination with Participants

Two years is a long time frame for a study. It was a challenge to motivate each of the homeowners to continue to take readings and to ensure everything was operating as intended for the duration of the study. Some motivation came from the Project Officer at CMHC. Ongoing communication and data transfer was an important tool used by the Project Co-ordinator to facilitate a successful monitoring program.

Under this task, Buchan, Lawton, Parent Ltd communicated with the participants, giving them reminders, providing instructions or troubleshooting and asking them to submit the collected data at regular intervals. Simple reminders, such as checking the battery level on data logger, also helped to catch problems before any data was lost or compromised.

The ongoing contact helped to ensure any changes in the household routines or equipment was obtained and documented as they happened so they could be factored into the final analysis, where necessary.

Task 4: Data Collection & Manipulation

The data collected for each house included:

- Temperature and relative humidity in the basement and in an upper floor (obtained with the HOBO data loggers)
- Moisture content of wood in five pre-determined basement locations and two main floor, or upper floor, locations (Monthly data reading)
- Surface temperature of wood in five pre-determined basement locations and seven main floor, or upper floor, locations (Monthly data reading)
- Water volumes extracted by the dehumidifier during the second year of study (As needed)
- Hourly exterior weather data (obtained from Environment Canada)

The data was collected on an ongoing basis for two major reasons: as a mechanism to remind the participants to keep collecting the information and to help mitigate some of the challenges of monitoring from a distance. It was an attempt to avoid loosing large amounts of data because of an instrument failure or problem. A further advantage was the ongoing feedback that was provided to the participants and the Project Officer.

With the ongoing data collection and review, it was also possible to fine-tune the protocol. The frequency of data collection, for example, could have been increased or decreased to achieve more useful results.

Buchan, Lawton, Parent Ltd obtained daily weather information including the humidex readings for each city/location from Environment Canada.

Task 5: Arrange for Return of all Data Loggers

Buchan, Lawton, Parent Ltd coordinated the dismantling and return of the 60 data loggers at four points during the study. Again, the ongoing contact helped to ensure continuing participant involvement and helped to avoid the loss of large amounts of data due to instrument failure or other problems.

Task 6: Download & Analyze Data

Buchan, Lawton, Parent Ltd downloaded and plotted the data from the data loggers along with the rest of the parameters, as each package of information arrived. The monitoring data obtained from the data loggers was reviewed for anomalies as soon as it was downloaded. Copies were sent to each of the participants for their information.

Task 7: Reporting

Buchan, Lawton, Parent Ltd compiled the monitoring results and prepared a report on the findings of the study.

3.0 HOUSES IN THE STUDY

The scope of the study originally comprised 30 test homes, ten houses from Ontario and Quebec, ten houses from British Columbia and Atlantic Canada, and ten houses from the Prairie region. Upon completion, data was obtained from 21 houses over the two-year period: eight from Ontario and Quebec, six from Alberta and Saskatchewan, and seven from the coastal regions (five from British Columbia, and two from Atlantic Canada).

None of the houses were equipped with dehumidifiers or air conditioners prior to commencing the field study.

The following table lists each of the participating homes and provides a brief description of the house and its occupants. At the start of the study, the houses all appeared to meet the criteria for the study with no obvious reasons to believe the house would give inconsistent or inaccurate results.

Table 1: Participant Housing Information

House	Description	Household	Moisture Indicators
#01 Calgary, Alberta	-Two storey Detached -Built: 1991, 172 m^2 -Finished basement, partially below grade. -Drainage membrane, vapour barrier and concrete foundation -Pitched roof. Wood framing, R20 Fibreglass insulation -Double-glazed windows -Weeping tile and eavestroughs -Forced air gas furnace	-3 occupants -Temperature: 21°C day; 18°C night -Windows open for ventilation in summer. Basement windows not opened. -Furnace fan only on when furnace is on	-Bathrooms have fans -3 showers a day, 2 loads of laundry per week -No flooding problems -No leakage problems -Humidifier used in winter
#02 Sherwood Park, Alberta	-Two storey detached -Built: 1991, 135 m^2 -Partially finished basement, full depth. -Insulated concrete and vapour barrier. -Pitched roof. Wood frame, R20 Fibreglass insulation -Double-glazed windows -Weeping tile, sump pump (covered), ground slopes away from home, and eavestroughs. -Force air gas furnace, and wood fireplace.	-2 occupants -Temperature: 20°C day; 18°C night -Windows open for ventilation in summer, and sometimes open in spring and fall. Basement windows not opened. -Furnace fan only on when furnace is on	-Bathrooms have fans -1 shower a day, 2 loads of laundry per week -Surrounding properties slope towards house; heavy rains cause sump to fill at regular intervals -No flooding problems -No leakage problems -Located in wet area -No humidifier used in the winter
#03 Edmonton, Alberta	-Detached bungalow -Built: 1981 -Finished basement	-Participant sold house	-No flooding problems

#04 Sherwood Park, Alberta	-Bungalow condominium -Built: 1998, 128 m^2 -Unfinished basement, full depth -Vapour barrier and concrete foundation -Pitched roof, with vented attic. Wood frame and fibreglass insulation -Double-glazed windows -Weeping tile, ground slopes away from home, sump pump (covered), and eavestroughs -Force air gas furnace with wood fireplace	-2 occupants -Summer temperature: 19°C day; 15°C night -Winter temperature: 16°C day; 12°C night -Windows open for ventilation in summer Basement windows not opened	-Bathroom fans always used when showering -2 showers a day, 4 loads of laundry per week - Sump pump is loosely covered -Condensation on inside of window pane during winter months -No flooding problems -Leakage: Concrete foundation cracked, water penetrated, pooling in basement. (Fixed) -Humidifier used in winter
#05 Calgary, Alberta	-Two storey detached -Built: 1980, 200 m^2 -Finished basement, full depth -No listed barriers or insulation in concrete foundation -Pitched roof. Wood frame, 12R fibreglass insulation -Double-glazed windows -No listed drainage -Forced air furnace and fire place	-2 occupants -Summer temperature: 28°C day; 23°C night -Winter temperature: 19°C day; 16°C night -Windows mostly closed throughout year -Furnace fan on all year	-Primary bathroom fan on timer. Second bathroom without fan -3 showers a day, 4 loads of laundry per week -No flooding problems -Leakage: Leaks during heavy rains in basement through broken aluminum slider on window (Unknown repair status) -No humidifier in the winter
#06 Calgary, Alberta	-Detached single -Built: 1912, 88 m^2 -Finished basement, full depth, rubblestone walls -Insulated walls and vapour barrier, concrete foundation -Vented attic. Wood frame, 40% blown in, 60% Fibreglass insulation -Double-glazed windows -Eavestroughs -Forced air gas furnace with wood fireplace	-1 occupant -Summer temperature: 23°C day; 18°C night -Winter temperature: 18°C day; 18°C night -Windows open for ventilation in spring, summer and fall. Basement windows open in July/August -Furnace fan only on when furnace is on -New wiring, plumbing, and windows installed in 1995. Washroom installed in basement in 2000	-Primary bathroom without fan. Basement bathroom fan always used when showering -1 shower a day, 3 loads of laundry per week -No flooding problems -Leakage: Exterior tap pipe broke, large amounts of water in basement. Carpet dried and tap replaced. (Fixed, 2002) Record rainfall caused seepage through walls in cold room. (Fixed, 2005) -Humidifier used in winter
#07 Saskatoon Sask.	-Detached bungalow -Built: 1981, 120 m^2 -Partly finished basement, partially below ground, walkout -P/T wood walls with concrete foundation -Vented attic. 12R fibreglass insulation plus 1" of Styrofoam -Triple paned windows, with some double-glazed energy efficient windows -Sump pump (covered), ground slopes away from home, and eavestroughs -Forced air gas furnace	-3 occupants -Summer temperature: 22°C day; 20°C night -Winter temperature: 22°C day; 18°C night -Windows open for ventilation in summer. Open only at night in spring and fall. Basement windows not opened -Fan on only when furnace is on	-Bathroom fans always used when showering -5 showers a day, 7 loads of laundry per week -Condensation on windows in winter -Smells occasionally linger throughout home -No flooding problems -Leakage: Dripping from water pipes in basement (Unknown repair status) Washing machine leaked down wall into basement (5 Gallons. Unknown repair status) -No humidifier in the winter

#08 Dundurn, Sask.	-Detached single -Built: 2001, 130 m^2 -Finished basement, full depth, walk out -ICF walls and foundation -Pitched roof, with wood floor system. 25R ICF insulation. -Triple-glazed, low E windows -Ground slopes away from home, and eavestroughs -HRV system installed -Hydronic gas heating, with gas fireplace	-2 occupants -Summer temperature: 24°C day; 20°C night -Winter temperature: 23°C day; 23°C night -Windows open for ventilation in spring, summer, and fall. Basement windows occasionally opened -No furnace fan	-Bathrooms are HRV vented outdoors -2 showers a day, (25 min each) 6 loads of laundry per week -Condensation on base of windows during coldest days of winter -Smells occasionally linger in house -Master bath is musty -No flooding problems -No leakage problems -No humidifier in the winter
#09 Grenfell, Sask.	-Detached bungalow -Built: 1984, 136 m^2 -Finished basement, full depth -P/T wood walls and foundation, on dirt/sand -Pitched roof. Wood frame. Unknown insulation type -Double-glazed energy efficient windows -Weeping tiles, sump pump (not covered) and eavestroughs -Forced air electric furnace	-3 occupants -Summer temperature: 25°C day; 20°C night -Winter temperature: 19°C day; 17°C night -Windows open for ventilation in spring, summer, and fall, including basement window -Furnace fan running at all times in winter	-Bathrooms have fans. Kitchen range only used if windows are closed -2.5 showers a day, 10 loads of laundry per week -Mold on exterior wall baseboard in basement bedroom (Fixed, 2005) -No flooding problems -Leakage: Service pipe broke inside house, 2” of water into basement, seeping through wood floor into crawl space (2003) -No humidifier in the winter
#10 Winnipeg, Manitoba	-Two storey, detached -Built: 1927, 163 m^2 -Finished basement	-5 occupants	-No flooding problems
#11 Prince George, BC	-Detached bungalow -Built: 1960, 110 m^2 -Partially finished basement	-2 occupants	-No flooding problems
# 12 Langley, BC	-Detached single -Built: 1980, 140 m^2 -Finished basement, partially below grade -No listed barriers or insulation in concrete foundation -Pitched roof. Batt insulation -Double-glazed windows -Weeping tiles, ground slopes away from home, and eavestroughs. -Forced air gas furnace	-5 occupants -Summer temperature: 25°C day; 20°C night -Winter temperature: 10°C day; 5°C night -Windows open for ventilation in spring, summer, and fall. Basement windows open in summer -Furnace fan is only on when furnace is on	-Primary bathroom has a fan, secondary bathroom is without a fan -Smells tend to linger -2 Showers a day, 7 loads of laundry per week, and 10 hours of cooking per week -Basement closest is musty -No flooding problems -No leakage problems -No humidifier in the winter

# 13 Yarmouth, NS	-Two storey detached -Built: 1919, 179 m^2 -Unfinished basement, full depth, with crawl space. -No listed barriers or insulation in concrete foundation. Crawl space rests on dirt/sand -Pitched roof with vented attic. Wood frame, unknown insulation type -Single pain windows on first floor, and double glazed on second -Weeping tiles, ground slopes away from home, and eavestroughs -Cast iron hydronic radiators with oil-fired boiler for heating	-5 occupants -Summer temperature: 22°C day; 20°C night -Winter temperature: 20°C day; 18°C night -Windows open for ventilation in spring, summer, and fall. Basement windows not opened -No furnace fan	-Primary bathroom has fan, secondary bathroom without a fan -4 showers a day, 7 loads of laundry per week, and no dishwasher -Located in wet area -Smells never linger -No flooding problems -Leakage: Occasional leak at bulkhead of exterior entrance into basement due to hydrostatic pressure. Concrete floor improperly poured. (Unresolved) -No humidifier in the winter
# 14 Corn Hill, NB	-Two story detached -Built: half -1900, with extensive renovations, other half -1984, 102 m^2 -Unfinished basement, full depth -No listed barriers or insulation in concrete foundation -Vented attic. Wood frame, 40R fibreglass insulation -Half double-glazed windows, half double-glazed plus energy efficient -Weeping tiles, and eavestroughs -Forced air wood furnace	-2 occupants -Temperature: 20°C day; 18°C night -Windows open for ventilation in summer. Opened occasionally in spring and fall. Seldom open in winter. Basement windows not opened -Furnace fan only when furnace is on -New windows and improved insulation (1985)	-Bathrooms without fans. Kitchen without fume hood -2 showers a day, 6 loads of laundry per week, and 12 hours of cooking per week -Wood for furnace is stored indoors -No flooding problems -Leakage: Blocked drain pipe in basement (Fixed) -No humidifier in the winter
# 15 Campbell River, BC	-Detached single -Built: 1954, 186 m^2 -Finished basement, full depth -No listed barriers or insulation in concrete foundation -Flat roofed. Wood frame, 21R mineral wool insulation -Double-glazed, low E windows -Weeping tile drainage -Forced air, oil furnace, with fireplace	-2 occupants -Summer temperature: 20°C day; 17°C night -Winter temperature: 21°C day; 16°C night -Windows generally not opened for ventilation. Basement windows opened occasionally in spring summer/fall -Furnace fan only on when furnace is on -Basement finished, increased insulation, and new bath upstairs (1998-2005)	-Primary bathroom without a fan, secondary bathroom fan on moisture sensor -2 showers a day, 2 loads a week, 12 hours of cooking -Odours tend to linger after cooking -No flooding problems -Leakage: Roof around chimney leaks into upstairs kitchen. Flashing on chimney and tar roof both leak (Unresolved) -No humidifier in winter

# 16 Prince George, BC	-1.5 storey detached -Built: 1979, 164 m^2 -Partially finished basement, full depth -No listed barriers or insulation in concrete foundation -Pitched roof with vented attic. Wood frame, 20R fibreglass insulation -Double-glazed windows -Eavestroughs and downspout drainage -Forced air gas furnace, with electric baseboards on top floor and gas fireplace in basement	-2 occupants -Summer temperature: 20°C day; 18°C night -Winter temperature: 20°C day; 16°C night -Windows open for ventilation in summer. Basement windows not opened -Furnace fan on only when furnace is on	-Bathrooms have fans running half the time. -1 shower a day, 1 load of laundry per week -No odour problems -Condensation appears on second story bedroom window, with a tendency to mold on walls on outside perimeter in winter -No flooding problems -Leakage: Copper pipe leak in basement bedroom closet (Repaired) -No humidifier in winter
# 17 Burnaby, BC	-Semi Detached -Built: 1997, 223 m^2	-5 occupants	- No flooding problems
# 18 Lytton, BC	-Detached Bungalow -Built: 1974, 186 m^2 -Unfinished basement, full depth walk out. -Concrete foundation with drainage membrane -Pitched roof with vented attic. Wood frame, 12R paperback insulation -Double-glazed windows -Weeping tiles, and downspouts -Electric baseboard heating, with woodstove	-2 occupants -Summer temperature: 29°C day; 18°C night -Winter temperature: 15°C day; 15°C night -Windows open for ventilation in spring, summer, and fall. Basement windows only open in summer -No furnace fan	-Bathrooms without fans. Kitchen without fume hood -Take baths instead of showers, 2 loads of laundry per week, and 7 hours of cooking -Musty smell in basement -Located in wet area -No flooding problems -Leakage: Roof had several leaks, causing moldy smell. (Roof replaced, 2005) -No humidifier in winter
# 19 Burnaby, BC	-Two storey detached -Built: 1994, 242 m^2 -Finished basement plus crawl space. -Concrete foundation with drainage membrane in walls and vapour barrier in floor -Pitched roof with vented attic. Wood frames, fibreglass insulation -Double glazed, energy efficient windows -Eavestroughs drainage -Forced air natural gas furnace with gas fireplace and electric baseboard heating	-3 occupants -Summer temperature: 25°C day; 20°C night -Winter temperature: 21°C day; 18°C night -Windows open for ventilation in summer, including basement windows -Furnace fan running at all times in winter	-Bathroom fans on timers -2 showers a day, 6 loads of laundry per week -Wet hockey equipment dried inside -Basement bath smells musty -No flooding problems -No leaking problems -No humidifier in winter

# 20 Burnaby, BC	-Detached single -Built: 1982, 242 m^2 -Finished basement, partially below ground -P/T wood walls with concrete floor foundation -Vented attic. Wood frame, pink foam insulation -Double-glazed windows (65%), double-glazed energy efficient windows (35%) -Sump pump (covered) -Hydronic gas furnace, and wood fireplace -No heating in basement	-5 occupants -Summer temperature: 25°C day; 15°C night -Winter temperature: 20°C day; 15°C night -Windows open for ventilation in summer, including basement windows -Furnace fan only on when furnace is on -New windows (2001)	-Bathroom fans on timers -2 showers a day, 2 loads of laundry per week, and 7 hours of cooking. -Laundry is hung to dry indoors -Plenty of indoor vegetation -Odours occasionally linger -Located in wet area -Flooding: Sump pump backed up causing extensive flooding in basement. Walls repainted and carpet replace (Fixed, 2002) -No leakage problems -No humidifier in winter
# 21 Tingwick, Quebec	-Two storey detached -Built: 1944, 98 m^2 -Partly finished basement, full depth -30% Concrete foundation, 70% rubblestone, with urethane insulated walls and floor -Pitched roof. Balloon frame, 10R wood shaving insulation -Double-glazed windows -Ground slopes away from house, and eavestroughs -Electric baseboard heating with wood stove	-4 occupants -Summer temperature: 22°C day; 19°C night -Winter temperature: 20°C day; 18°C night -Windows open for ventilation in summer, including basement windows -No furnace fan -Basement insulated, new windows, increased insulation in roofing and several exterior renovation (1990-2005)	-Bathroom fans on timers -5 showers a day, 10 loads of laundry per week, and 10 dishwasher loads per week -Washroom is musty -Condensation and mold through exterior wall behind owner's armoire. (Fixed) -No flooding problems -Leakage: leak by windows in basement prior to new windows being installed (Fixed) -No humidifier in winter
# 22 Cantley, Quebec	-1.5 storey detached -Built: 1988, 325 m^2 -Partly finished basement, full depth -Concrete foundation, vapour barrier, and insulated walls and floor -Pitched roof. Wood frame, 40R Batt insulation (60R in attic) -Double-glazed, energy efficient windows -Ground slopes away from house, weeping tiles, eavestroughs and stone splash pads under drip lines -HRV system installed -Forced air electric furnace	-2 occupants -Summer temperature: 24°C day; 20°C night -Winter temperature: 20°C day; 19°C night -Windows open for ventilation in summer. Basement windows occasionally opened -Furnace fan running full time in winter -1997 new fireplace and chimney. Changed roofline over garage (hip to gable), new windows in garage. Skylights removed, shingles replaced, and water shields installed to replace eavestroughs	-Bathroom fans on timer. Fans connected to HRV system -2 showers a day, 8 loads of laundry per week, and 15 hours of cooking per week. -Moisture spots on drywall in wine cellar under front porch (Unresolved) -Basement sometimes smells earthy or musty in summer -No flooding problems -Leakage: Water backup under shingles in room over garage during winter thaw. (Fixed 1994) -Humidifier used in winter

# 23 Gatineau, Quebec	-Two storey detached -Built: 1993, 300 m^2 -Unfinished basement, full depth. -No listed barriers or insulation in concrete foundation -Pitched roof with vented attic. Wood frame, 22R mineral fiber insulation -Double-glazed windows -Weeping tiles, sump pump (covered), ground slopes away from house, and eavestroughs -Forced air, oil and electric heating, with wood fireplace	-4 occupants -Summer temperature: 25°C day; 22°C night -Winter temperature: 20°C day; 17°C night -Windows open for ventilation in summer, including basement windows -Furnace fan only on when furnace is on	-Primary bathroom without a fan, secondary bathroom has a fan -5 showers a day, 4 loads of laundry per week, and 10 hours of cooking per week -Basement musty (Unresolved) -No flooding problems -Leakage: Wall by front porch leaked heavily. (Single occurrence) Roof leaked caused damage to drywall ceilings (Single occurrence, fixed) -No humidifier in winter
# 24 Port Stanley, Ontario	-Two storey detached -Built: 1992, 140 m^2 -Unfinished basement	-2 occupants	-No flooding problems
# 25 Ottawa, Ontario	-Semi-detached -Built: 1917, 186 m^2 -Finished basement	-5 occupants	-No flooding problems
# 26 Ottawa, Ontario	-Two storey Semi-detached (End unit) -Built: 1965, 140 m^2 -Finished basement, full depth -No listed barriers or insulation in concrete foundation -Pitched roof with vented attic. Wood frame, blown insulation in attic, "as built" for remainder of house, unknown R value -Double-glazed windows -Ground slopes away from house, and eavestroughs -Forced air gas furnace with wood fireplace	-2 occupants -Summer temperature: 22°C day; 20°C night -Winter temperature: 18°C day; 15°C night -Windows open for ventilation in spring, summer, and fall, including basement windows -Furnace fan only on when furnace is on -New roof with increased attic insulation (2002)	-Bathrooms without fans -2 showers a day, 6 loads of laundry per week, and 3 hours of cooking per week -Condensation in bathroom (Unresolved) -Mold back behind spare bed and basement (Fixed) -Some wood stored indoors -Clothes dried inside -No flooding problems -Leakage: Minor drips down wall in basement (2001) Old roof leaked in master bedroom. Roof repaired and vent closed (2002) -No humidifier in winter
# 27 Bécancour Québec	-Two storey detached -Built: 1987, 149 m^2 -Mostly finished basement, partially above ground -Concrete foundation with insulated walls and vapour barrier -Vented attic. R40 in roof, R26 in walls, and R20 in basement -Double-glazed windows -Weeping tiles, ground slopes away from house and eavestroughs -HRV system installed -Forced air wood burning furnace. Electrical heating as secondary source	-2 occupants -Temperature: 22°C day; 22°C night -Windows open for ventilation in summer, including basement windows -Furnace fan running all year	-Bathrooms without fans 1 showers a day, 7 loads of laundry per week, and 4 hours of cooking per week -HRV running 10% of the time -Occasional condensation around windows and linen closet (Unresolved) -Occasional musty zoned (Fixed) -Clothes are hung inside -No flooding problems -No leakage problems -No humidifier in winter

# 28 Laval, Quebec	-Detached bungalow -Built: 1956, 116 m^2 -Finished basement, full depth -No listed barriers or insulation in concrete foundation -Vented attic/ 20R mineral fibre insulation -Single-glazed windows with storm -Weeping tiles and downspouts -Forced air oil furnace	-5 occupants -Summer temperature: 25°C day; 23°C night -Winter temperature: 20°C day; 20°C night -Windows open for ventilation in summer, including basement -Furnace fan running all year	-Primary bathroom fan running at all times. Secondary bathroom without a fan -3 showers a day (30 min each), 15 loads of laundry per week, and 7 hours of cooking. No dishwasher -Odours never linger -Clothes are hung to dry inside -Located in wet area -No flooding problems -Leakage: Garage becomes moist along the exterior wall particularly in the spring and summer (Unresolved) -No humidifier in winter
# 29 Ancienne-Lorette, Quebec	-1.5 storey detached -Built: 1973, 200 m^2 -Partly finished basement, full depth -No listed barriers or insulation in concrete foundation -Pitched roof. Wood and balloon frame, standard insulation type -Double-glazed windows with thermal layer -Weeping tiles only form of drainage -Electric baseboard heating with wood burning stone fireplace	-4 occupants -Summer temperature: 24°C day; 23°C night -Winter temperature: 23°C day; 22°C night -Windows open for ventilation in summer. Windows opened occasionally in spring and fall. Basement windows open in summer only -No furnace fan -Shingles replaced. New windows and doors installed (1997)	-Primary bathroom fan running at all times. Secondary bathroom without fan -4 showers per day, 10 loads of laundry per week, and 10 hours of cooking per week -High levels of activity in basement, including some degree of sports -Some musty zones in basement during winter months -No flooding problems -No leakage problems -No humidifier in winter
# 30 Brossard, Quebec	-Detached bungalow -Built: 1982, 111 m^2 -Partly finished basement, full depth -No listed barriers or insulation in concrete foundation -Pitched roof. Unknown insulation type -Double-glazed, energy efficient windows -Sump pump (covered) -Forced air, oil burning furnace with wood burning fireplace	-2 occupants -Temperature: 19°C day; 19°C night -Windows open for ventilation in spring, summer, and fall, including basement windows -Furnace fan only on when furnace is on -New windows, and new vapour barrier on roof (2002)	-Bathrooms without fans. Kitchen hood only re-circulates air -2 showers a day, 5 loads of laundry per week, and 7 hours cooking per week -old windows showed condensation (fixed) -Located in wet area -No flooding problems -Leakage: Fissure in basement wall (Unknown Repair status) -No humidifier in winter

4.0 MONITORING PROTOCOL

The monitoring protocol was developed to ensure a consistent data collection process from each home during the two-year study. The protocol provided participants with the desired frequency and location of the moisture content and temperature readings, as well as the instructions for maintaining an accurate dehumidifier log. Each participant was provided with:

- Two HOBO U12 (or U13) Temp/RH data loggers to monitor the relative humidity and temperature at one location in the basement and at a second location on the main floor,
- A TimberCheck Moisture Meter for sampling the percentage of moisture in wood in various locations in the home, and
- A Raytek Infra-red Noncontact Thermometer for sampling surface temperatures in various locations in the home.
- And instructions on how and when to use the various monitoring tools and where to take the readings.

