



# Technical Challenges and Solutions for North Indigenous Housing

Trevor Trainor

Building Science Researcher

Bawating Building Science

[trevor@bawating.com](mailto:trevor@bawating.com)

# The Headlines:

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## **Attawapiskat shacks put First Nations housing crisis into perspective**

By **Colin Perkel** The Canadian Press  
Thu., April 21, 2016 | ⌚ 3 min. read

**Tour a family home in Kashechewan that is filled with love – and mold**  
National News | November 17, 2016 by Annette Francis Attributed to: | Comments Off on Tour a family home in Kashechewan that is filled with love – and mold

**NEWS** 06/26/2019 08:10 EDT

## **Canada's Biggest Housing Crisis Could Be In Nunavut**

A lack of available rentals means even those with six-figure salaries are out of luck.

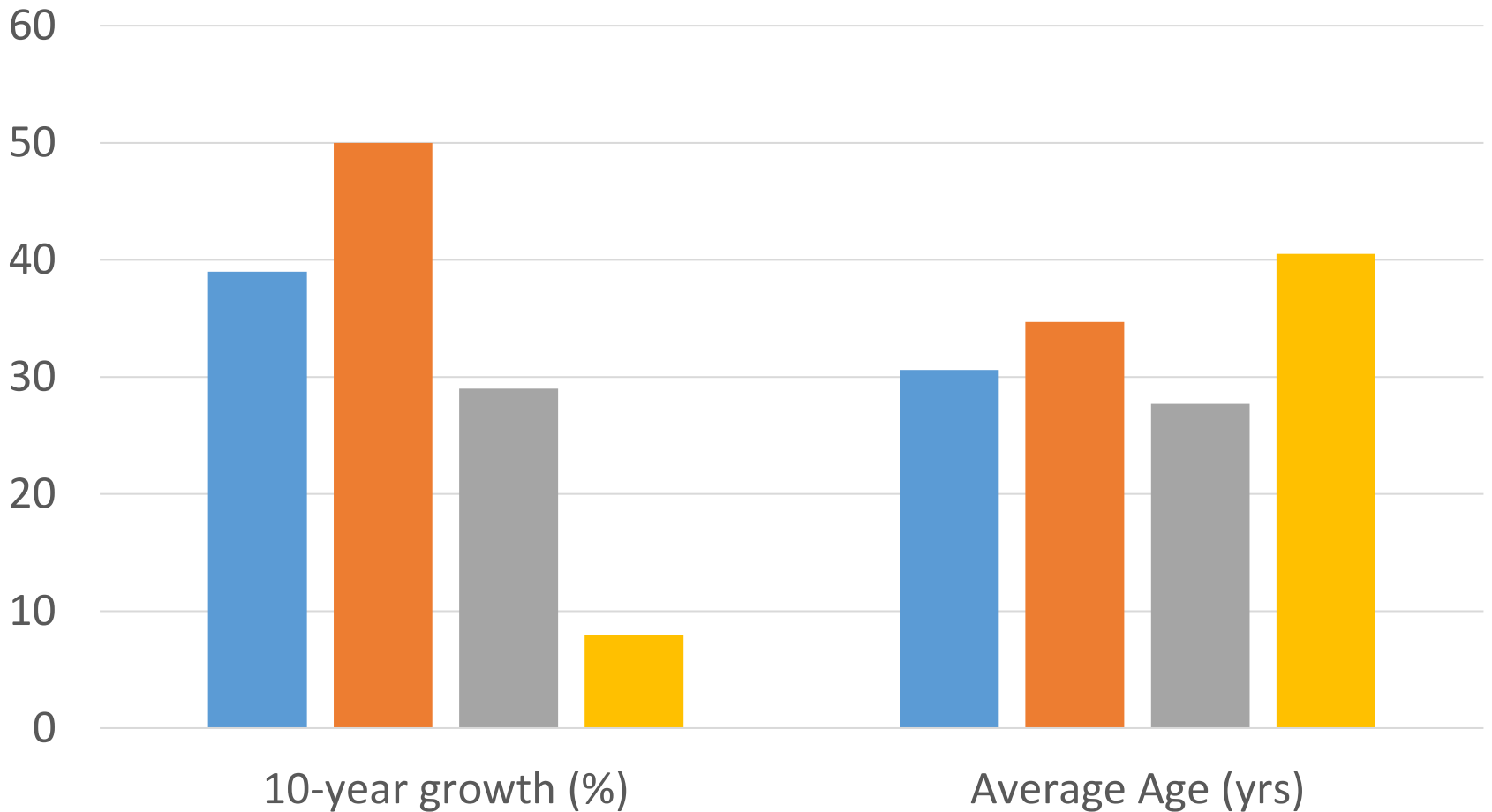
**Living in shacks and under boats – Nunavut's billion dollar housing problem**