4.1 HOBO Data Logger

To maintain consistency between homes, the participants were asked to install the data loggers using the following guidelines:

1. Locate the basement data logger close to the planned location for the dehumidifier (within five metres).
2. Avoid locating the data logger adjacent to any exterior walls or doors.
3. Locate the second data logger on the main floor avoiding the kitchen, bathrooms, a source of heat (such as a television or lamp), or an exterior wall or door. *(Participants were given the recommendation to locate the data logger beside the furnace thermostat or in a hallway.)*
4. Place the data logger approximately 1.5 to 2 metres above the floor on a wall (or on an interior column in the basement) using the mounting kits included with the HOBO.

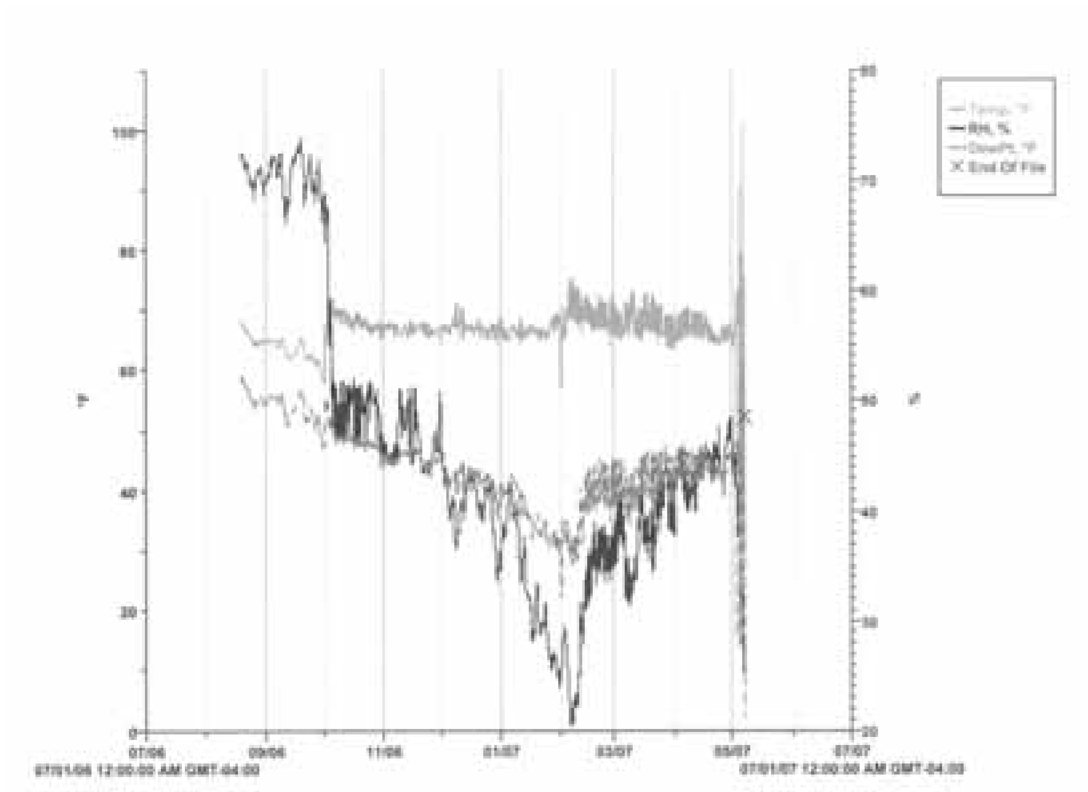
HOBO meter placed next to a thermostat

Once the data logger was installed, participants were asked to occasionally check whether the LED on each data logger was blinking to ensure the device was still functioning properly.

Over the course of the project, participants were asked to send the data loggers back on four occasions to extract their current data and to replace the batteries. The temporary return of the data loggers also provided Buchan, Lawton, Parent Ltd with an opportunity to ensure that useful data was being obtained.

Figure 4.1 is a sample of the type of data obtained from the HOBO meters installed in House #22 over a six-month period.

Figure 4.1 Graph of Data Obtained from the HOBO Meter



4.2 Manual Temperature and Wood Moisture Monitoring

To effectively monitor the relative moisture content in the wood of an average home, consistent and accurate data is required. The budget for the field study precluded the use of automated devices. Homeowner participation was required to obtain the required information. The participants were asked to manually monitor three crucial sources of data: wood moisture content, interior surface temperatures and, during the second year, the frequency and volume of water removed by the dehumidifier. To avoid time-of-day fluctuations, participants were asked to record the monthly moisture and temperature readings in the same location each month and at the same time of day. Although most participants appeared to be fairly compliant with these guidelines, inconsistencies in monitoring were expected due to the human element of the study. These inconstancies are discussed in greater detail later in the report.

Each participant was sent a excel spreadsheet for documenting the readings of the wood moisture percentages and interior surface temperatures. For the wood moisture content readings, participants were asked to select five specific locations in the basement and two on the main floor or second storey of the home. These locations included:

Basement:

1. Joist or main floor subfloor in central area of basement (near planned location of dehumidifier)
2. Stair stringer at base of basement stairs
3. Stair stringer at top of basement stairs
4. Header at top of west wall
5. Header at top of north wall

Main Floor / Upstairs:

6. Baseboard or doorframe of broom closet
7. Baseboard or doorframe of master bedroom closet

For the surface temperatures, participants were asked to measure the same seven locations as the wood moisture content readings and also asked to monitor an additional five locations on the main or upper floor. The temperature readings locations included:

Basement:

1. Joist or main floor subfloor in central area of basement (near planned location of dehumidifier)
2. Stair stringer at base of basement stairs
3. Stair stringer at top of basement stairs
4. Header at top of west wall
5. Header at top of north wall

Main Floor / Upstairs:

6. Baseboard or doorframe of broom closet
7. Baseboard or doorframe of master bedroom closet
8. Interior surface of outside top corner of north/east wall
9. Interior surface of outside top corner of east/south wall
10. Interior surface of outside top corner of south/west wall
11. Interior surface of outside top corner of west/north wall
12. Surface of hallway wall

4.3 Dehumidifier Installation and Logs

Just prior to the beginning of the second year of the study, each homeowner was asked to confirm their interest in continuing to participate in the study. Of the 30 original participants, 22 agreed to continue.

To ensure consistency with the dehumidifiers, the 22 units were purchased from one store in Ottawa and shipped via ground courier to the 22 sites across Canada. Because we were buying in bulk, the discount arranged on the purchase of the dehumidifiers basically covered the cost of the courier delivery. As well, some to the participants lived in remote areas of Canada with no easy access to stores selling the type and make of dehumidifier chosen for the study and had no other way of obtaining the dehumidifier.

The dehumidifier chosen was a Maytag model M7DH65B2A. It was a heavy-duty household floor model with a moisture removal capacity of 31 litres (65 pints) and a large ten-litre reservoir for the removed water. It was expected to be capable of adequately lowering the moisture levels in a typical Canadian basement and it was expected to be reliable with its five-year warranty. Several features were important to the study: the dehumidifier had an RH sensor that automatically stopped operation when the ambient air reached a pre-set RH of 50% and started again when it went above 50% RH; and it stopped when the reservoir was full. This ensured the dehumidifier did not dry out the basement too much during the winter and did not consume energy when it was not condensing moisture out of the air.

Prior to sending out the dehumidifiers, the water reservoir in each one was marked with calibration marks to assist the participants in determining how many litres of water had been removed from the air when emptying the reservoir.

Once the homeowners received the dehumidifiers, they were asked to immediately install them in their basement and set the RH to 50%. Ideally, the dehumidifier was to be left on at all times. Participants were informed that daily attention was likely required, especially during the summer months when the relative humidity in the air commonly increases. Participants were asked to empty the dehumidifier and record the time it was emptied, as well as the volume of water collected at each recording. A template data log was provided to participants for their use in the project.

The dehumidifiers arrived at the participants' homes in late October or early November 2006. At that time of the year, we did not expect the dehumidifier to draw much moisture out of the air. From our observations of the previous year, most basements were below 50% RH through the winter period. However, the goal was to monitor the impact of the dehumidifier over an entire year and that included the winter season. If the relative humidity in the basement was below 50% RH, the dehumidifier did not operate.

Note that, after committing to receive a dehumidifier, one of the participants decided to take several very extended vacations and was unable to carry out the dehumidifier monitoring portion of the study. Useful results were obtained from 21 households.

For 18 of the participating households, enough quantitative data was obtained to present graphs of the findings. Appendix A contains a table for each of the 18 households providing background information on the house and observations from the study along with graphs depicting the results of the monitoring.

5.0 RESULTS

There were challenges in keeping the participants engaged over the two-year period. By the time the study entered the second stage of the monitoring in year two, nine had dropped out, leaving twenty-one who maintained a useful level of participation. These remaining participants were distributed among the three targeted climatic regions.

Most participants generally followed the instructions given to them as far as monitoring and reporting back. The information collected from the participants was, for the most part, helpful to the project. Several participants failed to provide some data for a number of reasons, such as when they were absent or just could not do it. Overall, more than half of the participants gave very useful data on wood moisture content. Two-thirds of the participants submitted Dehumidifier Logs and provided the volumes of water extracted by the dehumidifier. A few had incomplete entries or did not submit a dehumidifier log, which suggests they may not have taken measurements. The HOBO meters were very reliable. Thus, information was obtained, even if the participant's monitoring was incomplete (except in two isolated instances).

The overall quality of the data retrieved was sufficient for analysis, notwithstanding the gaps in the available data. The intent was not to get quantitative data. We expected qualitative data bearing in mind limitations in measurements by individuals outside of a laboratory setting. A few individuals gave excellent data, meticulously recorded with very few gaps that reflected their interest and dedication to the project. Others submitted data to the best of their circumstances.

The data obtained from a number of homes was very useful; for the purposes of example, the data from House #22 is presented below.

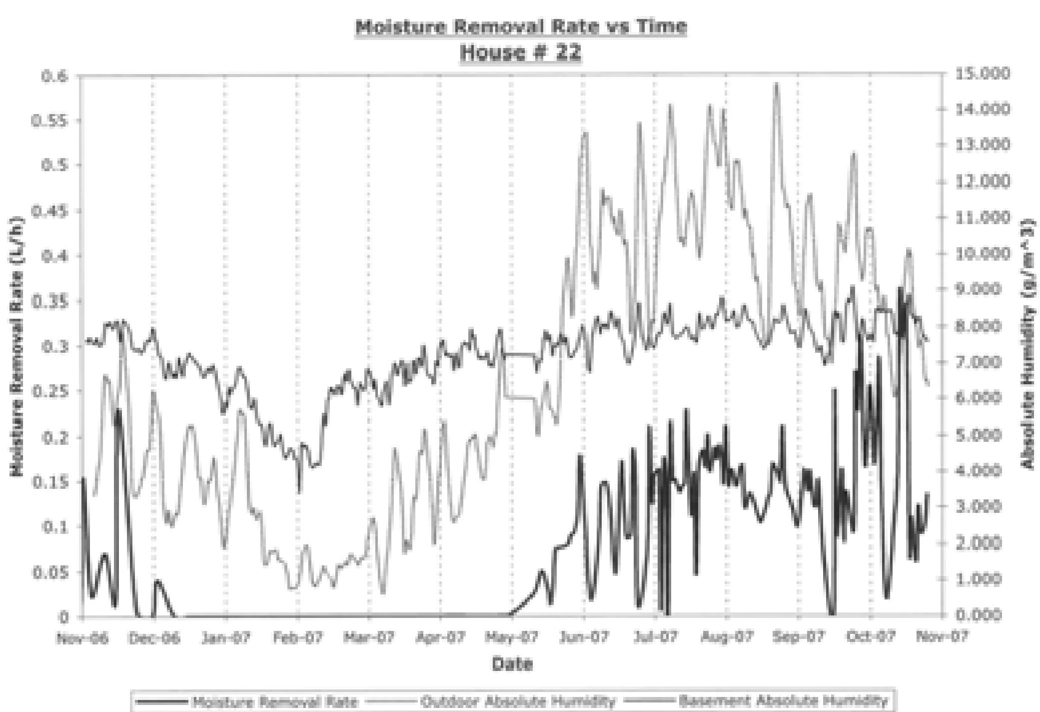
Figure 5.1 compares the absolute humidities (moisture content) of the basement air in year 1 (without a dehumidifier) and year 2 (with a dehumidifier) of House #22. The climatic data retrieved from Environment Canada for the location of the subject house for both years, also shown in the figure, are superimposed. As was expected, the indoor absolute humidities during the winter months were higher than those of outdoor air. During the warm months, from May to the beginning of October, the indoor absolute humidities followed closely that of the outside air on Year 1, with a peak in early August. In Year 2, when the dehumidifier was running, the indoor absolute humidity remained nearly constant and lower than the outdoor absolute humidity during the warm months from May to October.

A similar graph (not shown) of Mainfloor Absolute Humidity vs. Time during the two-year period superimposed over the Outdoor Absolute Humidity vs. Time from May to September of each year did not exhibit the same reduction in moisture levels during the second year. This is expected since the upper floors were open to the outdoors during the warm months. Mainfloor Absolute Humidities were, however, higher than Outdoor Absolute Humidities during the heating season – from October to April.

Figure 5.1 Comparison of Year 1 against Year 2 Indoor and Outdoor Absolute Humidities

The Moisture Removal Rate vs. Time graph for Year 2 in Figure 2 of House #22 shows the dehumidifier extracted water from the house for a month in November (start of Year 2) and from May until the end of October 2007. No water was extracted during the winter months. The Moisture Removal Rate was calculated from the measured volumes of water collected by the dehumidifier.

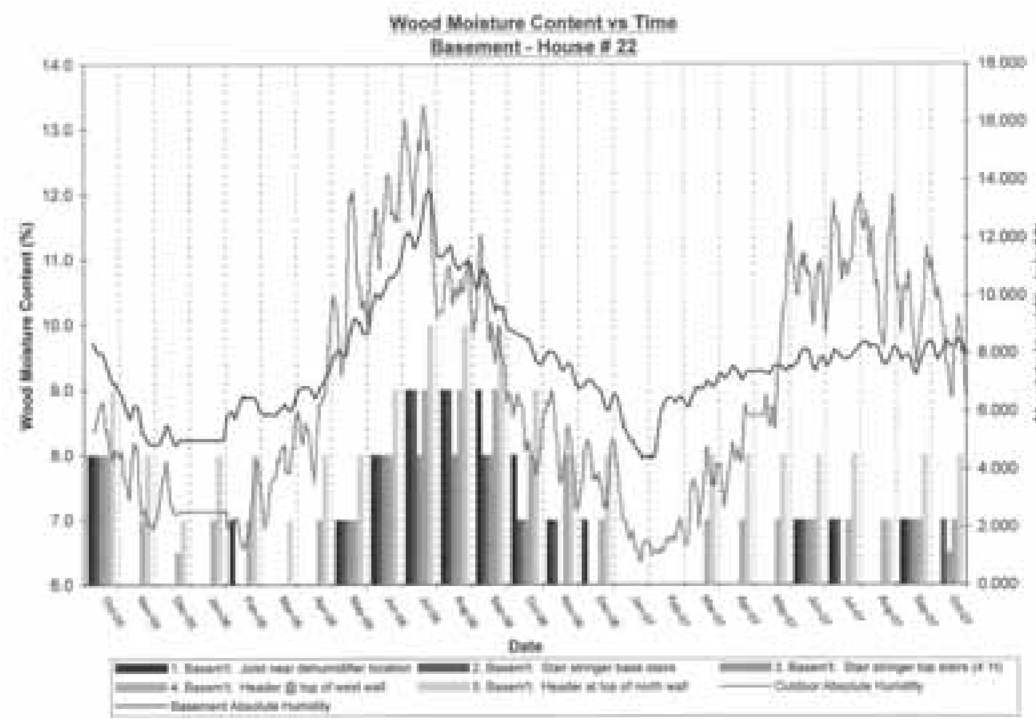
Figure 5.2 Moisture Removal Rate vs. Time graph for Year 2



In one house in British Columbia, the dehumidifier extracted water all year round with water removal rates of about 0.15 L/hr from December to June and slightly higher water removal rates from July to November. Running the dehumidifier in this house would be beneficial all year round.

In Figure 3, the moisture content of wood is graphed against time over the two-year period. There is some variation in the moisture content of the wood between the first and second year for the wood in the basement. During year 1, without dehumidification, the wood moisture content peaked to 10% during the months of June to October. During year 2, with dehumidification, the wood moisture content stayed around 7 to 8%. A similar graph of Wood Moisture Content vs. Time in the upper floors did not show much difference between the first year and second year. The measurements show that wood moisture content responds to the indoor absolute humidity. Dehumidification of the basement lowers the absolute indoor humidity and this is reflected in the moisture content of wood in the basement.

Figure 5.3 Basement Wood Moisture Content, First and Second Years



The results from two houses in the study were inconsistent with those from other houses. In House #13, the indoor absolute humidities exceeded those of the outdoors not only during the winter, as expected, but also during the summer months, even with dehumidification. Also, the wood moisture contents in the basement were unchanged by dehumidification. The dehumidifier in this house was removing an average of 0.60 L/hr, compared to 0.20 to 0.25 L/hr in other houses.

In House #9 the trends were right – dehumidification lead to lower indoor absolute humidities in the basement. Wood moisture contents, however, were surprisingly high with 7 to 12% MC during the summer months and up to 24% during the winter months of both years. The moisture removal rate was as high as 0.75 L/hr.

The two anomalies can be explained by higher moisture sources in the houses. House #13 had a dirt floor crawl space attached to the basement. The dehumidifier was unable to make a difference to the moisture loading from the dirt floor. House #9 had a preserved wood foundation on dirt/sand and the water may be wicking up through the wood. In the house with a dirt floor crawl space, a dehumidifier is not the primary strategy. The dirt floor must be covered with polyethylene film before using a dehumidifier.

The following subsections further discuss the data retrieved from the two-year study period and the corresponding results.

5.1 Manually Recorded Data

The amount of data collected over the two-year study period varied greatly from one participant to the next, however, collectively the data satisfied the requirements laid out by the scope of the project. As outlined in *Task 4: Data collection & manipulation*, the project sought five principal sources of data in order to obtain enough information to draw a reasonable conclusion regarding the effectiveness of a dehumidifier as a means of reducing indoor moisture levels. The following data were collected:

- Temperature and relative humidity in the basement and in the main floor or upper floor (Hourly data, obtained through the main floor and basement data loggers)
- Moisture content of wood in five pre-determined basement locations and two main floor, or upper floor, locations (Monthly data reading, obtained by participants)
- Surface temperature of wood in five pre-determined basement locations and seven main floor, or upper floor, locations (Monthly data reading, obtained by participants)
- Water volumes extracted by the dehumidifier during the second year of study (Data collected as needed by participants)
- Exterior weather data (Hourly data, obtained from Environment Canada)

Despite the occurrences of missing data, the overall quality of the data retrieved was sufficient for the study. It was not expected to yield misleading or inaccurate results.

5.2 Project Limitations

Throughout the two-year study, several problems of various magnitudes were identified regarding the methodology and the results of the project.

Participant Limitations: Assessing the Human Element of the Project

One limitation to the study related to the human element. The challenge was to maintain motivation in all 30 participants for the two years. As previously mentioned, eight participants withdrew from the study before the end of the first year and one received his dehumidifier but was unable to participate. Therefore, useful data was limited to the remaining 21 homes. Of those participants, most maintained a constant level of participation and were quite diligent in ensuring the data was collected and recorded correctly. Some data was lost, however, due to absence, vacations, unexpected difficulties or simply forgetting to record data. Most instances of missing data were as a result of absence or vacation. From the outset, this was expected. Two years of constant participation is a lot to ask, especially with the high level of attention required from the homeowners particularly during the summer months in the second year.

Human error was also a concern when measuring and recording data. While the monitoring instruments were relatively simple to use, care was required when taking the readings (especially with the wood moisture content meter). Transcription errors were possible and, in some cases, the wood moisture content readings may have been lower than the actual wood moisture content level of the wood.

Technical Difficulties with the Equipment

During the study, some technical difficulties resulted in a loss of data. One involved a problematic dehumidifier provided to participant 13. When it arrived, the dehumidifier did not work and it took over six months to repair the problem. The dehumidification data collection began in mid June with six months of moisture collection data lost. Due to the quality of the remaining months of the participant’s dehumidifier log, this dilemma was minimal in terms of the overall impact on the final results.

Two instances of technical difficulties occurred with the HOBO data loggers during the project. The first instance was an unexplainable technical error in a device, leading to six months of lost moisture and temperature data -- the device simply stopped functioning properly, despite no noticeable problems with the battery or device itself. A second instance occurred when a data logger was incorrectly reset before shipment back to the homeowner. This problem required the data logger be sent back to Buchan, Lawton, Parent Ltd and reset properly before it could be installed. This incidence resulted in an approximate loss of two months of data. With only two isolated problems, the data loggers were considered to be very reliable.

Missing Data During Shipping Periods

At four points during the study, the homeowners were asked to ship the HOBO data loggers back to Buchan, Lawton, Parent Ltd for data downloading and battery replacement. During those periods, the data was not collected. This loss was unavoidable and was scheduled for periods when the data was least valuable. The lost data was minimal when compared to the overall project length.