Investigates, National News | October 18, 2019 by Christopher Read | 0 Comments



Defining the Problem: |  
by the numbers |

# Aboriginal Population Trends



StatCan 2016 Data

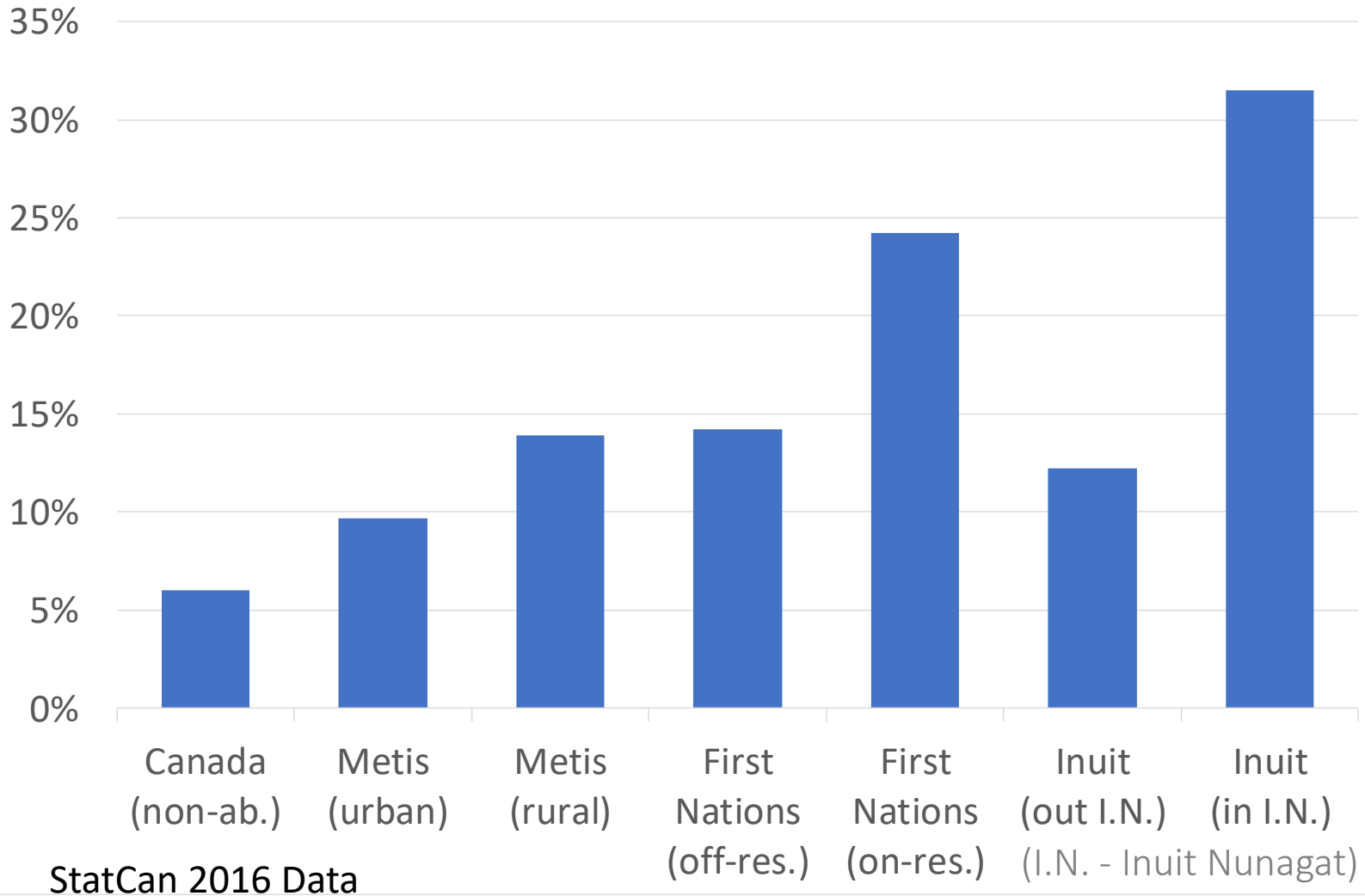
■ First Nations ■ Metis ■ Inuit ■ Canada