Dehumidifier Auto-Shutoff

The dehumidifier chosen for the study was equipped with an auto-shutoff function that turned off the dehumidifier once the reservoir was full. While this was a very practical feature of the dehumidifier, it likely led to less moisture removal than some of the dehumidifiers were capable of removing. Each participant was asked to record when the dehumidifier’s reservoir was emptied and how much moisture was removed. In some cases, the reservoir was not completely full when emptied; however, in other cases, the reservoir was full. In those cases, it is not known when the reservoir filled and shifted the dehumidifier to standby mode. An examination of the dehumidifier logs revealed situations where full dehumidifiers were emptied in the early morning and late afternoon. If the moisture removal were constant, the dehumidifier may have been in standby mode for up to six hours before the morning emptying. Of the 1810 dehumidifier log recordings, 161 entries may represent a dehumidifier that shut off when full and stopped removing moisture from the air. This suggests the data may have under represented the potential for a dehumidifier to remove excess moisture from the air.

Also, several participants did not record the time, only the day when the dehumidifier was emptied. For these cases, recording times were assumed to be made at 1800 hours.

Difficulties Locating Exposed Wood in the Basement

Some homeowners had difficulties accessing exposed wood for the wood moisture readings, especially in finished basements. Those participants were directed to take measurements as close as possibly to the desired locations of interest. Several homeowners placed pieces of unfinished wood in appropriate locations to be able to take moisture measurements where there was no exposed wood.

Wood Moisture Content Readings

A Timber Check Moisture Meter was used to measure the moisture content of the wood in various locations in the home. The minimum value measured by the meter is 6% moisture content. Six percent or lower is considered very dry and many of the moisture readings fell into that category. In houses with low wood moisture content to begin with, we would not expect to see a reduction in the wood moisture content with the use of a dehumidifier. Some homeowners mentioned that inserting the prongs of the moisture meter into drier wood proved to be rather difficult and, as a result, may not have measured the wood moisture content accurately each time. Since the reported problems with the moisture content meter occurred measuring dry wood, they are not considered to have an impact on the results of the study.

Dehumidifier Noise

During the study, some participants complained the dehumidifier was noisy. Although they were asked to put the dehumidifier in their basement, some homeowners had people sleeping near the dehumidifier. They reported shutting off the dehumidifier on certain occasions to minimize noise in the house. Most participants noted when the dehumidifier was turned off.

6.0 FINDINGS

The two-year field study of dehumidifier use in houses yielded data from twenty-one Canadian houses of various ages, types and occupancy. Data collected were of two types: a) logged readings of temperature and relative humidity; and b) measurements collected by participants. The design of the study, which consisted of one full year of baseline readings and one year of “dehumidified” readings, showed moisture trends in the house without dehumidification and the reduction of absolute humidities in the basement during the warm months of the year by dehumidification. This first set of data was reliable and independent of human variables. Obtaining these measurements required minimal engagement of the participants. If the study had only been based on the information obtained from the data loggers, the finding that dehumidifiers reduce dampness during the warm months of the year in Canadian houses would not have changed.

The measurements taken by the participants added a layer of information to the automatically recorded data. We were able to show that wood moisture content in the basement responded to changes in the absolute indoor humidities. The moisture content of wood can be used as an indicator of dampness in the basement. Surface temperatures were less useful.

At the completion of the two-year study, Buchan, Lawton, Parent Ltd requested the final return of the HOBO meters and the readings. Of the 21 participants that maintained involvement throughout the full period, three participants never returned their final data. The remaining 18 participants (seven from Quebec and Ontario, four from Alberta and Saskatchewan, five from British Columbia and two from the Atlantic region) provided adequate information for the assessment. Some participants were missing information in regards to wood moisture content, but still provided sufficient information through the data loggers and dehumidifier logs.

After analyzing all of the data, the results were graphed and observations noted. A full overview of the results is presented in Appendix A. The overall findings were quite varied and each geographical region yielded results unique to that region. Overall, 10 of the 18 participating houses showed a notable improvement in the indoor humidity levels when compared to the corresponding climatic data. All houses returning sufficient data showed at least some level of moisture removal, with half of the 18 homes showing good levels of moisture removal. Wood moisture content proved to be the least useful source of data -- seven of the 18 participants did not have adequate information to produce a wood moisture content graph. Of the other 11 participants, seven showed some reduction in the wood moisture content and four did not appear to show any reduction.

Measurement of the volume of water collected by the dehumidifiers served two purposes. It made it very real to the participants that water was being extracted from the air and the amounts were very tangible. Participants who were initially sceptical about the value of dehumidifiers were convinced as they were emptying large volumes of water. Secondly, it permitted the determination of the water removal rate by the dehumidifier. The volumes were not precise. To prevent overflow, the dehumidifiers turned off when the container was full. Thus, there would have been periods when the dehumidifier was on stand-by when it should have been removing more moisture from the air. The alternative would have been to drain the condensate automatically with calibrated flow meters. Lapses or delays in emptying the water would result in higher absolute humidities sensed by the data loggers. In other words, the reduction in absolute humidities could have been greater if there were no lapses or delays. In spite of the unavoidable lapses or delays due to human involvement, we believe that the overall results were minimally affected.

The homes in the Prairie Provinces showed the most improvement of the four Canadian regions, yielding improved humidity levels in all four houses, as well, the second highest moisture removal rates in the country. It was also noted that the Prairie region homes, when dehumidified, resulted in more consistent humidity levels with less seasonal fluctuation when compared to other regions. Moisture removal was very seasonal; once humidity levels increased, moisture removal rates were very good, yielding a peak removal average of 0.77 L/h in the summer, well above the national average.

The British Columbian homes yielded mixed results, posting values at the extremes of both ends of the national average. In regards to indoor and outdoor humidity levels, B.C. homes had split results with half the houses surveyed showing the greatest improvements in indoor humidity levels, while the other half showed no improvement at all. British Columbia also generated the lowest moisture removal rates of any region with a peak average of only 0.42 L/h; however, three of the five houses surveyed obtained twelve months of moisture removal readings.

Homes in the Atlantic Provinces showed results typically expected of that region. No improvement in indoor humidity levels was found in either home, nor was there any observable reduction in wood moisture content, despite results reflecting the nation's highest moisture removal rate with a peak average rate of 0.9 L/h. At the launch of the study, homes in the Atlantic Provinces were not expected to show a drastic reduction in humidity levels, due to the region's wet climate.

The homes in Ontario and Quebec generated the most diverse results of all the regions. Of the seven participants who submitted data, three showed improvements of various degrees in indoor humidity levels compared to those of the previous year, while three homes showed no improvements over the pervious year's humidity levels. All homes had good moisture removal levels and two participants in the Quebec region showed evidence of moisture removal throughout the entire year. The Ontario and Quebec homes also showed a fair reduction in wood moisture content with the use of a dehumidifier.

Characteristics such as size, shape, location and construction of the houses and the living habits and size of the households all affect the outcome of the results in a survey of this type.

The following table presents the results of the data obtained in regards to improvements in the dehumidification of the given home. The table summarizes how each region's houses faired in the overall result.

Table 6.1 Summary of House Results

	Quantity	Alb/Sask	B.C.	Atl. Prov	Que/Ont
Indoor vs. Outdoor Humidity Levels	***18***	***4***	***5***	***2***	***7***
Significant Improvement	**4**	*1*	*2*		*1*
Good Improvement	**5**	*3*			*2*
Minimal Improvement	**1**				*1*
No Improvement	**7**		*2*	*2*	*3*
Not Enough Information	**1**		*1*		
Overall consistency in humidity	***5/18***	*3*	*1*		*1*
Moisture Removal Rates					
Excellent Moisture Removal	**5**	*1*	*1*	*1*	*2*
Good Moisture Removal	**4**	*3*			*1*
Low Moisture Removal	**5**		*4*	*1*	
Not Enough Information	**4**				*4*
Year-Round Moisture Removal	***5/18***		*3*		*2*
Wood Moisture Content					
Significant Reduction	**3**	*1*			*2*
Good Reductions	**2**		*1*		*1*
Minimal Reduction	**2**	*1*	*1*		
No Reduction	**4**		*1*	*2*	*1*
Not Enough Information	**7**	*2*	*2*		*3*

Moisture Removal Rates	Peak Avg	Average	
Saskatchewan / Alberta	0.77	0.225	L/h
British Columbia	0.42	0.13	L/h
Atlantic Provinces	0.9	0.5	L/h
Quebec / Ontario	0.63	0.29	L/h
National Results	**0.67**	**0.28**	**L/h**

6.1 Participant Feedback

The observations and opinions of the participants in the two years of testing provide useful insight to the effectiveness of the dehumidifiers. Of the 21 participants who completed the study, 11 were passionate enough about the experience to express their opinions at the completion of the study. Only two of the eleven felt that the dehumidifier made very little impact; one comment came from Alberta, while the other from the Quebec region. Most participants felt that the dehumidifier did, in fact, make a positive difference. The most frequent comments were made with respect to the temperature of the basement: some felt the basement was cooler with the dehumidifier, while others felt the basement was warmer. All agreed that the basement was more comfortable than it was before dehumidification.

Some participants were amazed at the amount of water removed by the dehumidifier. One participant felt the dehumidifier solved a lingering mold problem, while another stated that, as a result of the dehumidifier, sweat was no longer a problem on windows and condensation became a rarity, even when cooking. For the participants, the study was an eye opening revelation of the value of a dehumidifier.

7.0 CONCLUSIONS

This study supports the recommendation to operate a dehumidifier from spring to fall in Canadian basements. Absolute humidities in the basement were reduced and wood was drier with dehumidification. We can extrapolate that other materials in the basement would also be drier. Homeowners reported their basements were more comfortable with dehumidification.

A dehumidifier can be installed in a basement, set to operate at 50% RH and left operational year round. The units would be activated when the relative humidity in the basement goes above 50%RH. This would be especially beneficial in Maritime regions.

Contrary to the perception that the Prairie region is very dry and, therefore, does not need dehumidifiers in the warm months, the study showed that dehumidifiers are needed in all regions of the country. In areas with mild winters and Maritime regions, year round use of dehumidifiers may be warranted.

Selected References

Government Of Canada. Environment Canada. The Green Lane. Canadian Climate Data Online Climate Data. 11 April 2005 to 9 January 2008. http://www.climate.weatheroffice.ec.gc.ca/climateData/canada_e.html

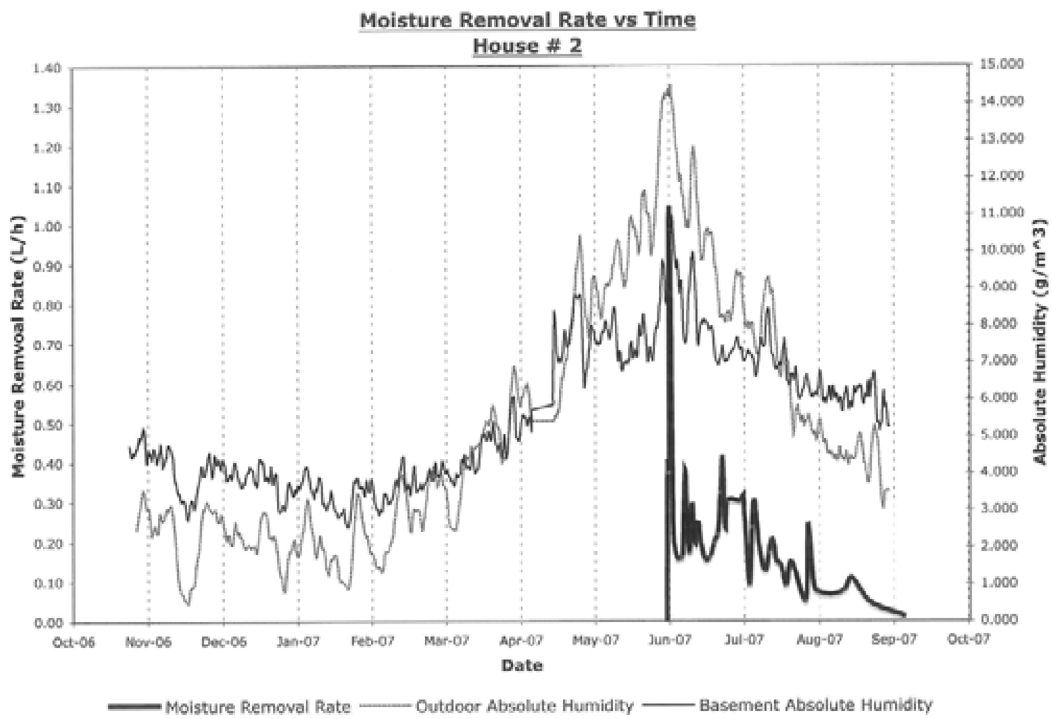
Canada Mortgage and Housing Corporation, 2005. Choosing a Dehumidifier

Canada Mortgage and Housing Corporation, 2005. Fighting Mold: The Homeowners' Guide.

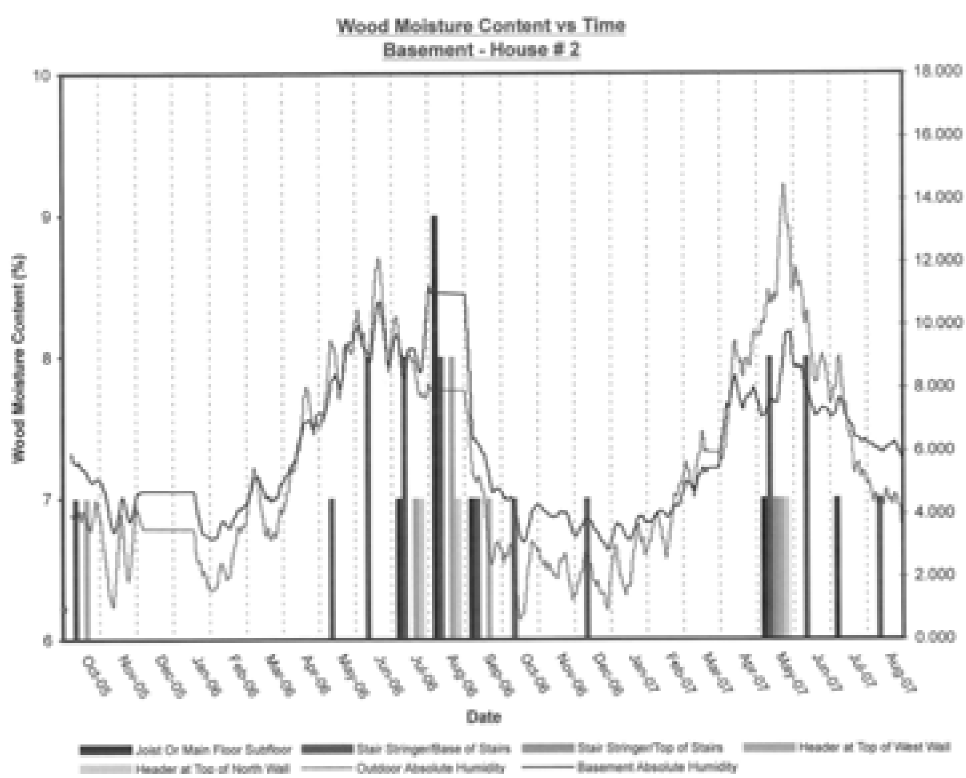
APPENDIX A
GRAPHICAL PRESENTATION
OF
FINAL RESULTS

House #2, Sherwood Park, Alberta

Description	Household	Moisture Indicators	Observations
-Two storey detached -Built: 1991, 135 m^2 -Partially finished basement, full depth. -Insulated concrete and vapour barrier. -Pitched roof. Wood frame, R20 Fibreglass insulation -Double-glazed windows -Weeping tile, sump pump (covered), ground slopes away from home, and eavestroughs. -Force air gas furnace, and wood fireplace.	-2 occupants -Temperature: 20°C day; 18°C night -Windows open for ventilation in summer, and sometimes open in spring and fall. Basement windows not opened. -Furnace fan only on when furnace is on	-Bathrooms have fans -1 shower a day, 2 loads of laundry per week -Surrounding properties slope towards house; heavy rains cause sump to fill at regular intervals -No flooding problems -No leakage problems -Located in wet area -No humidifier used in the winter	-Improvement in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier. -Despite increase in climatic moisture levels for second year, wood moisture content in wood appears to have decreased. -Peak Moisture removal rate approximately 1.1 L/h -Average removal rate approximately 0.15 L/h



Moisture Removal Rate vs Time
House # 2
Moisture Remvoal Rate (L/h)
Absolute Humidity (g/m^3)
Date
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity

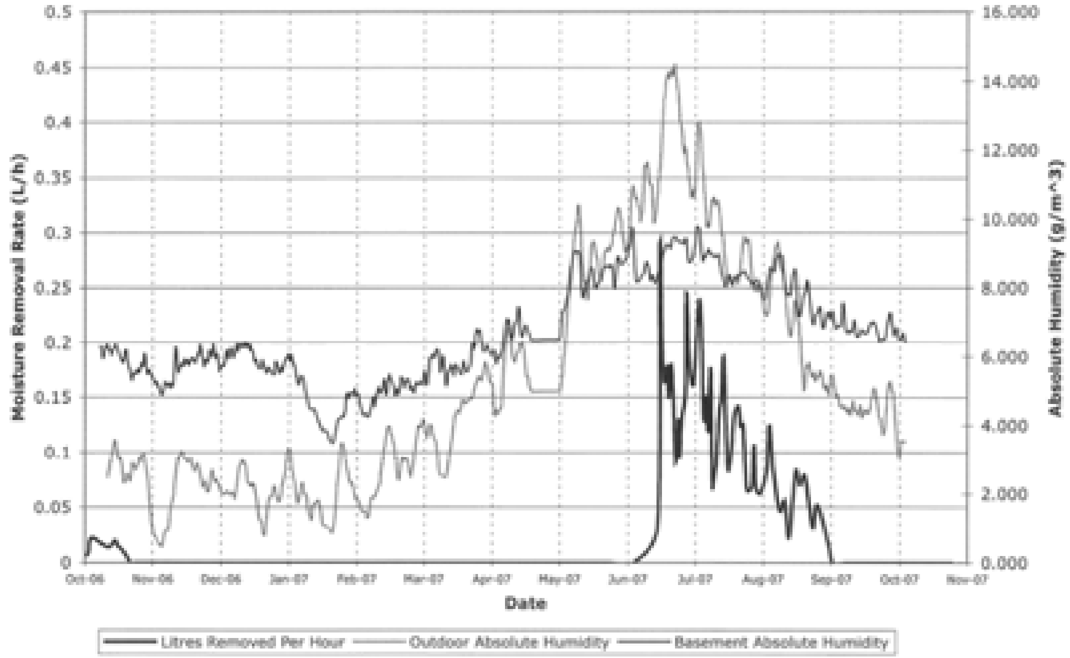


Wood Moisture Content vs Time
Basement - House # 2
Wood Moisture Content (%)
Absolute Humidity (g/m^3)
Date
Joist Or Main Floor Subfloor
Stair Stringer/Base of Stairs
Stair Stringer/Top of Stairs
Header at Top of West Wall
Header at Top of North Wall
Outdoor Absolute Humidity
Basement Absolute Humidity

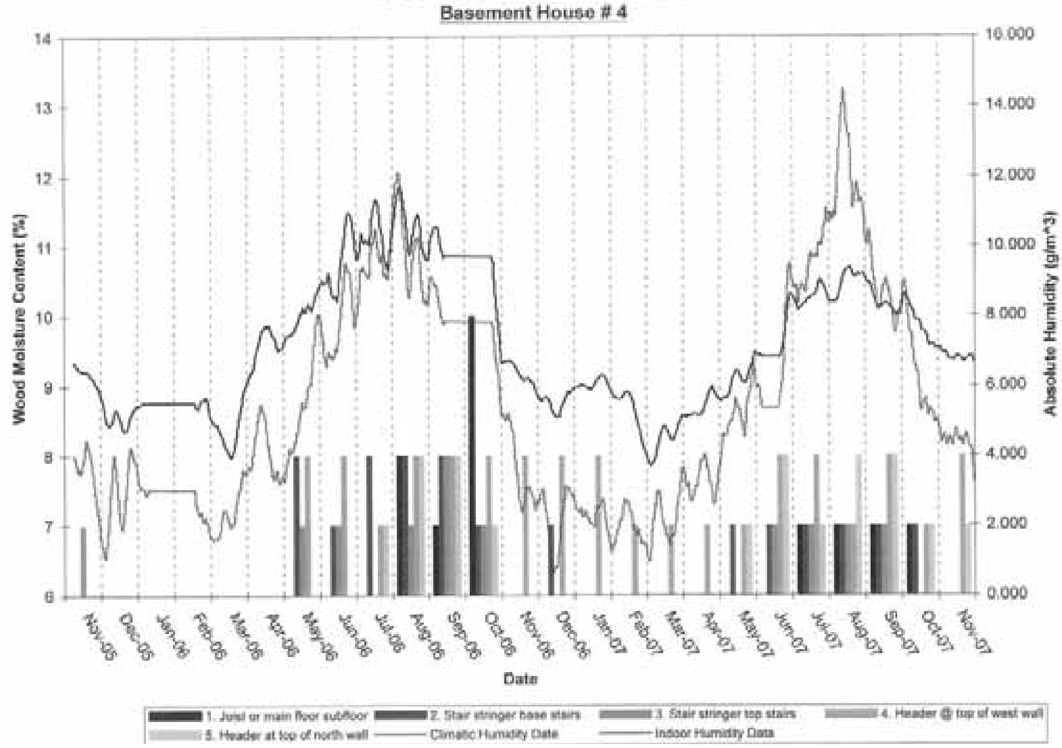
House #4, Sherwood Park, Alberta

Description	Household	Moisture Indicators	Observations
-Bungalow condominium -Built: 1998, 128 m^2 -Unfinished basement, full depth -Vapour barrier and concrete foundation -Pitched roof, with vented attic. Wood frame and fibreglass insulation -Double-glazed windows -Weeping tile, ground slopes away from home, sump pump (covered), and eavestroughs -Force air gas furnace with wood fireplace	-2 occupants -Summer temperature: 19°C day; 15°C night -Winter temperature: 16°C day; 12°C night -Windows open for ventilation in summer Basement windows not opened	-Bathroom fans always used when showering -2 showers a day, 4 loads of laundry per week - Sump pump is loosely covered -Condensation on inside of window pane during winter months -No flooding problems -Leakage: Concrete foundation cracked, water penetrated, pooling in basement. (Fixed) -Humidifier used in winter	-Drastic improvement in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier. - Moderate moisture removal rates. -Peak moisture removal rate approx. 0.3 L/h -Average moisture removal rate approx. 0.1 L/h -Observed minor improvements in wood moisture contents in 2nd year.