Major Repairs

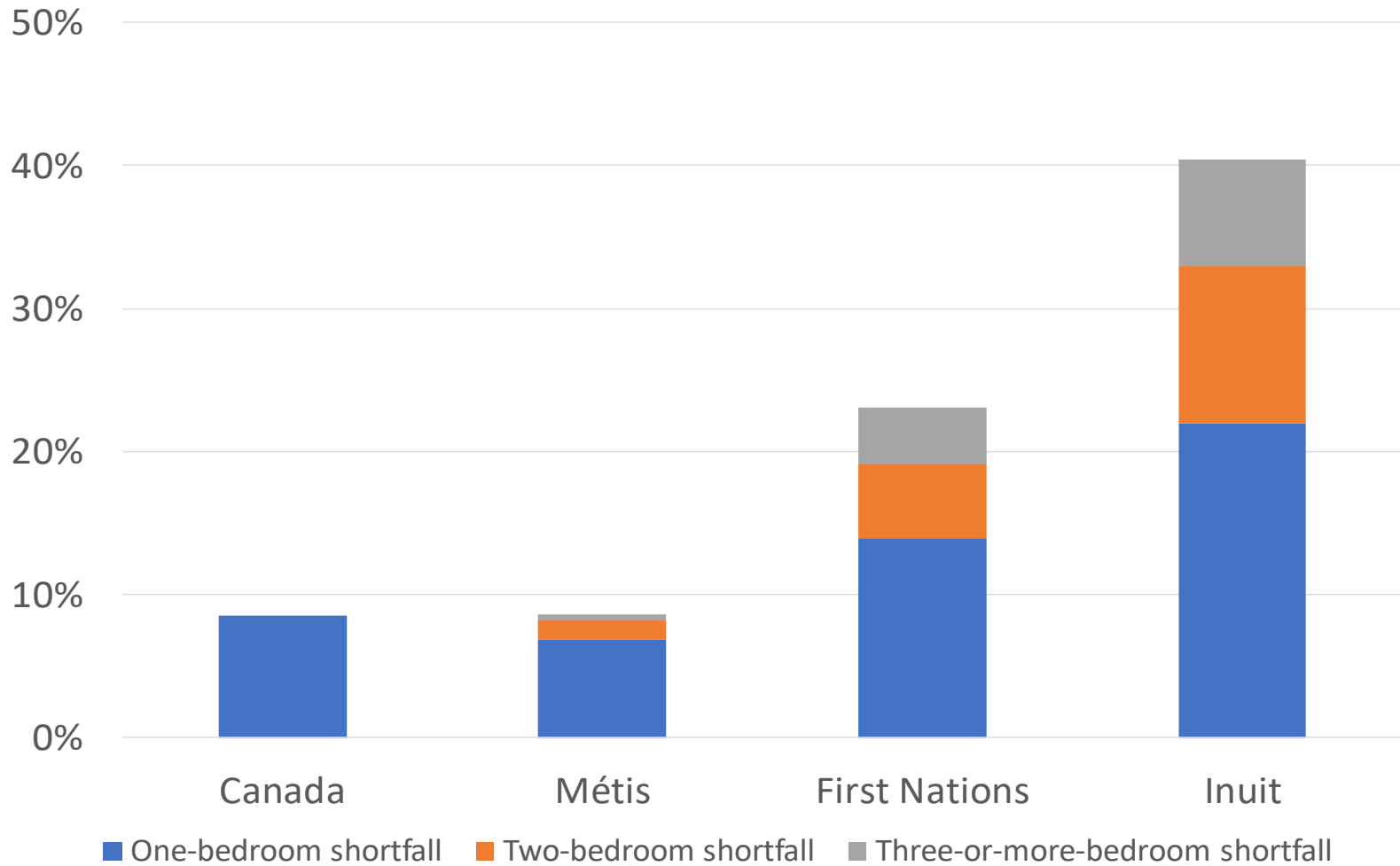
# Housing in Need of Major Repairs



# Overcrowding



# Aboriginal Housing Shortage:



StatCan 2016 Data





**NEWS**

| Election 2019 | Indigenous Affairs | Housing

# How to Fix the First Nations Housing Crisis

Next government could take a major step by handing control of housing back to First Nations with proper funding, say leaders.



**Katie Hyslop**, 18 Oct 2019 | [TheTye.ca](http://TheTye.ca)

Katie Hyslop is a reporter for The Tye. Reach her [here](#).

- More funding for housing is critical, but.....

# How these funds are spent is also important

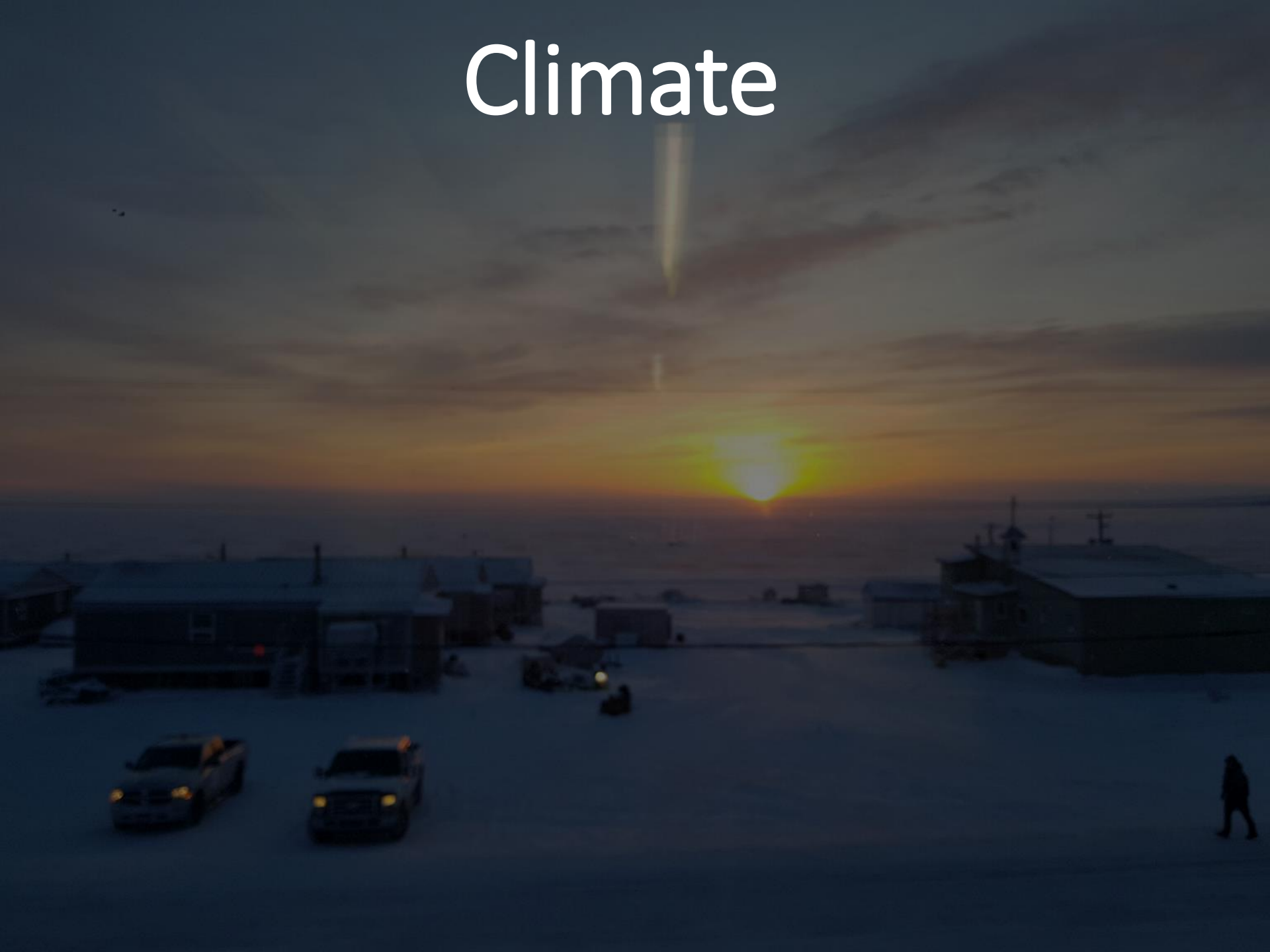
- Many **new** housing units require major repairs or become uninhabitable after only a few years
- We need to understand why this is happening and we need to understand the role that design is playing in this crisis
- This is where building science plays a crucial role