Moisture Removal Rate vs Humidity Index
House #4

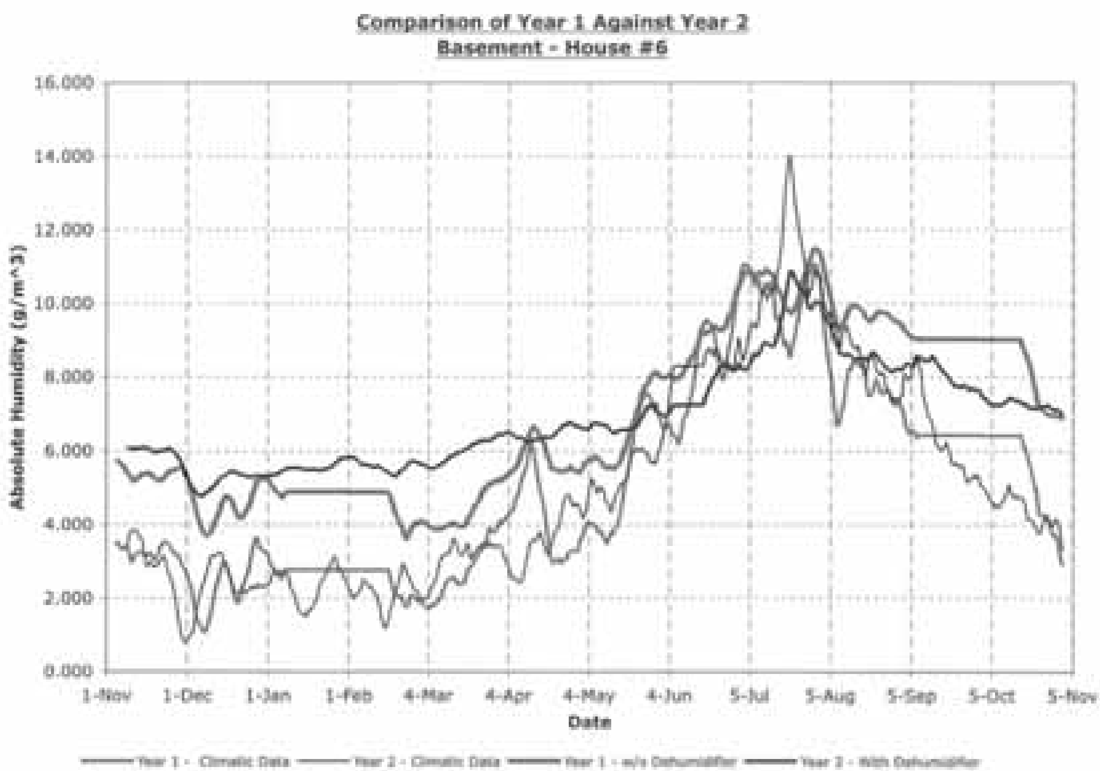


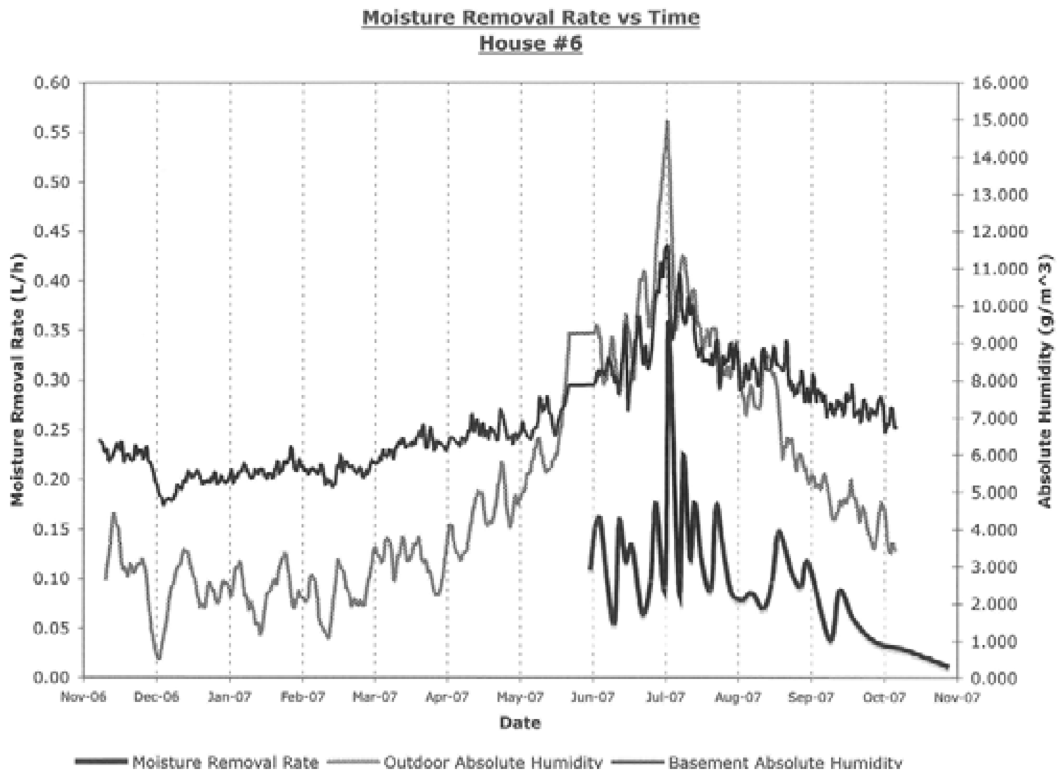
Wood Moisture Content vs Time
Basement House # 4



House #6, Calgary, Alberta

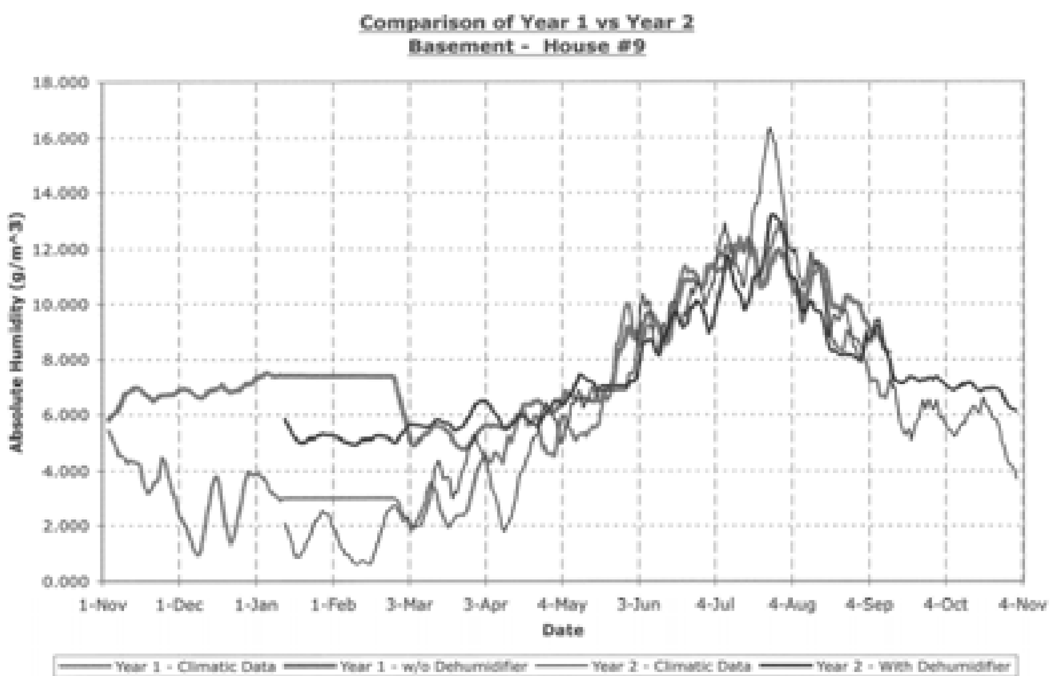
Description	Household	Moisture Indicators	Observations
-Detached single -Built: 1912, 88 m^2 -Finished basement, full depth, rubblestone walls -Insulated walls and vapour barrier, concrete foundation -Vented attic. Wood frame, 40% blown in, 60% Fibreglass insulation -Double-glazed windows -Eavestroughs -Forced air gas furnace with wood fireplace	-1 occupant -Summer temperature: 23°C day; 18°C night -Winter temperature: 18°C day; 18°C night -Windows open for ventilation in spring, summer and fall. Basement windows open in July/August -Furnace fan only on when furnace is on -New wiring, plumbing, and windows installed in 1995. Washroom installed in basement in 2000	-Primary bathroom without fan. Basement bathroom fan always used when showering -1 shower a day, 3 loads of laundry per week -No flooding problems -Leakage: Exterior tap pipe broke, large amounts of water in basement. Carpet dried and tap replaced. (Fixed, 2002) Record rainfall caused seepage through walls in cold room. (Fixed, 2005) -Humidifier used in winter	-Fair reduction in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier -Seasonal fluctuations in indoor humidity level reduced. Humidity levels appear to be more constant. -Moderate moisture removal rates -Peak removal rate approx. 0.37 L/h -Average removal rate approx. 0.15 L/h -Insufficient information for wood moisture results

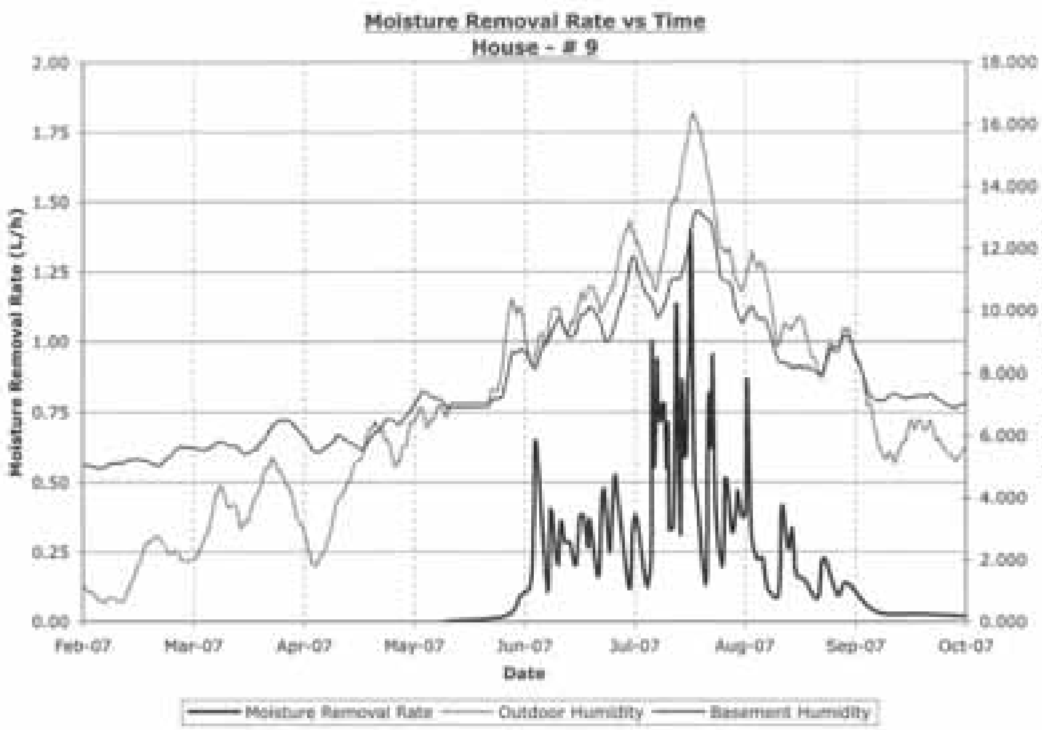


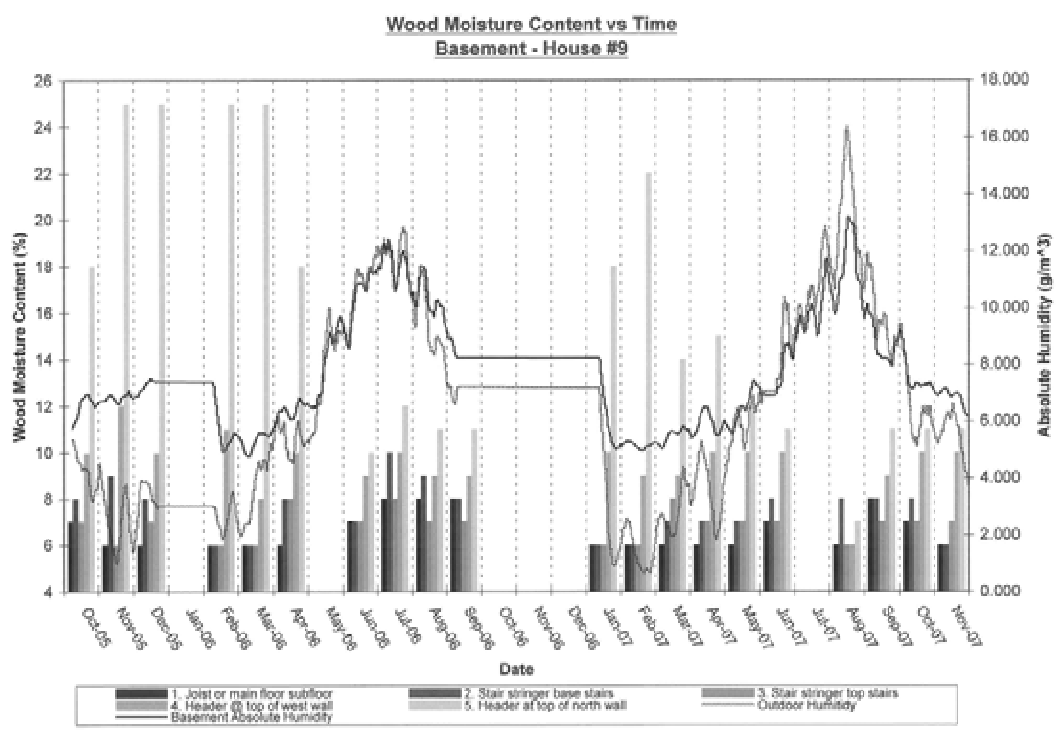

Moisture Removal Rate vs Time
House #6
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Moisture Rmoval Rate (L/h)
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
Absolute Humidity (g/m^3)
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Date
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity

House #9, Grenfell, Saskatchewan

Description	Household	Moisture Indicators	Observations
-Detached bungalow -Built: 1984, 136 m^2 -Finished basement, full depth -P/T wood walls and foundation, on dirt/sand -Pitched roof. Wood frame. Unknown insulation type -Double-glazed energy efficient windows -Weeping tiles, sump pump (not covered) and eavestroughs -Forced air electric furnace	-3 occupants -Summer temperature: 25°C day; 20°C night -Winter temperature: 19°C day; 17°C night -Windows open for ventilation in spring, summer, and fall, including basement window -Furnace fan running at all times in winter	-Bathrooms have fans. Kitchen range only used if windows are closed -2.5 showers a day, 10 loads of laundry per week -Mold on exterior wall baseboard in basement bedroom (Fixed, 2005) -No flooding problems -Leakage: Service pipe broke inside house, 2" of water into basement, seeping through wood floor into crawl space (2003) -No humidifier in the winter	-Fair reduction in indoor vs. outdoor humidity levels in 2nd year when using dehumidifier. -Excellent moisture removal rates -Peak moisture removal rate approx. 1.3 L/h -Average moisture removal rate approx. 0.5 L/h -Moisture removal corresponds closely with increase and decrease in outdoor humidity levels -Drastic reduction in Header at North wall. No significant reduction otherwise.

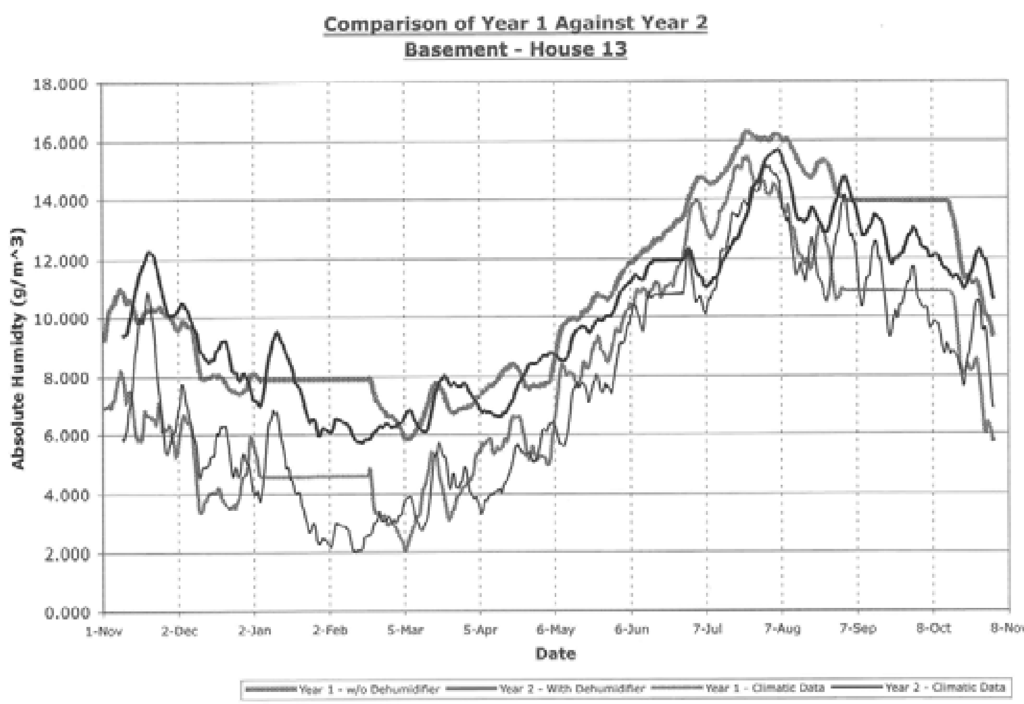


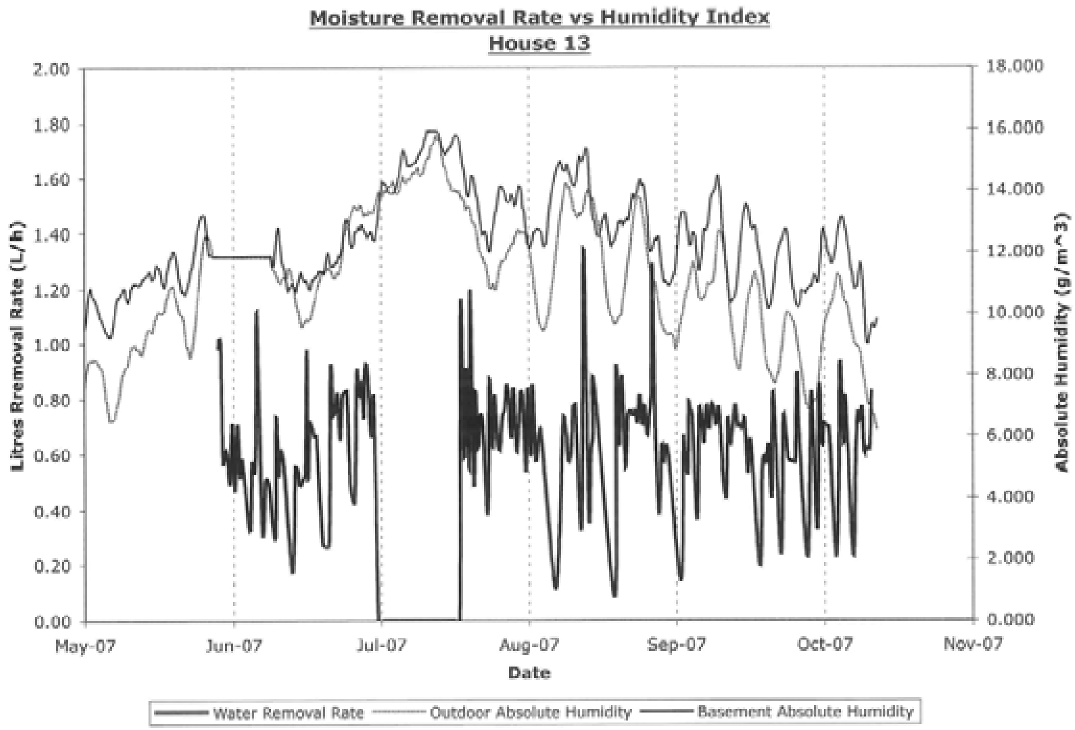

Moisture Removal Rate vs Time
House - # 9
Moisture Removal Rate (L/h)
Absolute Humidity (g/m^3)
Date
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Moisture Removal Rate
Outdoor Humidity
Basement Humidity

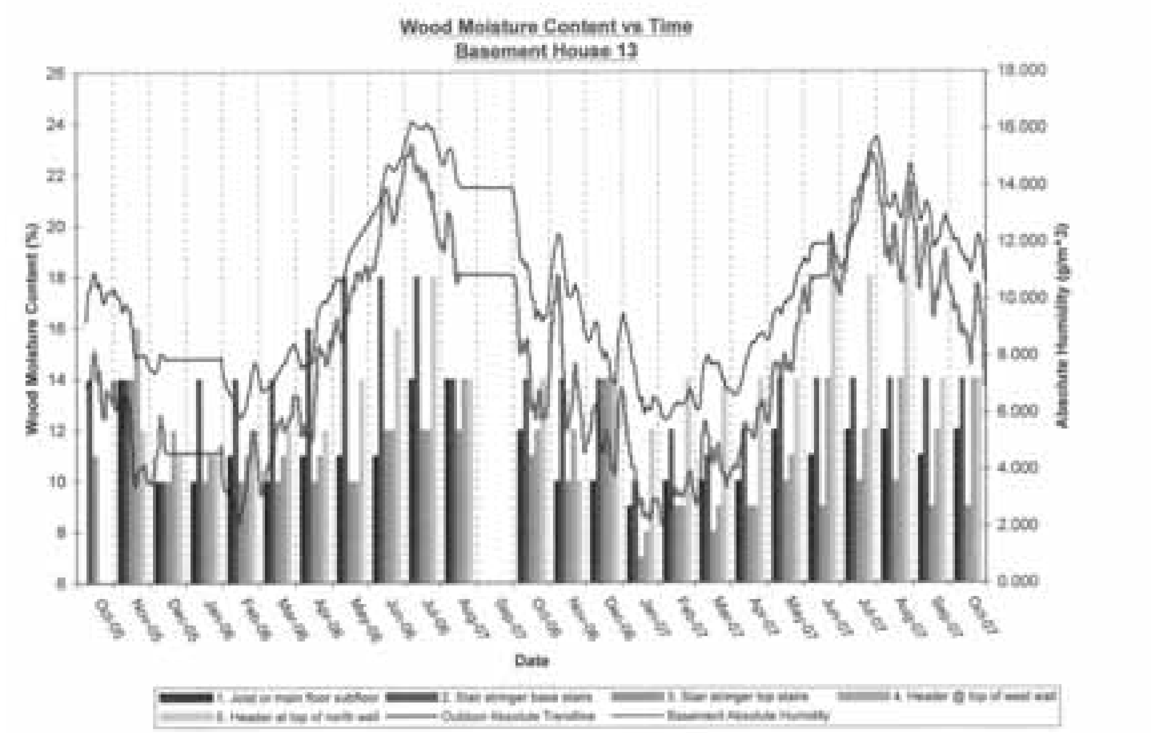

Wood Moisture Content vs Time
Basement - House #9
Wood Moisture Content (%)
Absolute Humidity (g/m^3)
Date
1. Joist or main floor subfloor
2. Stair stringer base stairs
3. Stair stringer top stairs
4. Header @ top of west wall
5. Header at top of north wall
Outdoor Humitidy
Basement Absolute Humidity

House #13, Yarmouth, Nova Scotia

Description	Household	Moisture Indicators	Observations
-Two storey detached -Built: 1919, 179 m^2 -Unfinished basement, full depth, with crawl space. -No listed barriers or insulation in concrete foundation. Crawl space rests on dirt/sand -Pitched roof with vented attic. Wood frame, unknown insulation type -Single pane windows on first floor, and double glazed on second -Weeping tiles, ground slopes away from home, and eavestroughs -Cast iron hydronic radiators with oil-fired boiler for heating	-5 occupants -Summer temperature: 22°C day; 20°C night -Winter temperature: 20°C day; 18°C night -Windows open for ventilation in spring, summer, and fall. Basement windows not opened -No furnace fan	-Primary bathroom has fan, secondary bathroom without a fan -4 showers a day, 7 loads of laundry per week, and no dishwasher -Located in wet area -Smells never linger -No flooding problems -Leakage: Occasional leak at bulkhead of exterior entrance into basement due to hydrostatic pressure. Concrete floor improperly poured. (Unresolved) -No humidifier in the winter	-No significant improvement in indoor vs. outdoor humidity levels -Periods where indoor humidity levels exceed those of corresponding climatic levels. -Excellent moisture removal rates despite no significant reduction in indoor humidity levels. -Peak rate approx. 1.4 L/h -Avg. rate approx. 0.75 L/h -Moisture removal over 6-month period. -No significant change in wood moisture levels.

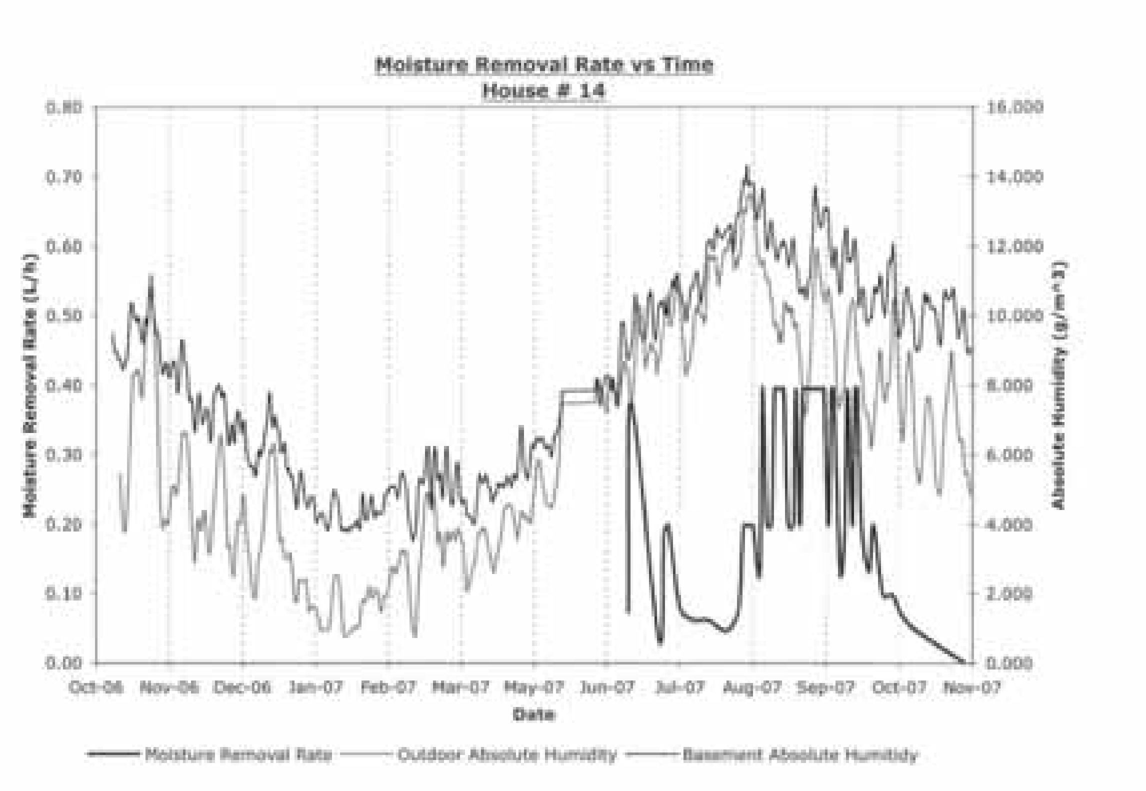


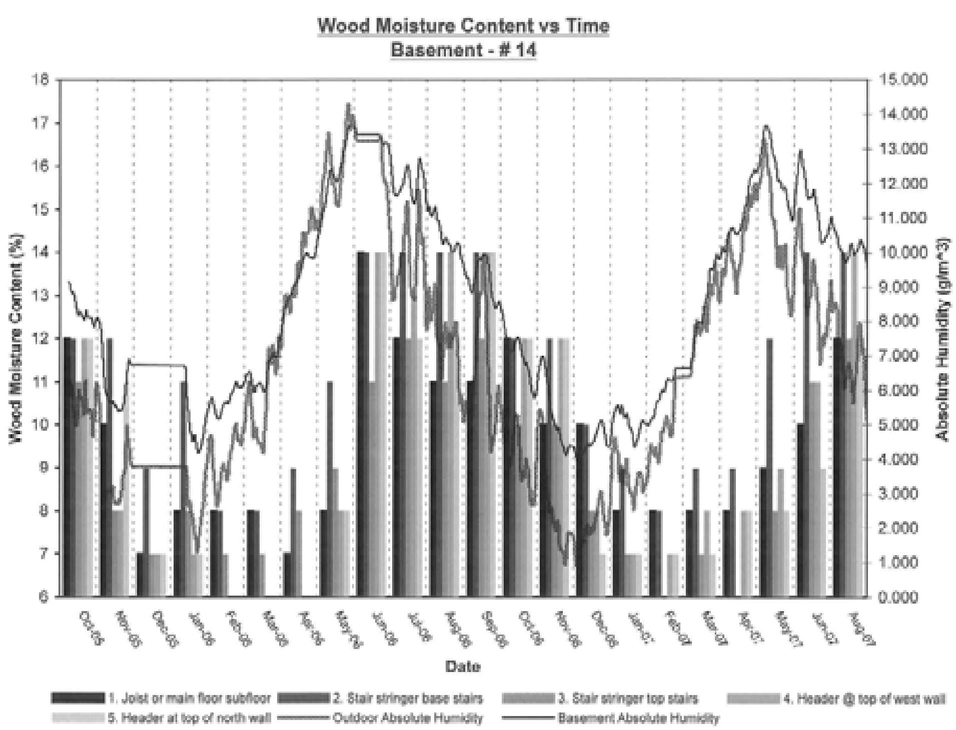

Moisture Removal Rate vs Humidity Index
House 13
Litres Rremoval Rate (L/h)
Absolute Humidity (g/m^3)
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Date
Water Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity


Wood Moisture Content vs Time
Basement House 13
Wood Moisture Content (%)
Date
Basement Absolute Humidity

House #14, Corn Hill, New Brunswick

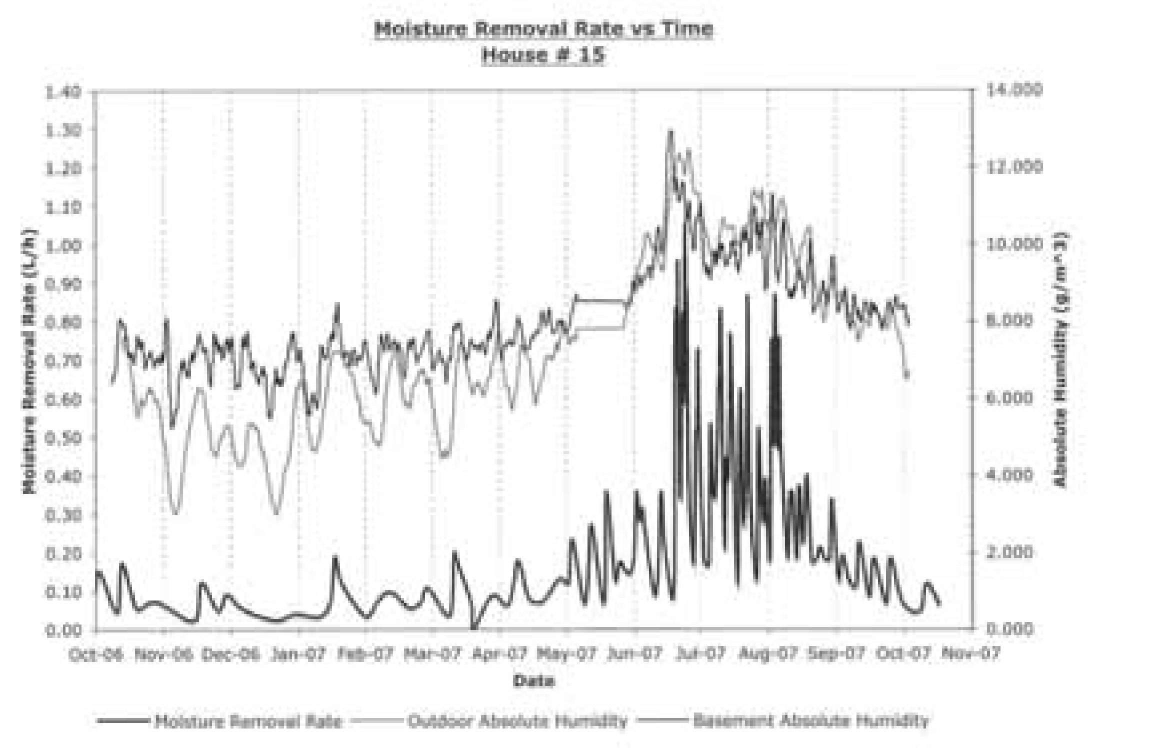
Description	Household	Moisture Indicators	Observations
-Two story detached -Built: half -1900, with extensive renovations, other half -1984, 102 m^2 -Unfinished basement, full depth -No listed barriers or insulation in concrete foundation -Vented attic. Wood frame, 40R fibreglass insulation -Half double-glazed windows, half double-glazed plus energy efficient -Weeping tiles, and eavestroughs -Forced air wood furnace	-2 occupants -Temperature: 20°C day; 18°C night -Windows open for ventilation in summer. Opened occasionally in spring and fall. Seldom open in winter. Basement windows not opened -Furnace fan only when furnace is on -New windows and improved insulation (1985)	-Bathrooms without fans. Kitchen without fume hood -2 showers a day, 6 loads of laundry per week, and 12 hours of cooking per week -Wood for furnace is stored indoors -No flooding problems -Leakage: Blocked drain pipe in basement (Fixed) -No humidifier in the winter	- No significant improvement in indoor vs. outdoor humidity levels -Periods where indoor humidity levels exceed those of corresponding climatic levels. -Fair moisture removal rates. -Several peak moisture removal rates: 0.4 L/h -Avg. rate approx. 0.25 L/h -No observable reduction in wood moisture content. No data available at end of second year.


Moisture Removal Rate vs Time
House # 14
Moisture Removal Rate (L/h)
Absolute Humidity (g/m^3)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Date
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humitidy

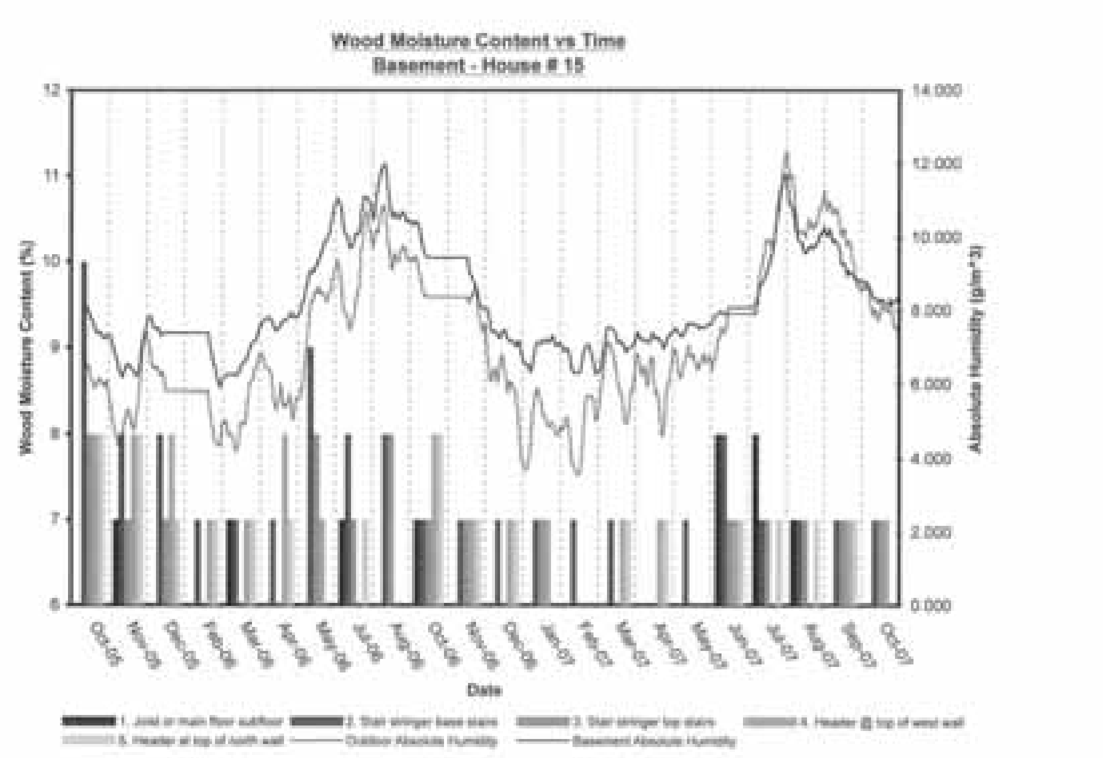

Wood Moisture Content vs Time
Basement - # 14
Wood Moisture Content (%)
Absolute Humidity (g/m^3)
6
7
8
9
10
11
12
13
14
15
16
17
18
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
8.000
9.000
10.000
11.000
12.000
13.000
14.000
15.000
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Feb-07
Mar-07
May-07
Jun-07
Aug-07
Date
1. Joist or main floor subfloor
2. Stair stringer base stairs
3. Stair stringer top stairs
4. Header @ top of west wall
5. Header at top of north wall
Outdoor Absolute Humidity
Basement Absolute Humidity

House #15, Campbell River, British Columbia

Description	Household	Moisture Indicators	Observations
-Detached single -Built: 1954, 186 m^2 -Finished basement, full depth -No listed barriers or insulation in concrete foundation -Flat roofed. Wood frame, 21R mineral wool insulation -Double-glazed, low E windows -Weeping tile drainage -Forced air, oil furnace, with fireplace	-2 occupants -Summer temperature: 20°C day; 17°C night -Winter temperature: 21°C day; 16°C night -Windows generally not opened for ventilation. Basement windows opened occasionally in spring summer/fall -Furnace fan only on when furnace is on -Basement finished, increased insulation, and new bath upstairs (1998-2005)	-Primary bathroom without a fan, secondary bathroom fan on moisture sensor -2 showers a day, 2 loads a week, 12 hours of cooking -Odours tend to linger after cooking -No flooding problems -Leakage: Roof around chimney leaks into upstairs kitchen. Flashing on chimney and tar roof both leak (Unresolved) -No humidifier in winter	-No significant reduction in indoor vs. outdoor humidity levels in 2nd year. -Good moisture removal rates. -Moisture removal possible throughout full year. -Peak removal rate approx. 1.05 L/h -Avg. removal rate in summer approx. 0.55 L/h -Avg. removal rate during winter approx. 0.1 L/h -Minor decrease in wood moisture content in 2nd year



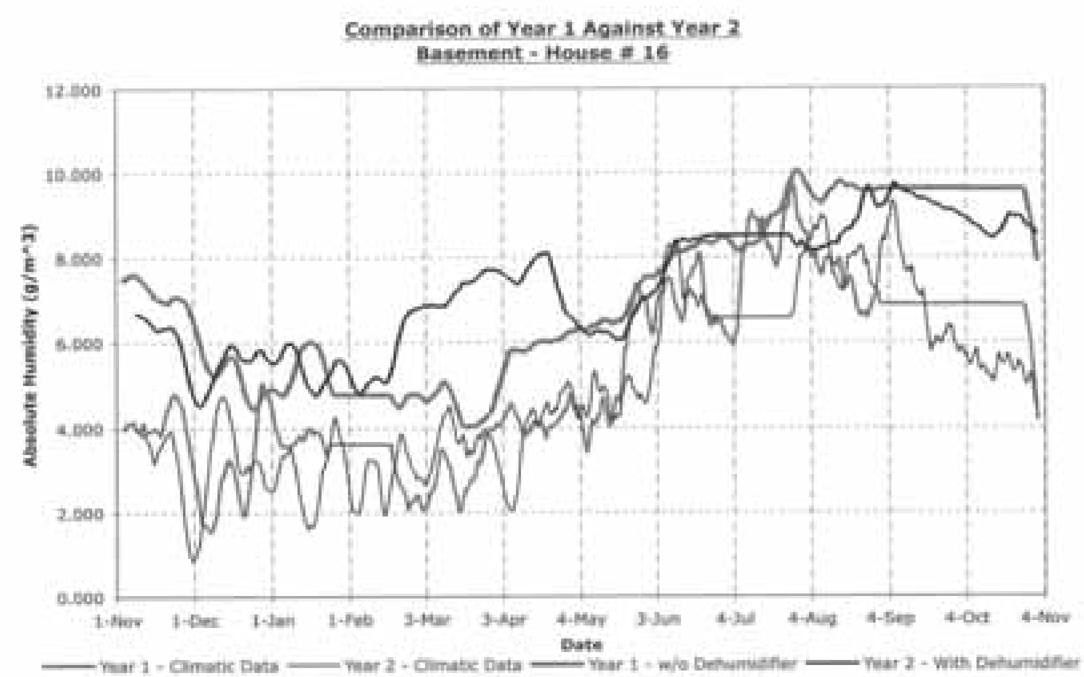
Moisture Removal Rate vs Time
House # 15
Moisture Removal Rate (L/h)
Absolute Humidity (g/m^3)
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Oct-06 Nov-06 Dec-06 Jan-07 Feb-07 Mar-07 Apr-07 May-07 Jun-07 Jul-07 Aug-07 Sep-07 Oct-07 Nov-07
Date
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity

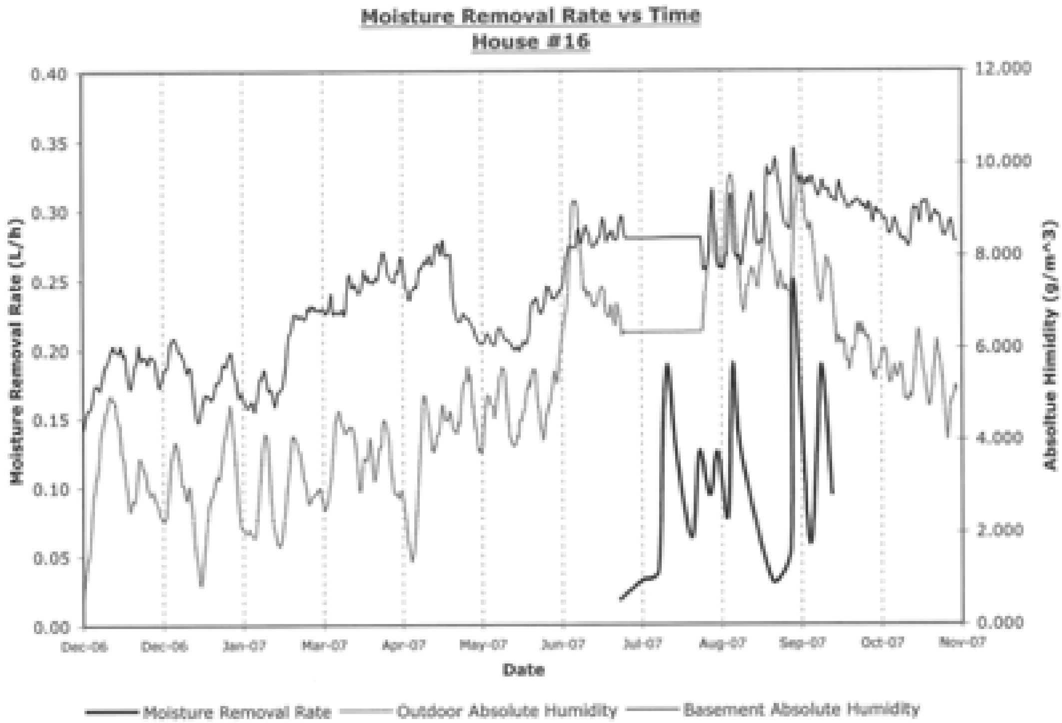


Wood Moisture Content vs Time
Basement - House # 15
Wood Moisture Content (%)
Absolute Humidity (g/m^3)
12
11
10
9
8
7
6
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Date
1. Joist or main floor subfloor
2. Stair stringer base stairs
3. Stair stringer top stairs
4. Header @ top of west wall
5. Header at top of north wall
Outdoor Absolute Humidity
Basement Absolute Humidity

House #16, Prince George, British Columbia

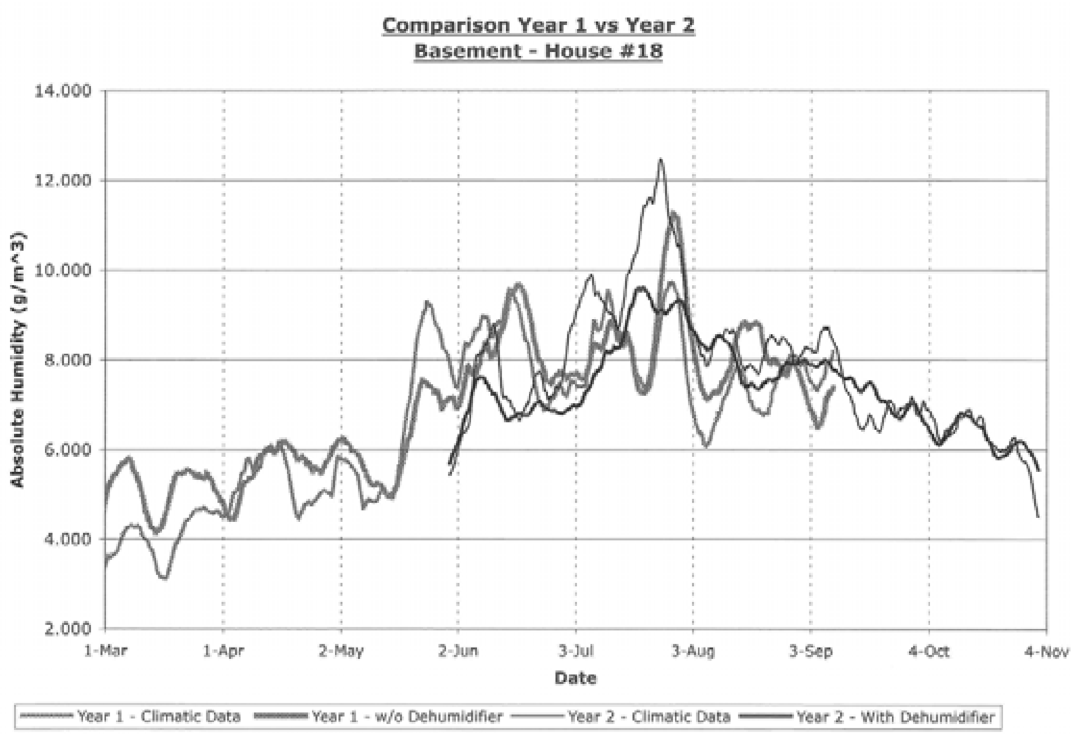
Description	Household	Moisture Indicators	Observations
-1.5 storey detached -Built: 1979, 164 m^2 -Partially finished basement, full depth -No listed barriers or insulation in concrete foundation -Pitched roof with vented attic. Wood frame, 20R fibreglass insulation -Double-glazed windows -Eavestroughs and downspout drainage -Forced air gas furnace, with electric baseboards on top floor and gas fireplace in basement	-2 occupants -Summer temperature: 20°C day; 18°C night -Winter temperature: 20°C day; 16°C night -Windows open for ventilation in summer. Basement windows not opened -Furnace fan on only when furnace is on	-Bathrooms have fans running half the time. -1 shower a day, 1 load of laundry per week -No odour problems -Condensation appears on second story bedroom window, with a tendency to mold on walls on outside perimeter in winter -No flooding problems -Leakage: Copper pipe leak in basement bedroom closet (Repaired) -No humidifier in winter	-No significant improvement in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier -Low moisture removal levels. -Moisture removal values only significant at peak humidity points -Peak removal rate approx. 0.25 L/h -Average removal rate approx. 0.13 L/h -Insufficient information for wood moisture results