# Unique Challenges

## For Northern Indigenous Housing

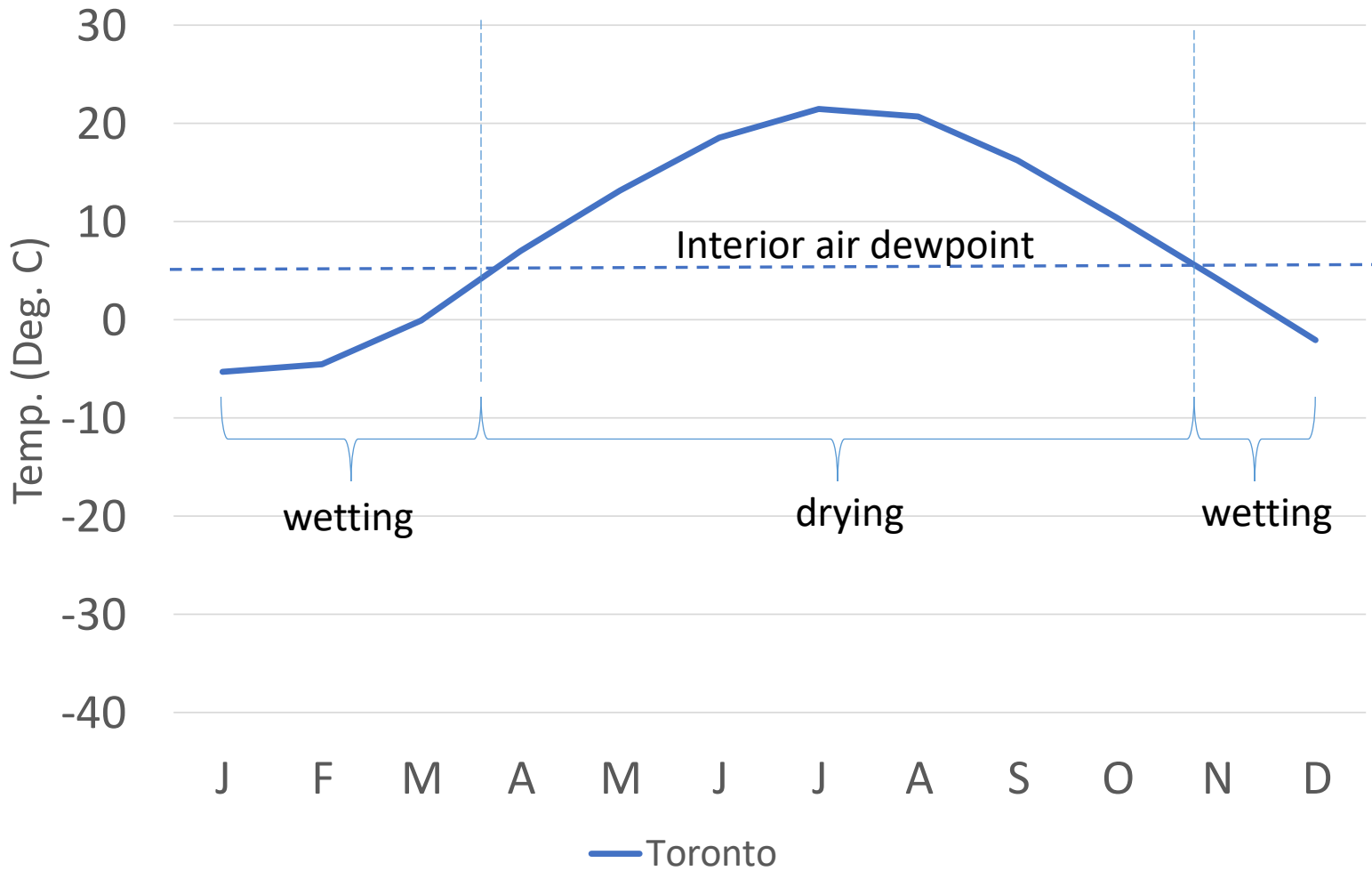
- Climate
  - Colder temperatures, for more of the year
    - **more potential condensation hours**
    - **Less drying capacity**
  - Windy and often wet coastal climates
- Over crowding
  - More people, generating more moisture
  - **Higher levels of interior humidity**
- Limited resources for design and construction
  - Leads to lowest cost solutions
  - **Leads to inappropriate designs**

# Climate

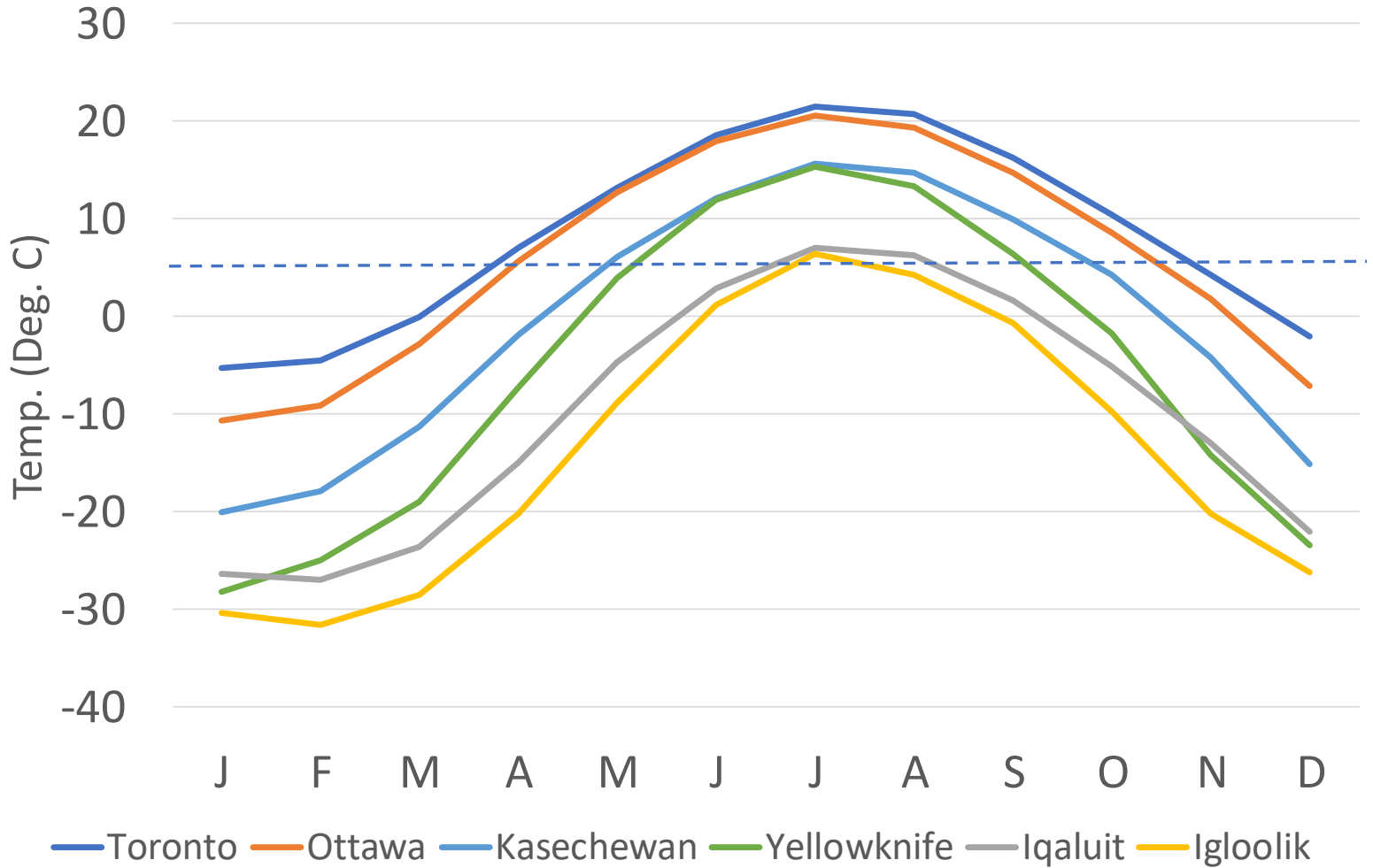




# Average Monthly Temperatures



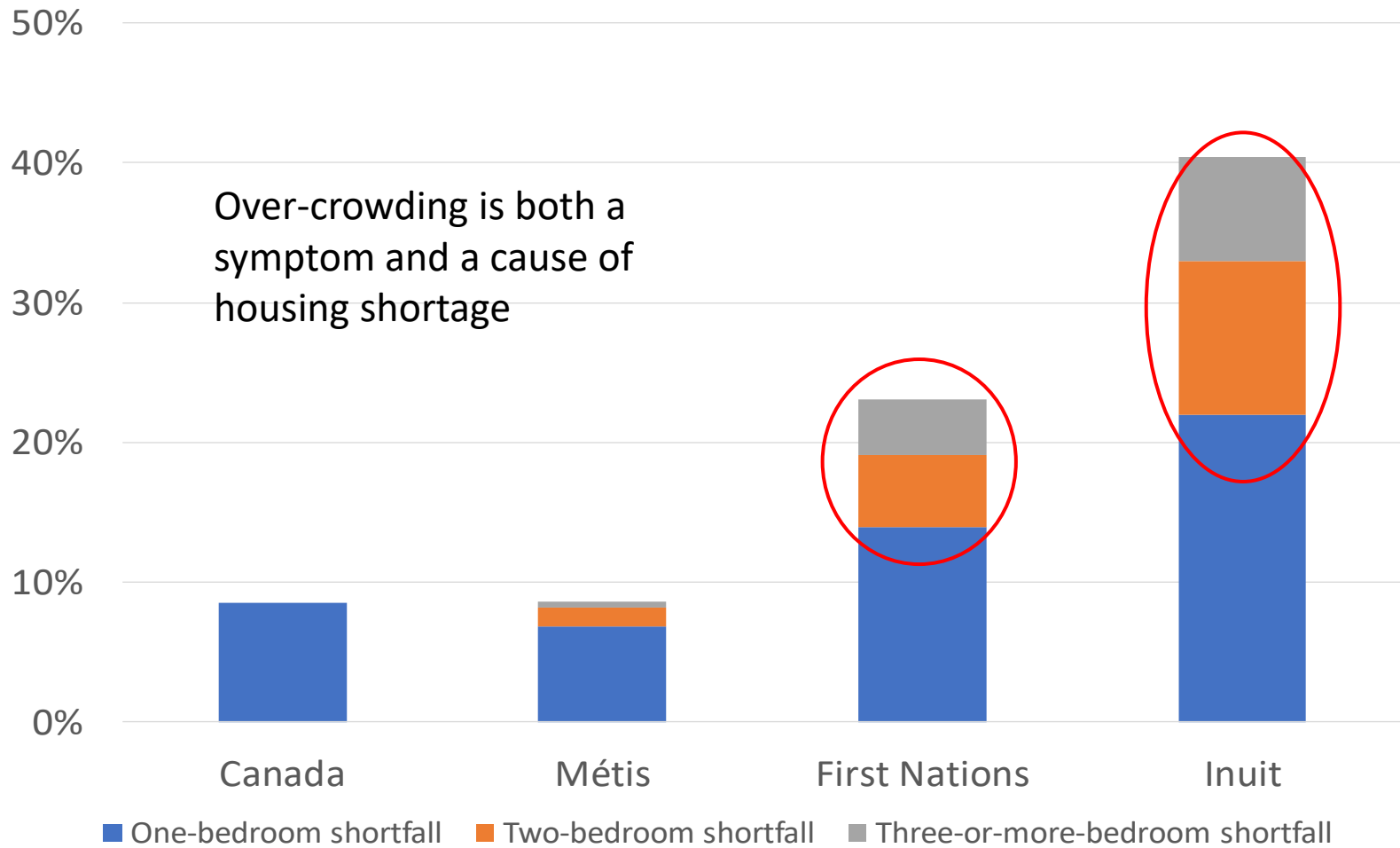
# Average Monthly Temperatures





Interior Humidity

## Aboriginal Housing Shortage:



StatCan 2016 Data



# Interior Relative

## Moisture generation activities

Breathing



Drying cloths