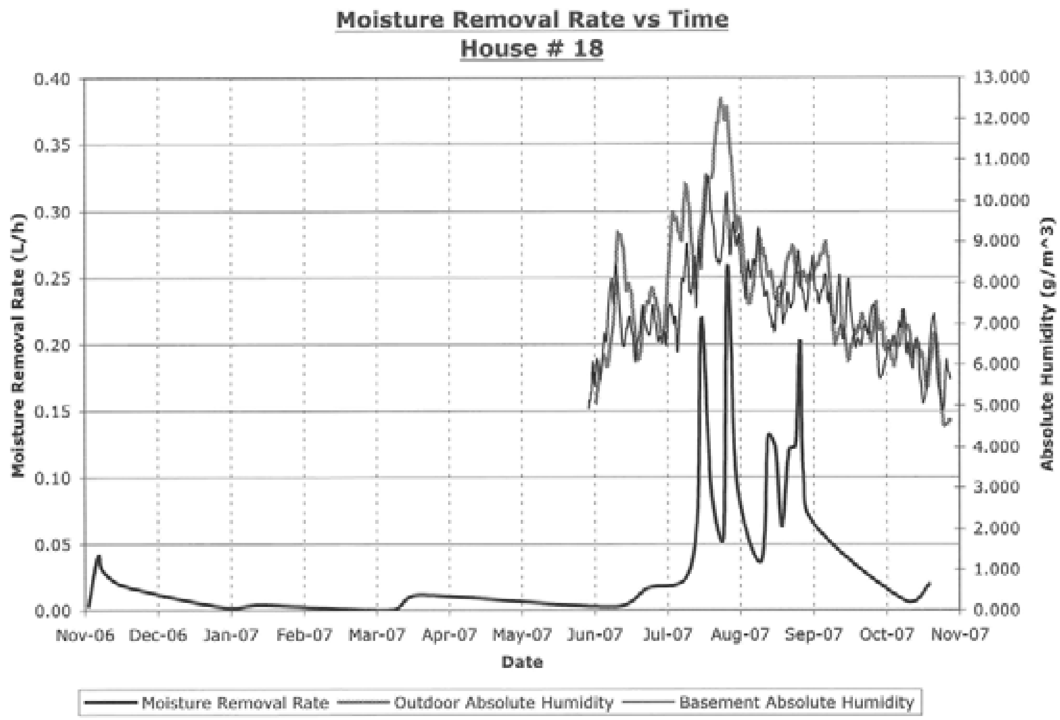


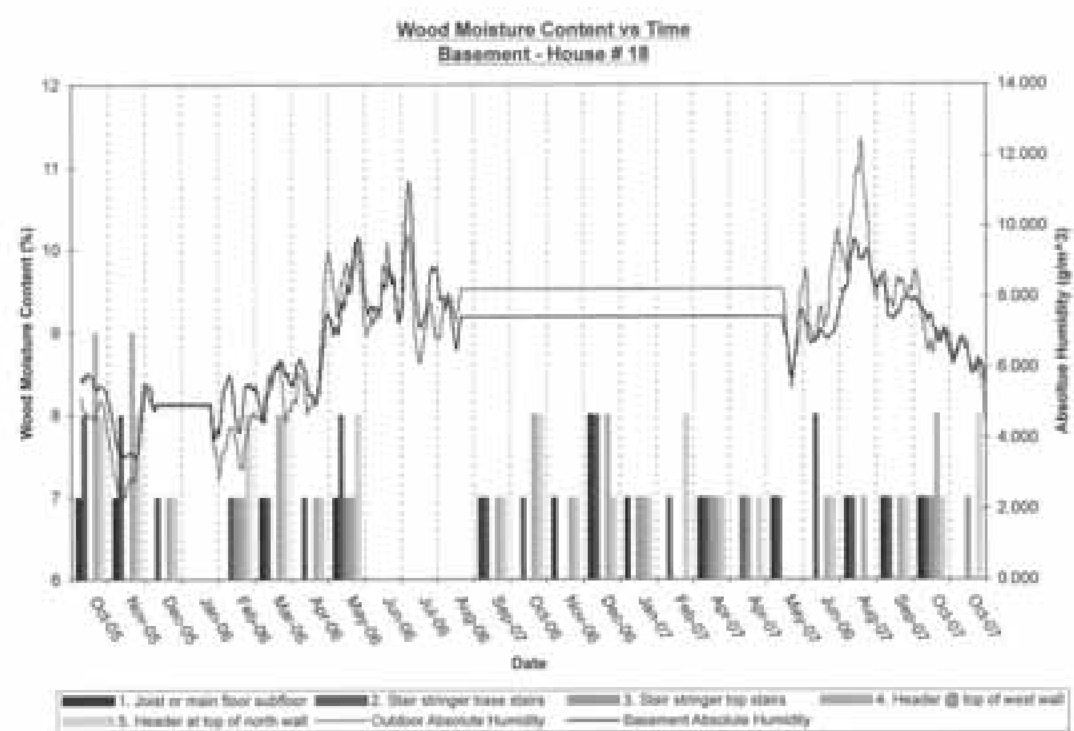

Moisture Removal Rate vs Time
House #16
Moisture Removal Rate (L/h)
Absoltue Himidity (g/m^3)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Dec-06
Dec-06
Jan-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Date
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity

House #18, Lytton, British Columbia

Description	Household	Moisture Indicators	Observations
-Detached Bungalow -Built: 1974, 186 m^2 -Unfinished basement, full depth walk out. -Concrete foundation with drainage membrane -Pitched roof with vented attic. Wood frame, 12R paperback insulation -Double-glazed windows -Weeping tiles, and downspouts -Electric baseboard heating, with woodstove	-2 occupants -Summer temperature: 29°C day; 18°C night -Winter temperature: 15°C day; 15°C night -Windows open for ventilation in spring, summer, and fall. Basement windows only open in summer -No furnace fan	-Bathrooms without fans. Kitchen without fume hood -Take baths instead of showers, 2 loads of laundry per week, and 7 hours of cooking -Musty smell in basement -Located in wet area -No flooding problems -Leakage: Roof had several leaks, causing moldy smell. (Roof replaced, 2005) -No humidifier in winter	-Significant improvement in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier. -Moisture removal values only significant at peak humidity points -Peak removal rate approx. 0.26 L/h -Average removal rate approx. 0.05 L/h -No observable change in wood moisture content levels from year 1 to year 2.

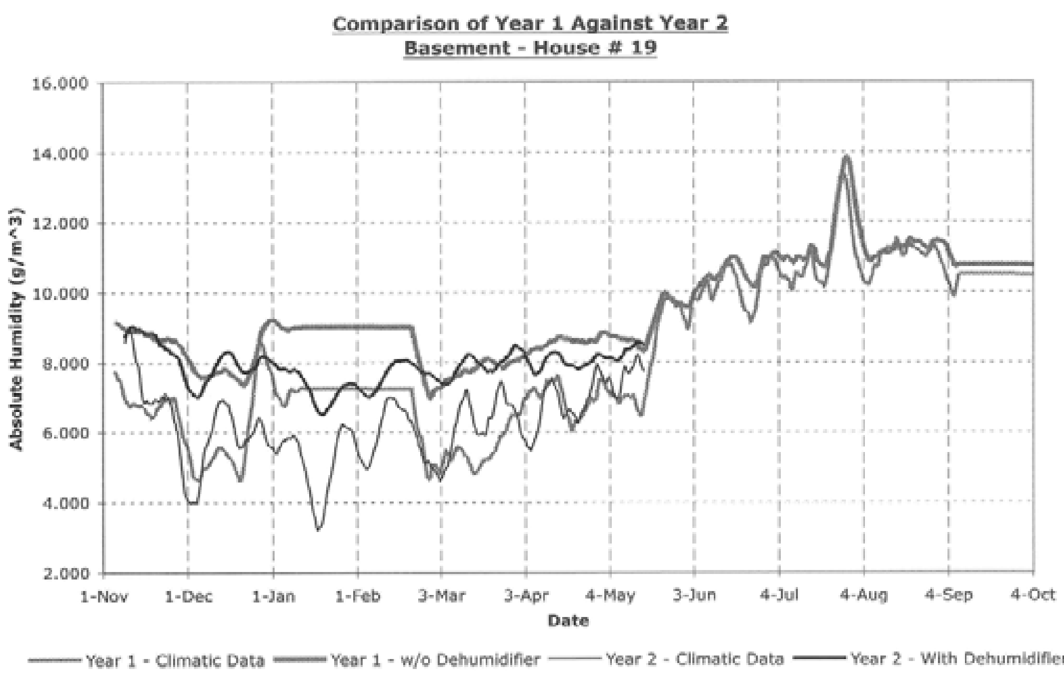



Moisture Removal Rate vs Time
House # 18
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Moisture Removal Rate (L/h)
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
Absolute Humidity (g/m^3)
Nov-06 Dec-06 Jan-07 Feb-07 Mar-07 Apr-07 May-07 Jun-07 Jul-07 Aug-07 Sep-07 Oct-07 Nov-07
Date
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity


Wood Moisture Content vs Time
Basement - House # 18
12
11
10
9
8
7
6
Wood Moisture Content (%)
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Date
1. Joist or main floor subfloor
2. Stair stringer base stairs
3. Stair stringer top stairs
4. Header @ top of west wall
5. Header at top of north wall
Outdoor Absolute Humidity
Basement Absolute Humidity

House #19, Burnaby, British Columbia

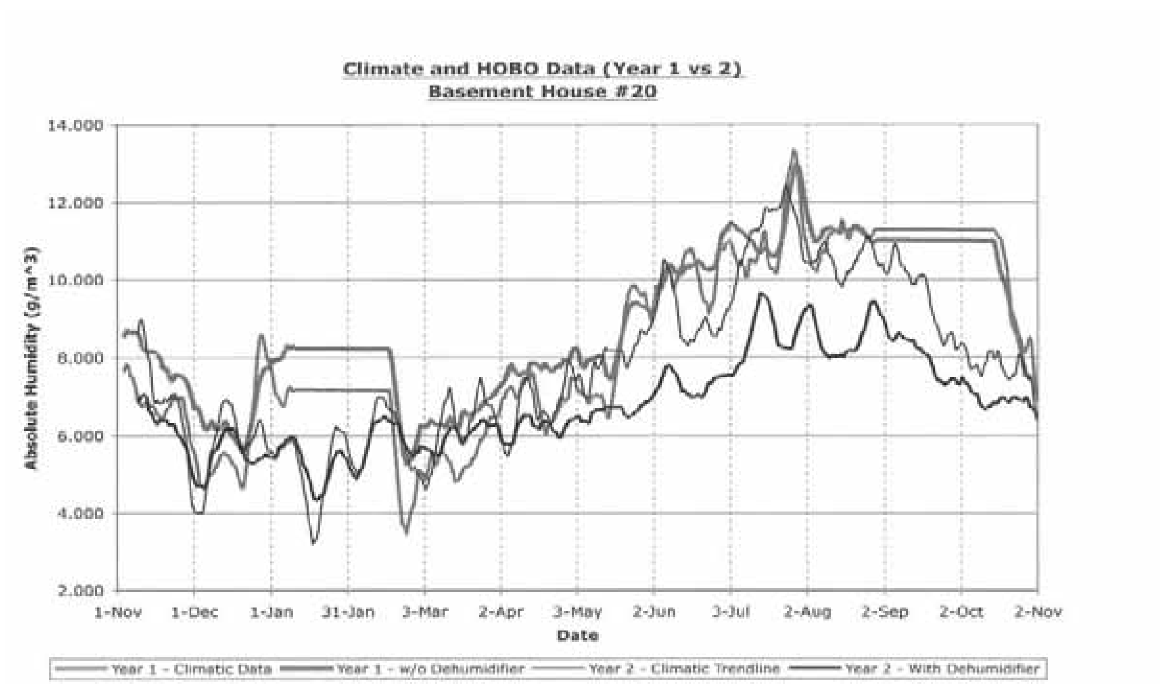
Description	Household	Moisture Indicators	Observations
-Two storey detached -Built: 1994, 242 m^2 -Finished basement plus crawl space. -Concrete foundation with drainage membrane in walls and vapour barrier in floor -Pitched roof with vented attic. Wood frames, fibreglass insulation -Double glazed, energy efficient windows -Eavestroughs drainage -Forced air natural gas furnace with gas fireplace and electric baseboard heating	-3 occupants -Summer temperature: 25°C day; 20°C night -Winter temperature: 21°C day; 18°C night -Windows open for ventilation in summer, including basement windows -Furnace fan running at all times in winter	-Bathroom fans on timers -2 showers a day, 6 loads of laundry per week -Wet hockey equipment dried inside -Basement bath smells musty -No flooding problems -No leaking problems -No humidifier in winter	-Insufficient information during summer months. -Moisture removal possible throughout full year. -Peak moisture removal rate approx. 0.5 L/h -Average moisture removal rate approx. 0.16 L/h -Insufficient information for wood moisture results

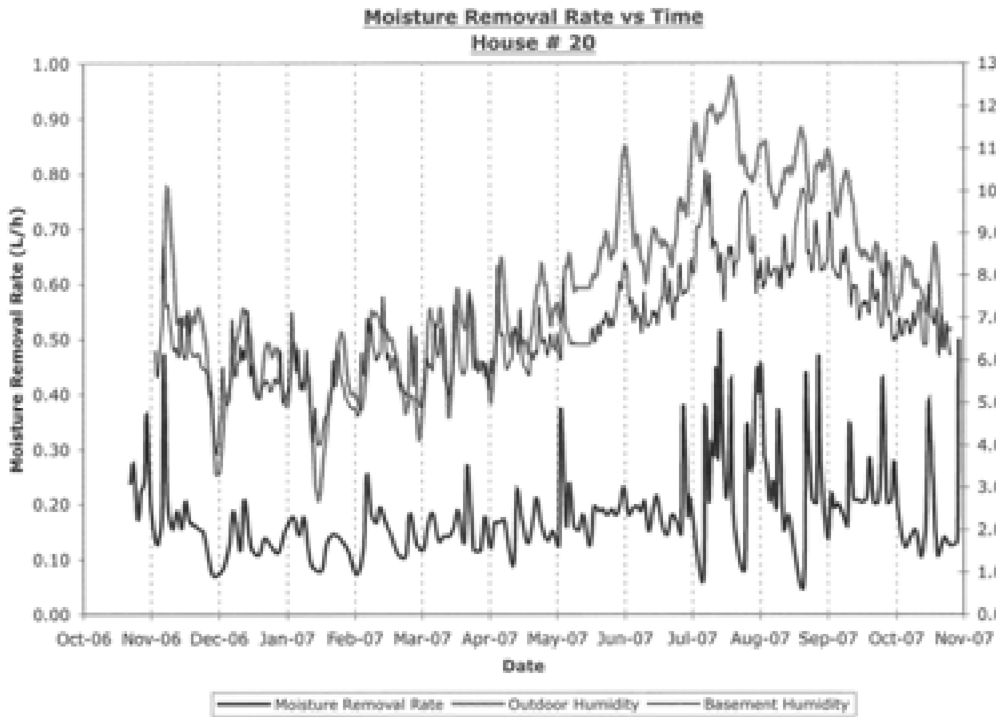


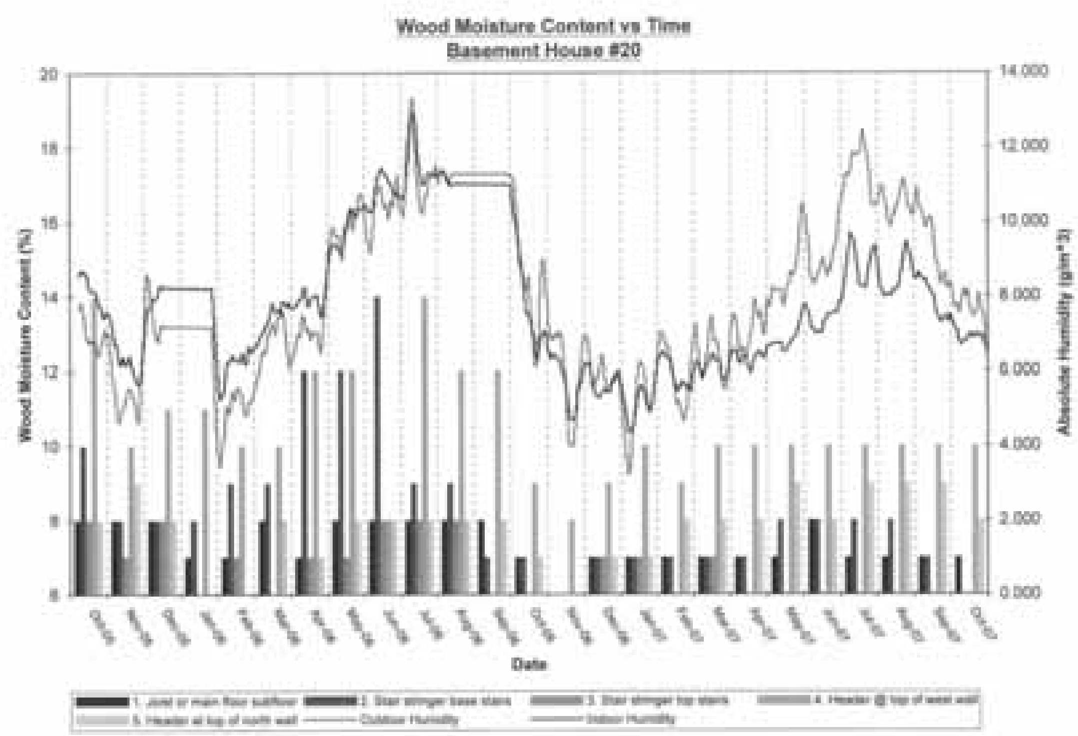

Moisture Removal Rate vs Time
House # 19
Moisture Removal Rate (L/h)
Absolute Humidity (g/m^3)
0.75
0.60
0.45
0.30
0.15
0.00
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Oct-06 Nov-06 Dec-06 Jan-07 Feb-07 Mar-07 Apr-07 May-07 Jun-07 Jul-07 Aug-07 Sep-07 Oct-07 Nov-07
Date
Moisture Removal Rate
Basement Absolute Humidity
Outdoor Absolute Humidity

House #20, Burnaby, British Columbia

Description	Household	Moisture Indicators	Observations
-Detached single -Built: 1982, 242 m^2 -Finished basement, partially below ground -P/T wood walls with concrete floor foundation -Vented attic. Wood frame, pink foam insulation -Double-glazed windows (65%), double-glazed energy efficient windows (35%) -Sump pump (covered) -Gas furnace, with baseboard heating and wood fireplace -No heating in basement	-5 occupants -Summer temperature: 25°C day; 15°C night -Winter temperature: 20°C day; 15°C night -Windows open for ventilation in summer, including basement windows -Furnace fan only on when furnace is on -New windows (2001)	-Bathroom fans on timers -2 showers a day, 2 loads of laundry per week, and 7 hours of cooking. -Laundry is hung to dry indoors -Plenty of indoor vegetation -Odours occasionally linger -Located in wet area -Flooding: Sump pump backed up causing extensive flooding in basement. Walls repainted and carpet replace (Fixed, 2002) -No leakage problems -No humidifier in winter	-Drastic reduction in indoor vs. outdoor humidity levels in 2nd year when using dehumidifier - Moisture removal possible throughout full year. -Moisture removal rate fairly constant throughout full year -Peak removal rate approx. 0.5 L/h -Average removal rate approx. 0.2 L/h -Noticeable reduction in wood moisture content from year 1 to year 2

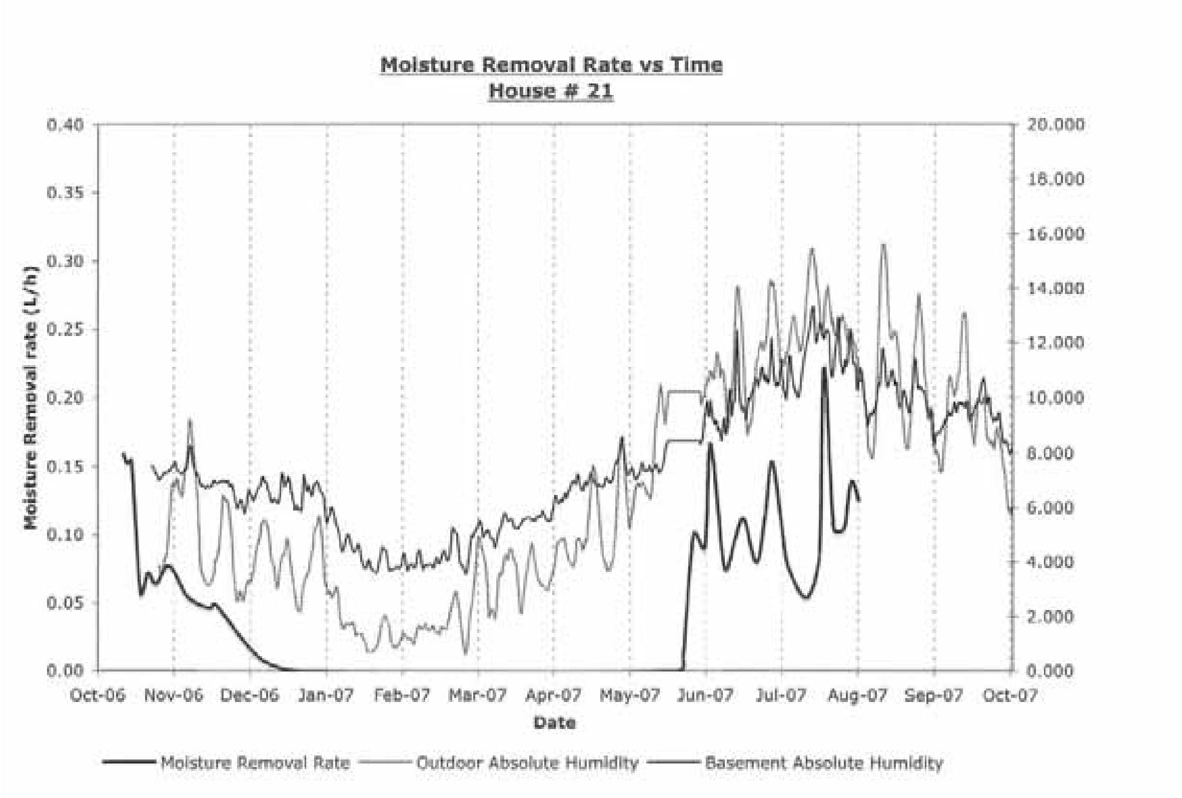



Moisture Removal Rate vs Time
House # 20
Moisture Removal Rate (L/h)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Absolute Humidity (g/m^3)
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
Oct-06 Nov-06 Dec-06 Jan-07 Feb-07 Mar-07 Apr-07 May-07 Jun-07 Jul-07 Aug-07 Sep-07 Oct-07 Nov-07
Date
Moisture Removal Rate
Outdoor Humidity
Basement Humidity