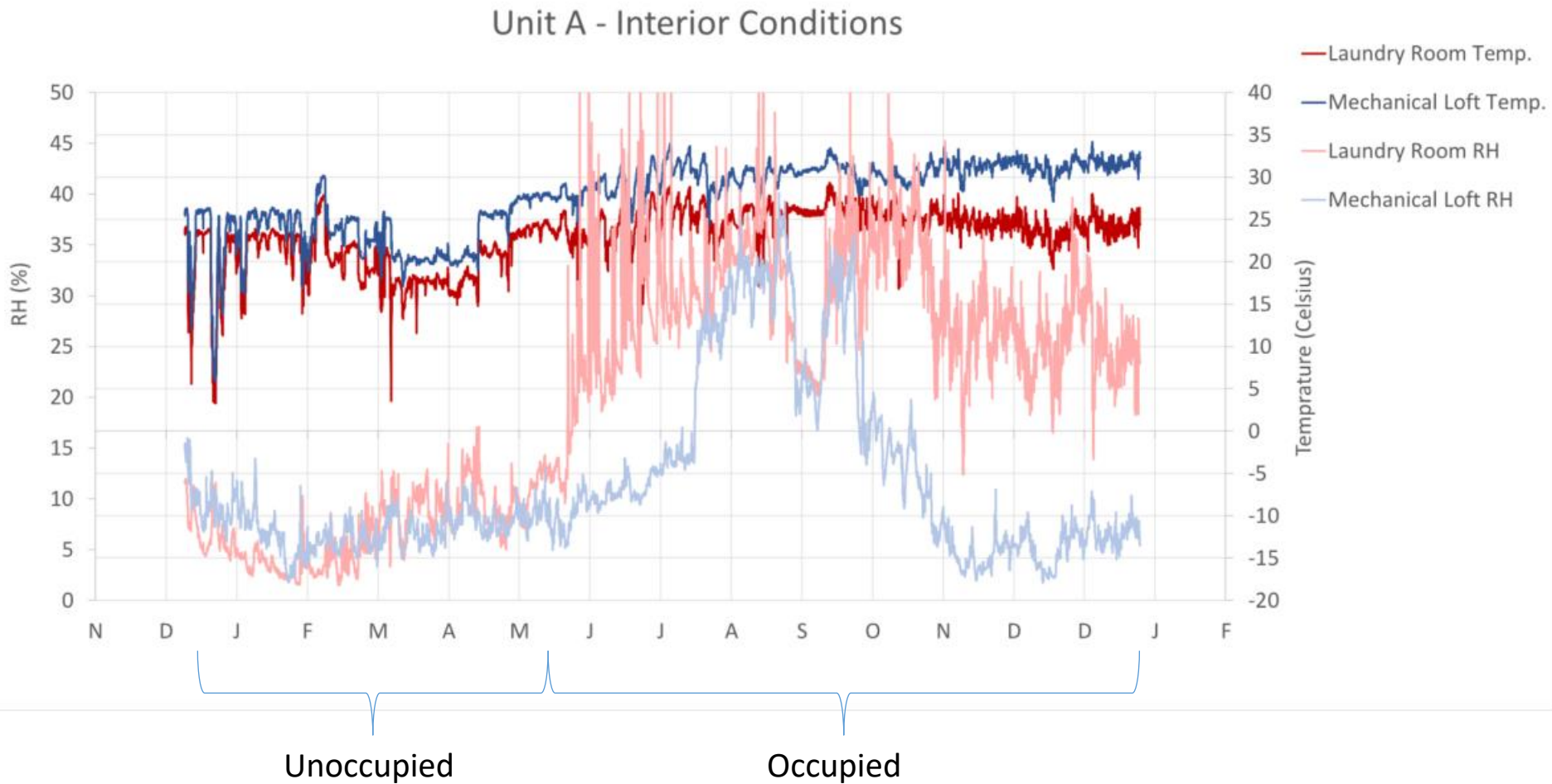
Baths/Showers



Cooking/boiling water

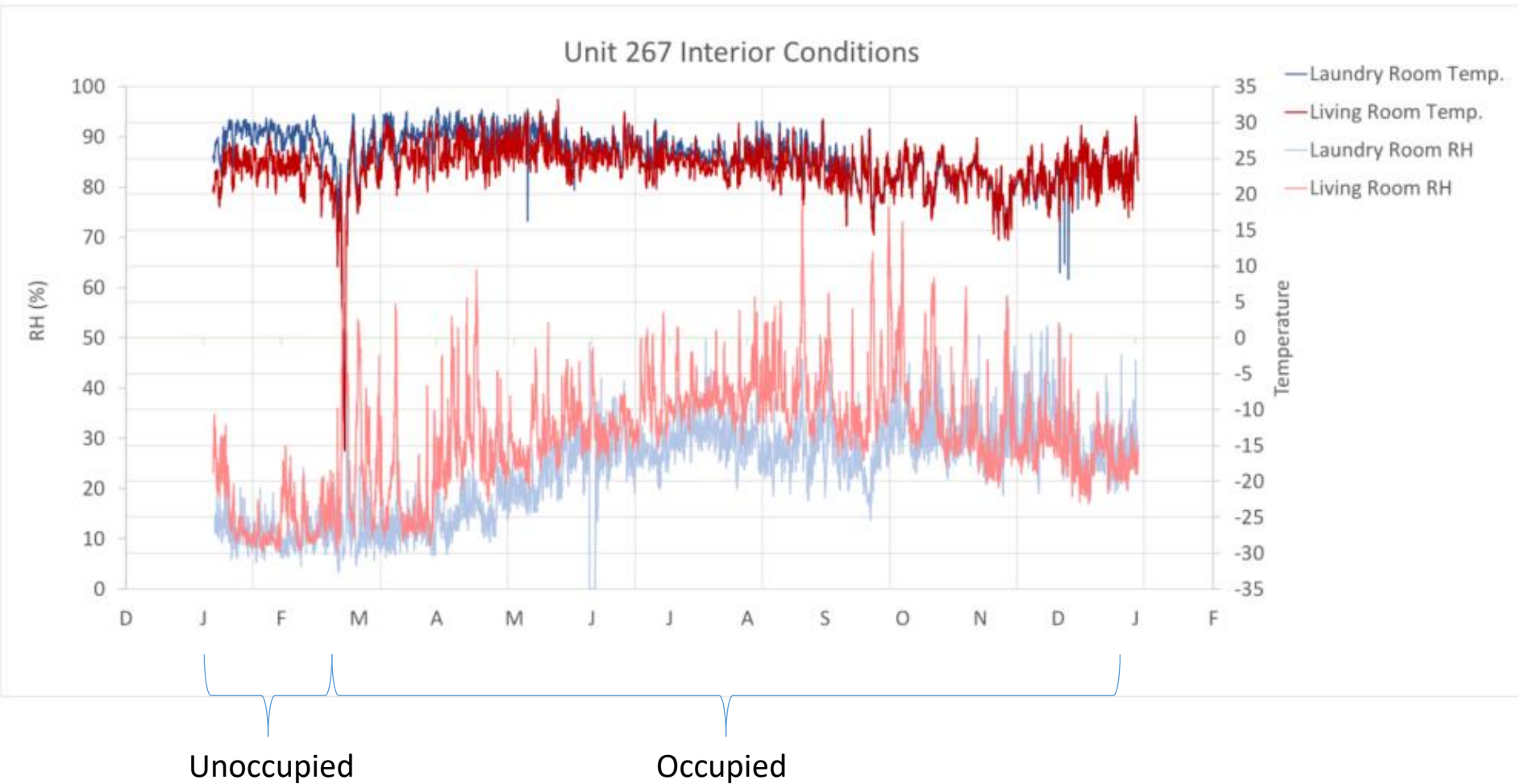


# Measuring Interior RH and Temp.



Interior humidity levels and interior air temperatures are higher than expected

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Interior humidity levels and interior air temperatures are higher than expected