Wood Moisture Content vs Time
Basement House #20
Wood Moisture Content (%)
20
18
16
14
12
10
8
6
Absolute Humidity (g/m^3)
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Date
1. Joist or main floor subfloor
2. Stair stringer base stairs
3. Stair stringer top stairs
4. Header @ top of west wall
5. Header at top of north wall
Outdoor Humidity
Indoor Humidity

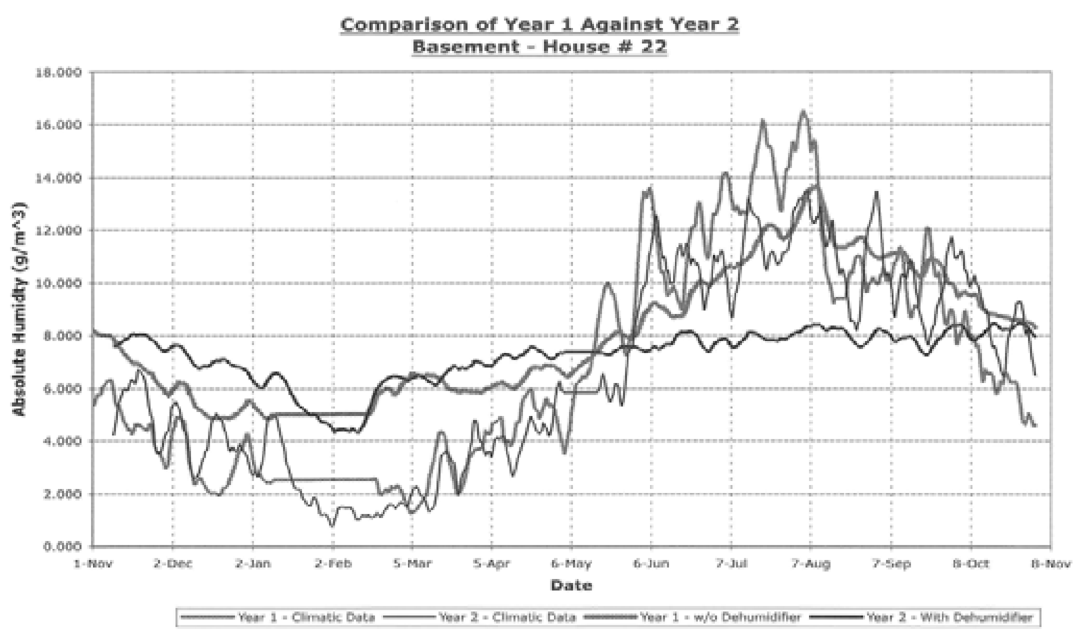
House #21, Tingwick, Quebec

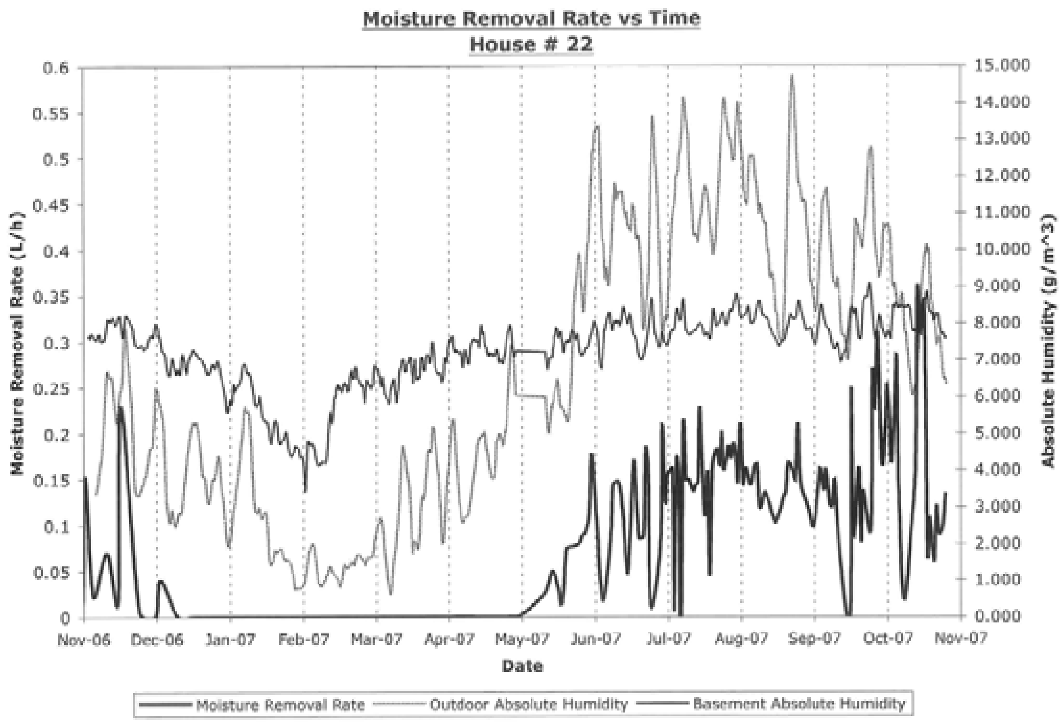
Description	Household	Moisture Indicators	Observations
-Two storey detached -Built: 1944, 98 m^2 -Partly finished basement, full depth -30% Concrete foundation, 70% rubblestone, with urethane insulated walls and floor -Pitched roof. Balloon frame, 10R wood shaving insulation -Double-glazed windows -Ground slopes away from house, and eavestroughs -Electric baseboard heating with wood stove	-4 occupants -Summer temperature: 22°C day; 19°C night -Winter temperature: 20°C day; 18°C night -Windows open for ventilation in summer, including basement windows -No furnace fan -Basement insulated, new windows, increased insulation in roofing and several exterior renovation (1990-2005)	-Bathroom fans on timers -5 showers a day, 10 loads of laundry per week, and 10 dishwasher loads per week -Washroom is musty -Condensation and mold through exterior wall behind owner's armoire. (Fixed) -No flooding problems -Leakage: leak by windows in basement prior to new windows being installed (Fixed) -No humidifier in winter	-Improvement in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier -Minimal moisture removal data -Moisture removal values only significant at peak humidity points -Peak removal rate approx. 0.24 L/h -Insufficient information for wood moisture results

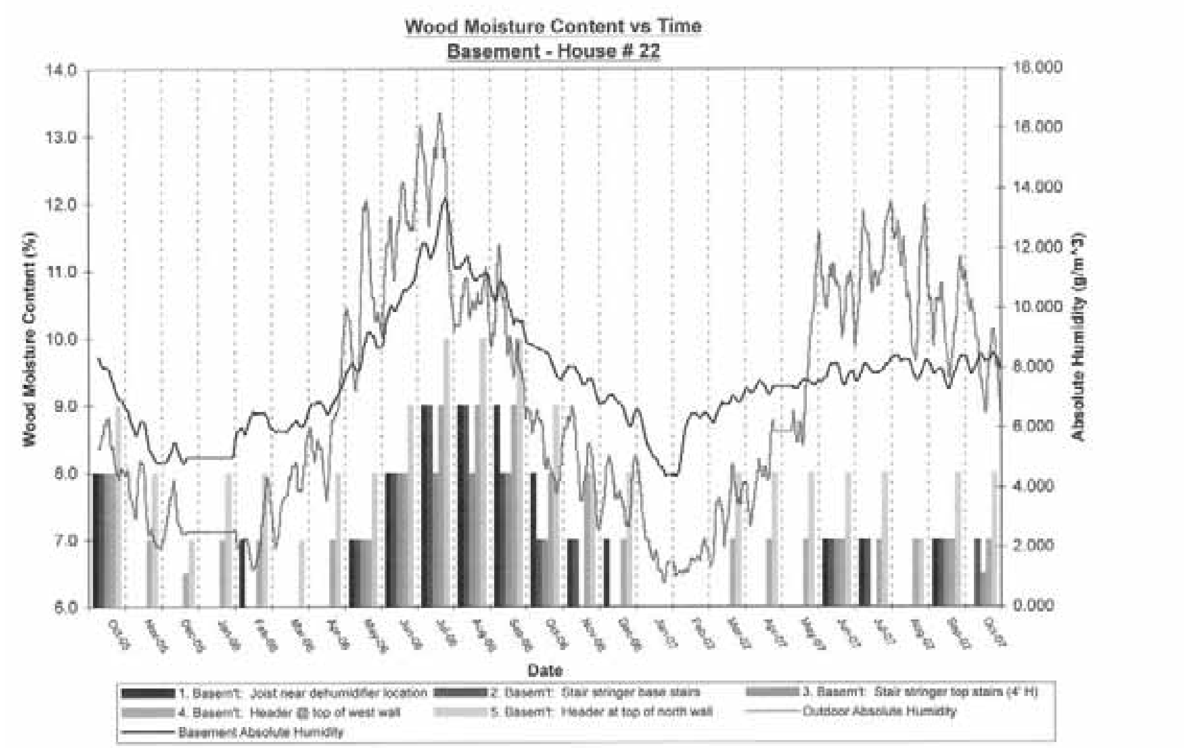

Moisture Removal Rate vs Time
House # 21
Moisture Removal rate (L/h)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
20.000
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Oct-06 Nov-06 Dec-06 Jan-07 Feb-07 Mar-07 Apr-07 May-07 Jun-07 Jul-07 Aug-07 Sep-07 Oct-07
Date
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity

House #22, Cantley, Quebec

Description	Household	Moisture Indicators	Observations
-1.5 storey detached -Built: 1988, 325 m^2 -Partly finished basement, full depth -Concrete foundation, vapour barrier, and insulated walls and floor -Pitched roof. Wood frame, 40R Batt insulation (60R in attic) -Double-glazed, energy efficient windows -Ground slopes away from house, weeping tiles, eavestroughs and stone splash pads under drip lines -HRV system installed -Forced air electric furnace	-2 occupants -Summer temperature: 24°C day; 20°C night -Winter temperature: 20°C day; 19°C night -Windows open for ventilation in summer. Basement windows occasionally opened -Furnace fan running full time in winter -New fireplace and chimney. Changed roofline over garage (hip to gable), new windows in garage. Skylights removed, shingles replaced, and water shields installed to replace eavestroughs (1997)	-Bathroom fans on timer. Fans connected to HRV system -2 showers a day, 8 loads of laundry per week, and 15 hours of cooking per week. -Moisture spots on drywall in wine cellar under front porch (Unresolved) -Basement sometimes smells earthy or musty in summer -No flooding problems -Leakage: Water backup under shingles in room over garage during winter thaw. (Fixed 1994) -Humidifier used in winter	-Drastic reduction in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier. -Seasonal fluctuations in indoor humidity levels greatly reduced. Humidity levels appear to be much more constant -Fair moisture removal rates -Peak removal rate approx. 0.35 L/h -Average removal rate approx. 0.13 L/h -Noticeable reduction in wood moisture levels from year 1 to year 2

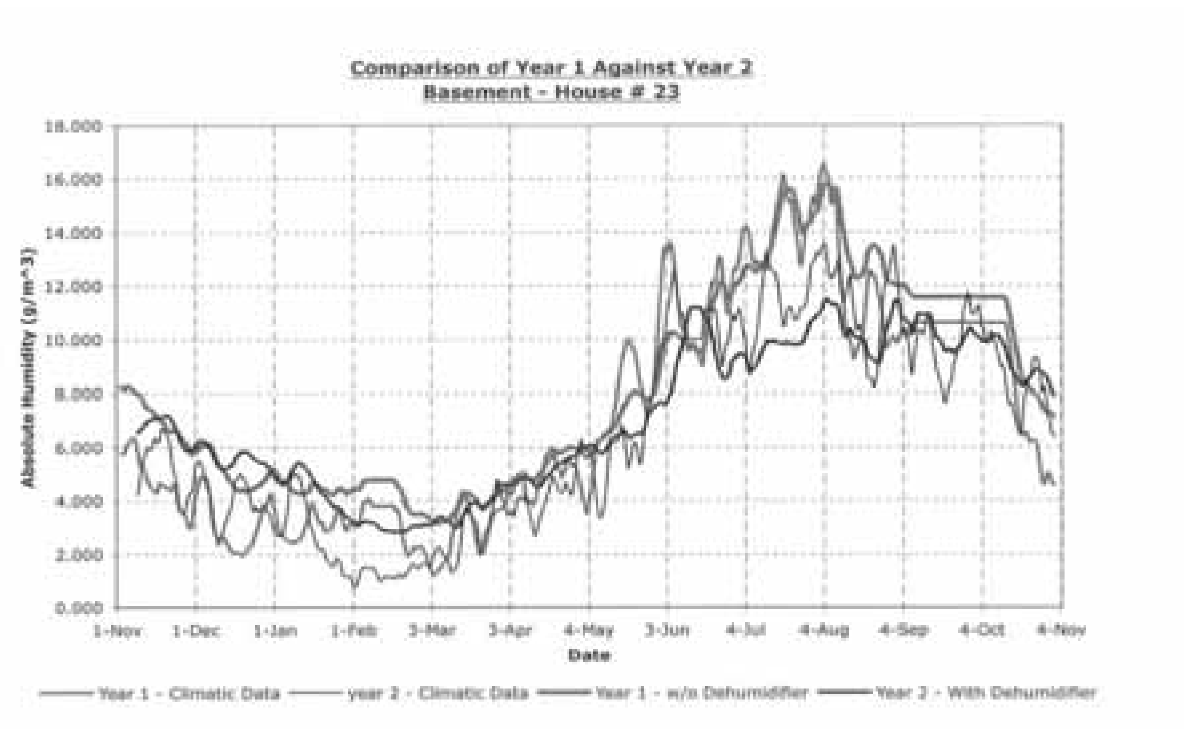


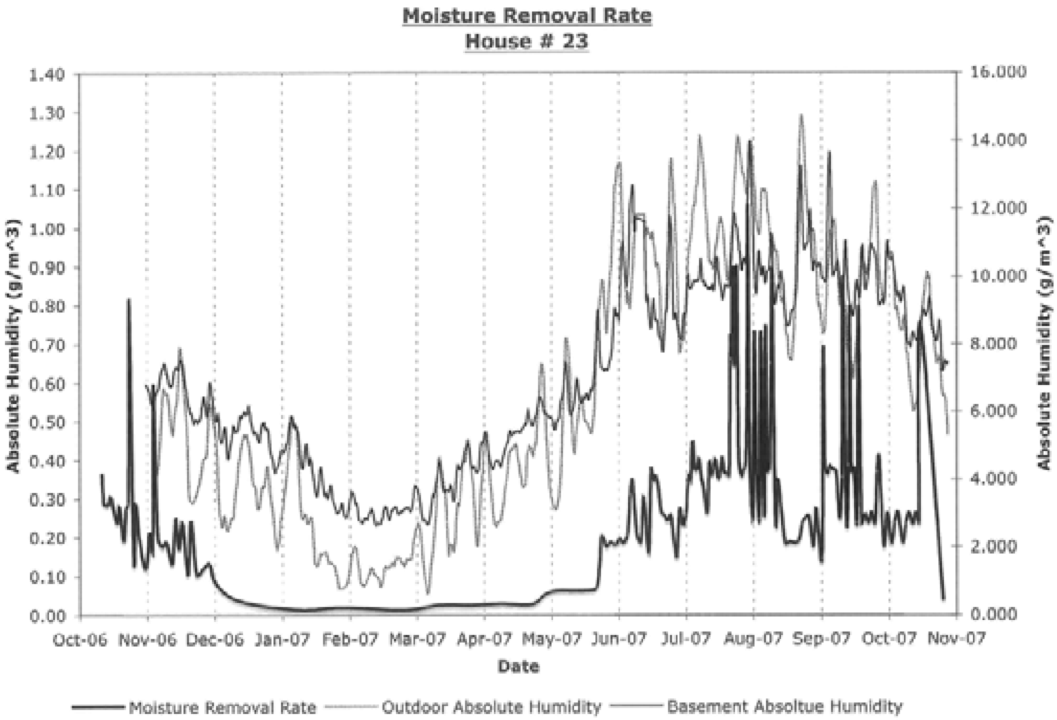

Moisture Removal Rate vs Time
House # 22
Moisture Removal Rate (L/h)
Absolute Humidity (g/m^3)
Date
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity

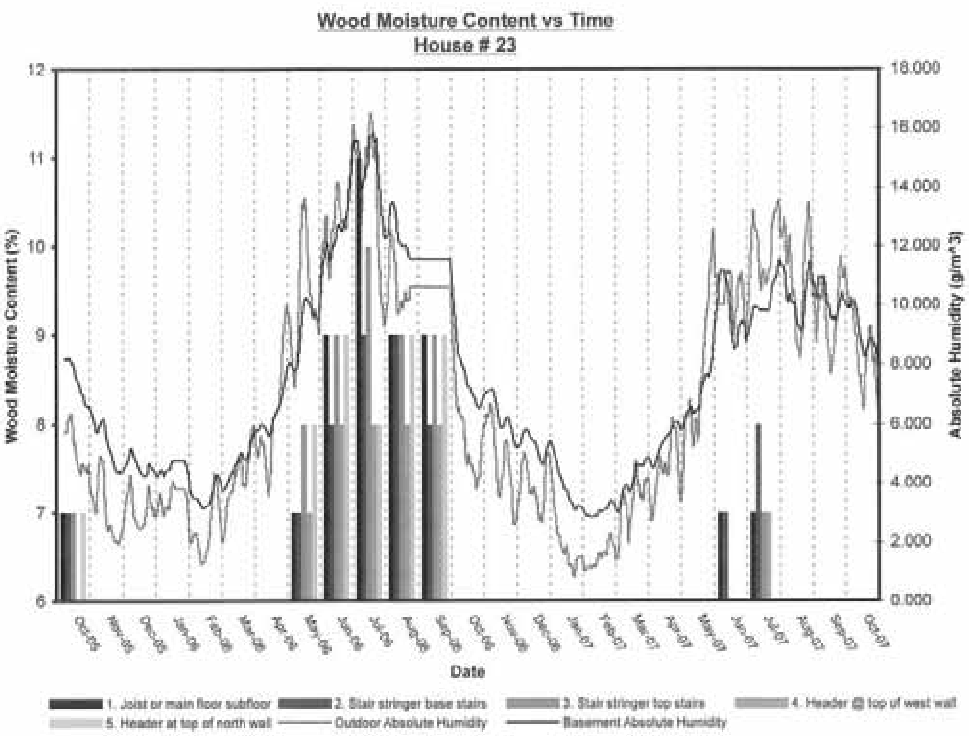

Wood Moisture Content vs Time
Basement - House # 22
Wood Moisture Content (%)
Absolute Humidity (g/m^3)
Date
1. Basem't: Joist near dehumidifier location
2. Basem't: Stair stringer base stairs
3. Basem't: Stair stringer top stairs (4' H)
4. Basem't: Header @ top of west wall
5. Basem't: Header at top of north wall
Outdoor Absolute Humidity
Basement Absolute Humidity

House #23, Gatineau, Quebec

Description	Household	Moisture Indicators	Observations
-Two storey detached -Built: 1993, 300 m^2 -Unfinished basement, full depth. -No listed barriers or insulation in concrete foundation -Pitched roof with vented attic. Wood frame, 22R mineral fibre insulation -Double-glazed windows -Weeping tiles, sump pump (covered), ground slopes away from house, and eavestroughs -Forced air, oil and electric heating, with wood fireplace	-4 occupants -Summer temperature: 25°C day; 22°C night -Winter temperature: 20°C day; 17°C night -Windows open for ventilation in summer, including basement windows -Furnace fan only on when furnace is on	-Primary bathroom without a fan, secondary bathroom has a fan -5 showers a day, 4 loads of laundry per week, and 10 hours of cooking per week -Basement musty (Unresolved) -No flooding problems -Leakage: Wall by front porch leaked heavily. (Single occurrence) Roof leaked caused damage to drywall ceilings (Single occurrence, fixed) -No humidifier in winter	-Improvement in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier -Excellent moisture removal rates -Moisture removal possible throughout year, though primarily during summer months. -Peak removal rate approx. 0.95 L/h -Average removal rate approx 0.3 L/h -Drastic reduction in wood moisture contents from year 1 to year 2

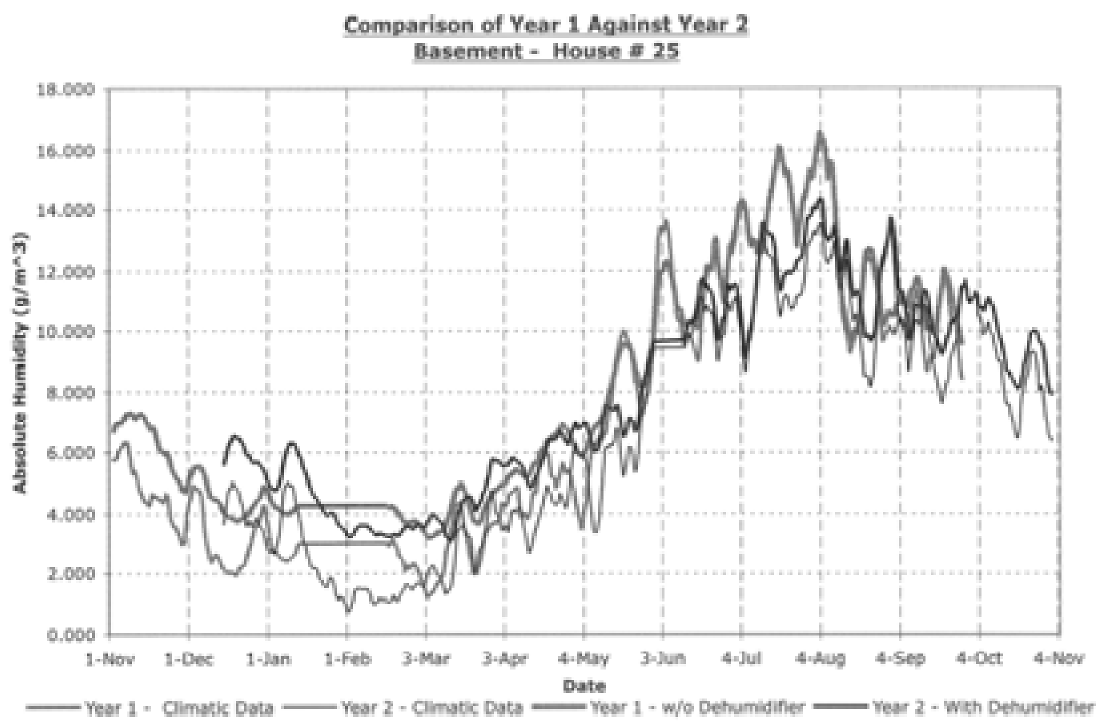


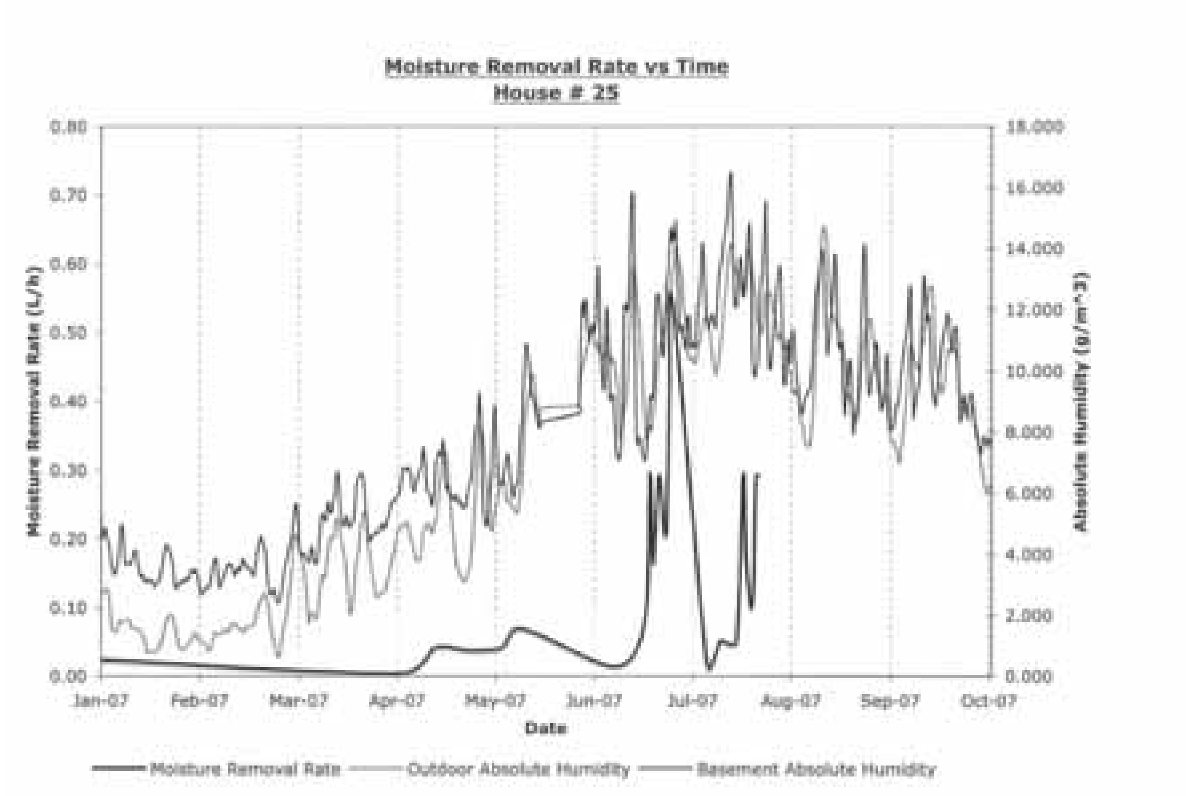

Moisture Removal Rate
House # 23
Absolute Humidity (g/m^3)
Absolute Humidity (g/m^3)
Date
Oct-06 Nov-06 Dec-06 Jan-07 Feb-07 Mar-07 Apr-07 May-07 Jun-07 Jul-07 Aug-07 Sep-07 Oct-07 Nov-07
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absoltue Humidity


Wood Moisture Content vs Time
House # 23
Wood Moisture Content (%)
Absolute Humidity (g/m^3)
Date
1. Joist or main floor subfloor
2. Stair stringer base stairs
3. Stair stringer top stairs
4. Header @ top of west wall
5. Header at top of north wall
Outdoor Absolute Humidity
Basement Absolute Humidity

House #25, Ottawa, Ontario

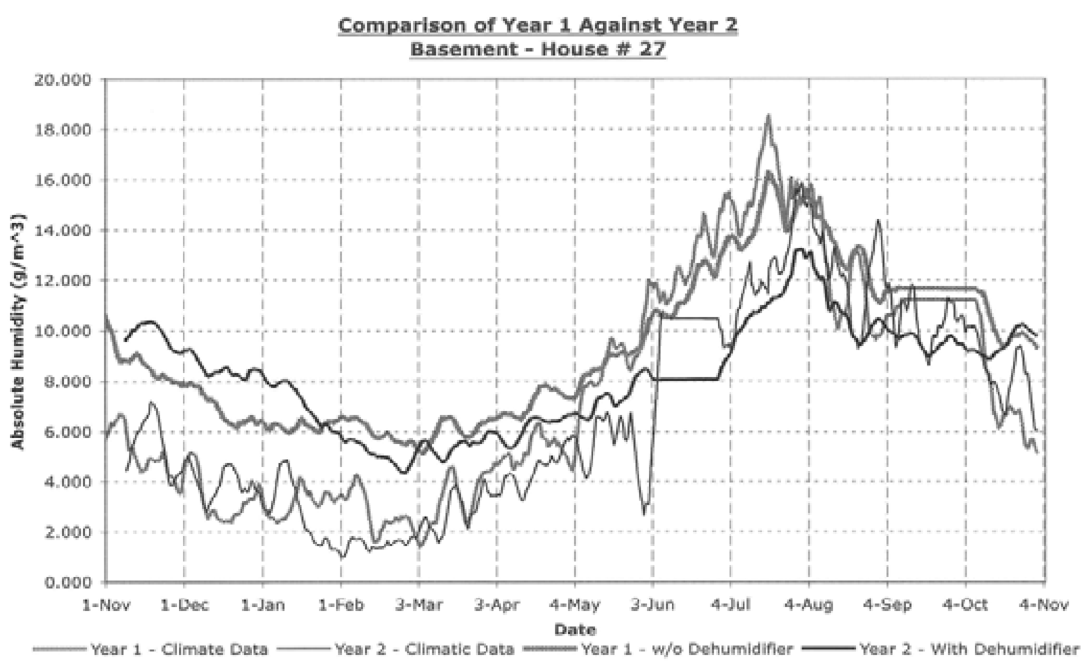
Description	Household	Moisture Indicators	Observations
-Semi-detached -Built: 1917, 186 m^2 -Finished basement	-5 occupants	-No flooding problems	- No significant improvement in indoor vs. outdoor humidity levels -Indoor humidity levels exceed those of corresponding climatic levels. -Poor moisture removal readings -Peak removal rate approx 0.6 L/h -Insufficient information for wood moisture results

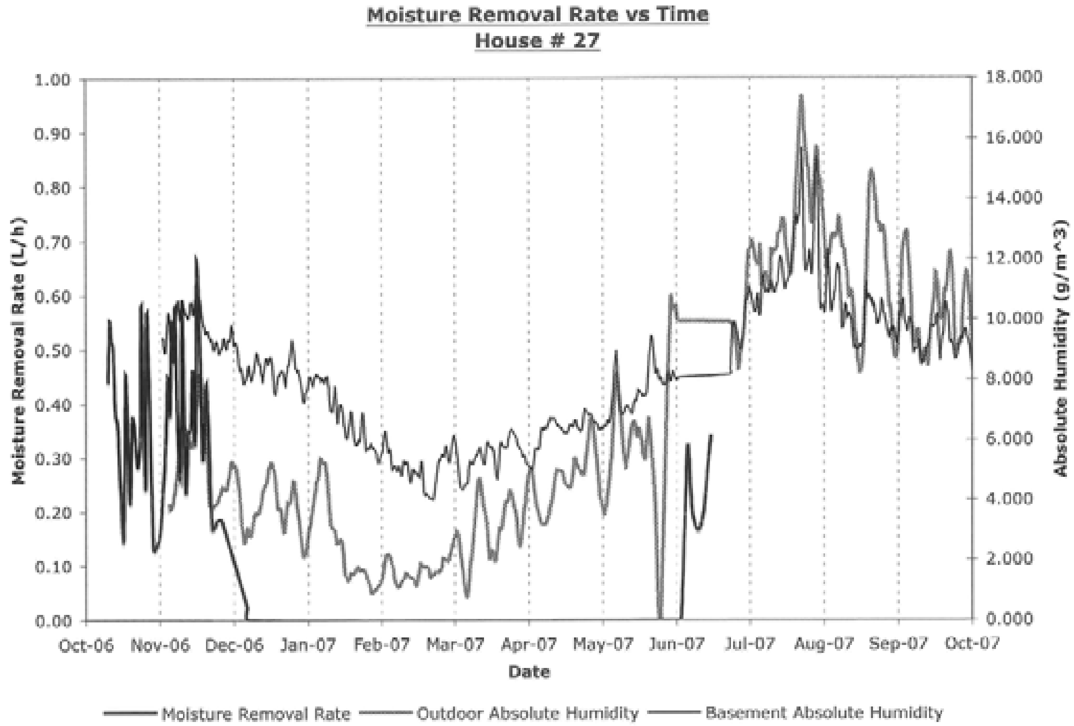


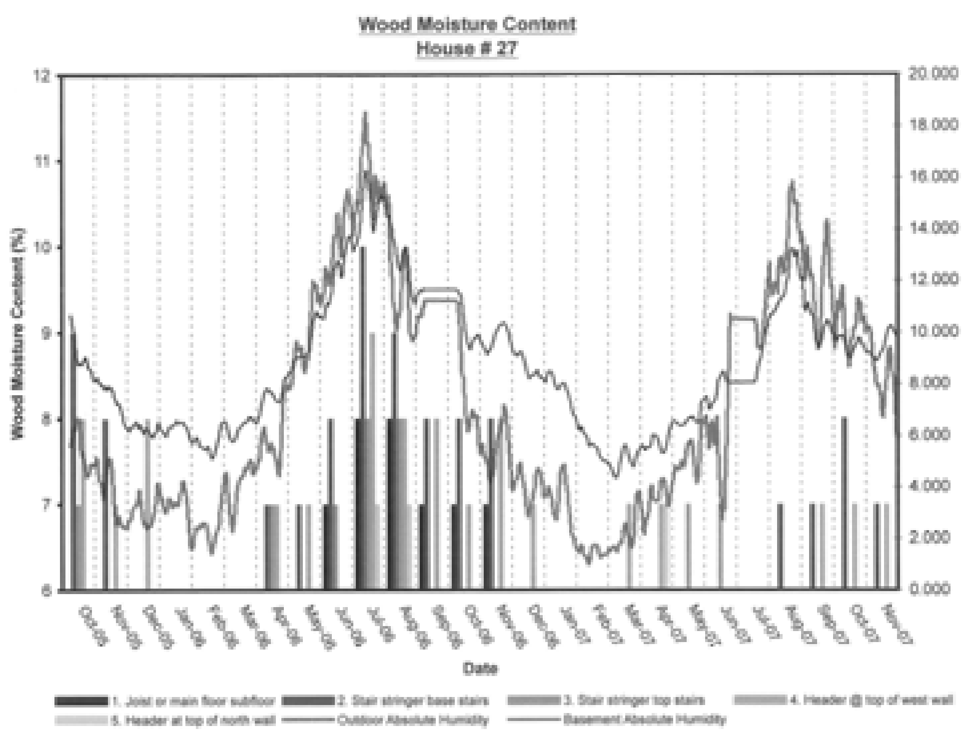

Moisture Removal Rate vs Time
House # 25
Moisture Removal Rate (L/h)
Absolute Humidity (g/m^3)
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Date
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity

House #27, Bécancour, Québec

Description	Household	Moisture Indicators	Observations
-Two storey detached -Built: 1987, 149 m^2 -Mostly finished basement, partially above ground -Concrete foundation with insulated walls and vapour barrier -Vented attic. R40 in roof, R26 in walls, and R20 in basement -Double-glazed windows -Weeping tiles, ground slopes away from house and eavestroughs -HRV system installed -Forced air wood burning furnace. Electrical heating as secondary source	-2 occupants -Temperature: 22°C day; 22°C night -Windows open for ventilation in summer, including basement windows -Furnace fan running all year	-Bathrooms without fans 1 showers a day, 7 loads of laundry per week, and 4 hours of cooking per week -HRV running 10% of the time -Occasional condensation around windows and linen closet (Unresolved) -Occasional musty zoned (Fixed) -Clothes are hung inside -No flooding problems -No leakage problems -No humidifier in winter	-No significant improvement in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier -Insufficient moisture removal rate readings -Excellent moisture removal reading in fall of 2006 -Peak removal rate approx 0.7 L/h -Avg. fall removal rate approx 0.4 L/h -Excellent reduction in wood moisture levels from year 1 to year 2

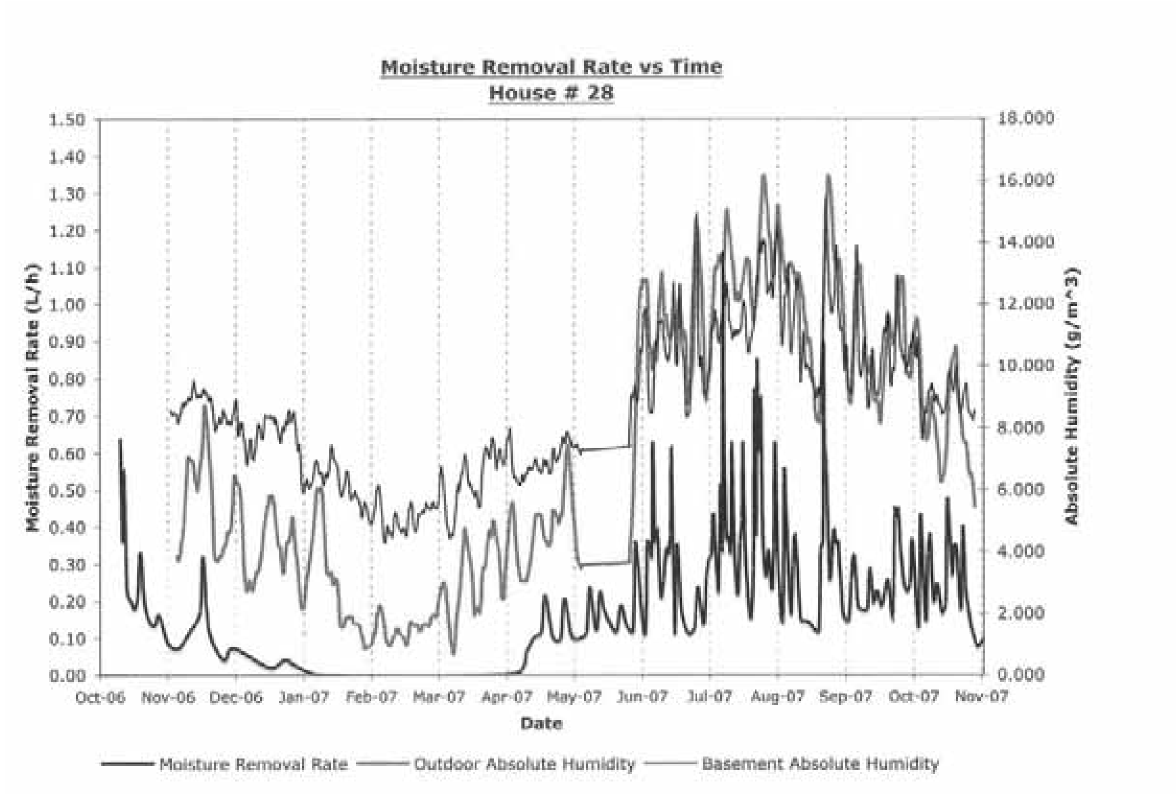



Moisture Removal Rate vs Time
House # 27
Moisture Removal Rate (L/h)
Absolute Humidity (g/m^3)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Oct-06 Nov-06 Dec-06 Jan-07 Feb-07 Mar-07 Apr-07 May-07 Jun-07 Jul-07 Aug-07 Sep-07 Oct-07
Date
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity


Wood Moisture Content
House # 27
Wood Moisture Content (%)
Absolute Humidity (g/m^3)
12
11
10
9
8
7
6
20.000
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Date
1. Joist or main floor subfloor
2. Stair stringer base stairs
3. Stair stringer top stairs
4. Header @ top of west wall
5. Header at top of north wall
Outdoor Absolute Humidity
Basement Absolute Humidity

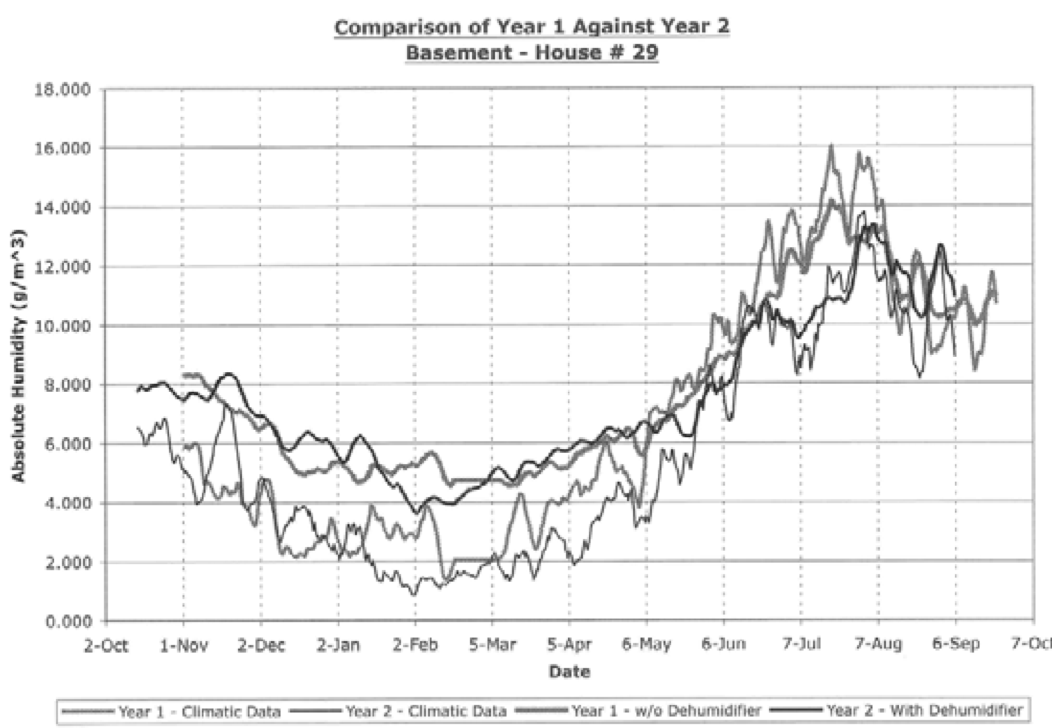
House #28, Laval, Quebec

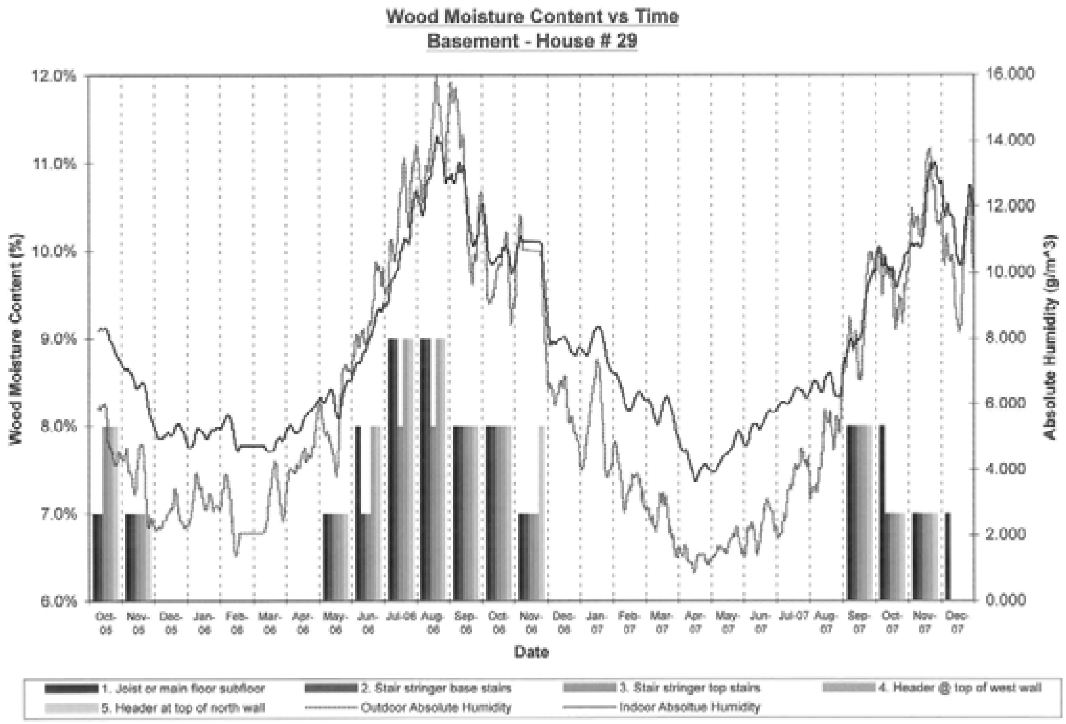
Description	Household	Moisture Indicators	Observations
-Detached bungalow -Built: 1956, 116 m^2 -Finished basement, full depth -No listed barriers or insulation in concrete foundation -Vented attic/ 20R mineral fibre insulation -Single-glazed windows with storm -Weeping tiles and downspouts -Forced air oil furnace	-5 occupants -Summer temperature: 25°C day; 23°C night -Winter temperature: 20°C day; 20°C night -Windows open for ventilation in summer, including basement -Furnace fan running all year	-Primary bathroom fan running at all times. Secondary bathroom without a fan -3 showers a day (30 min each), 15 loads of laundry per week, and 7 hours of cooking. No dishwasher -Odours never linger -Clothes are hung to dry inside -Located in wet area -No flooding problems -Leakage: Garage becomes moist along the exterior wall particularly in the spring and summer (Unresolved) -No humidifier in winter	-Minor reduction in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier - Moisture removal possible throughout full year -Good moisture removal rates -Peak removal rate approx. 1.1 L/h -Avg. summer removal rate approx. 0.4 L/h -Avg. winter removal rate approx. 0.1 L/h -Insufficient information for wood moisture results


Moisture Removal Rate vs Time
House # 28
Moisture Removal Rate (L/h)
Absolute Humidity (g/m^3)
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Oct-06 Nov-06 Dec-06 Jan-07 Feb-07 Mar-07 Apr-07 May-07 Jun-07 Jul-07 Aug-07 Sep-07 Oct-07 Nov-07
Date
Moisture Removal Rate
Outdoor Absolute Humidity
Basement Absolute Humidity

House #29, Ancienne-Lorette, Quebec

Description	Household	Moisture Indicators	Observations
-1.5 storey detached -Built: 1973, 200 m^2 -Partly finished basement, full depth -No listed barriers or insulation in concrete foundation -Pitched roof. Wood and balloon frame, standard insulation type -Double-glazed windows with thermal layer -Weeping tiles only form of drainage -Electric baseboard heating with wood burning stone fireplace	-4 occupants -Summer temperature: 24°C day; 23°C night -Winter temperature: 23°C day; 22°C night -Windows open for ventilation in summer. Windows opened occasionally in spring and fall. Basement windows open in summer only -No furnace fan -Shingles replaced. New windows and doors installed (1997)	-Primary bathroom fan running at all times. Secondary bathroom without fan -4 showers per day, 10 loads of laundry per week, and 10 hours of cooking per week -High levels of activity in basement, including some degree of sports -Some musty zones in basement during winter months -No flooding problems -No leakage problems -No humidifier in winter	-No significant improvement in indoor vs. outdoor humidity levels in 2nd year when using the dehumidifier. -Insufficient information for moisture removal graph -No significant evidence of reduction in wood moisture content from year 1 to year 2




Wood Moisture Content vs Time
Basement - House # 29
Wood Moisture Content (%)
Absolute Humidity (g/m^3)
Date
1. Joist or main floor subfloor
2. Stair stringer base stairs
3. Stair stringer top stairs
4. Header @ top of west wall
5. Header at top of north wall
Outdoor Absolute Humidity
Indoor Absoltue Humidity

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