# Interior Humidity

- Conventional wisdom is that in very cold climates, interior humidity levels will be low
- Preliminary research shows that interior humidity levels are higher than expected due to:
  - Over-crowding and high levels of moisture generation
  - Ineffective or under-utilized ventilation systems
  - Inappropriate foundation designs
- Ventilation and foundation design need to be addressed
- **Building enclosure design** also has a large role to play



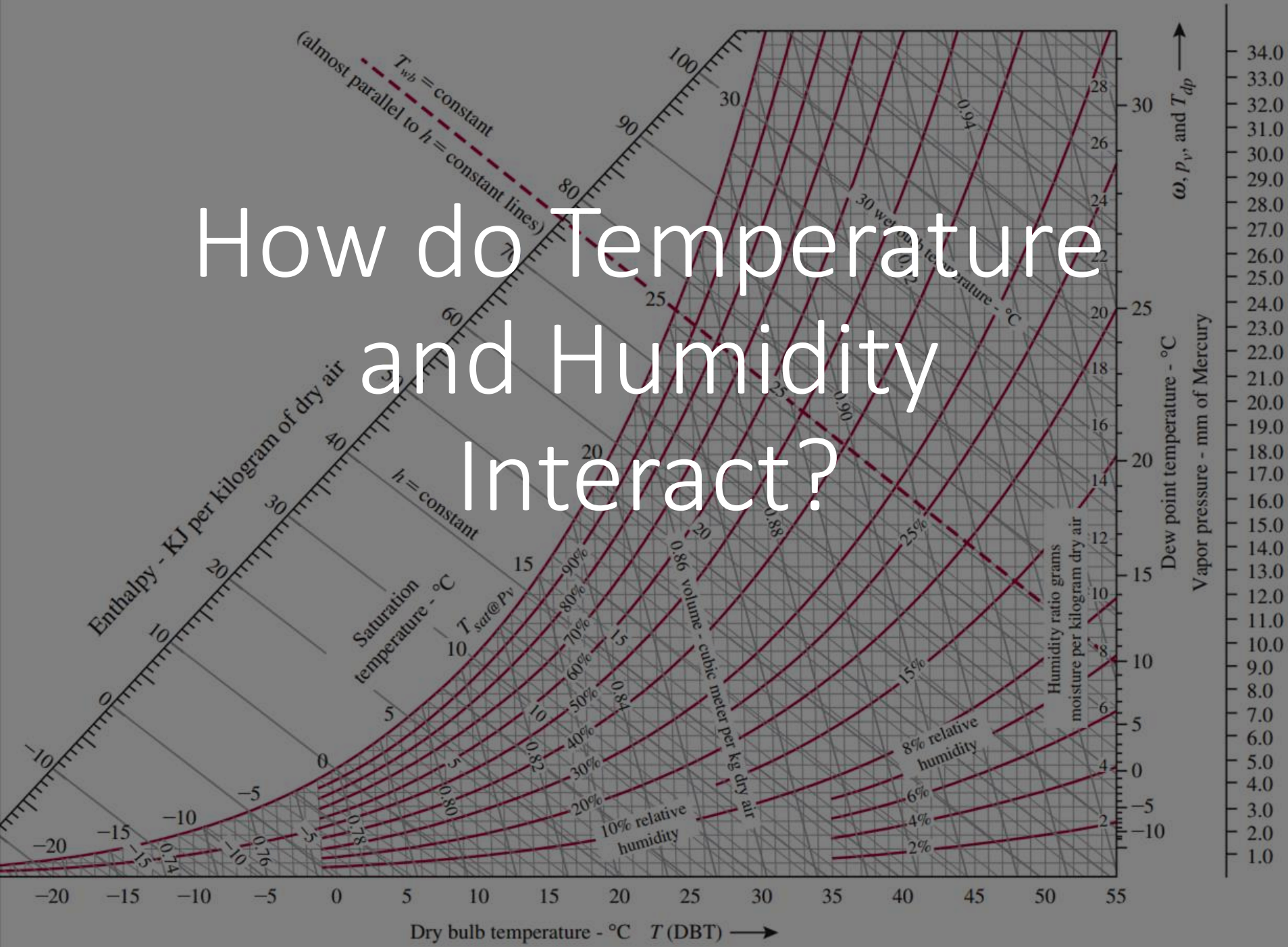


# Cold Surfaces and High Interior Humidity

The perfect storm.....



# How do Temperature and Humidity Interact?

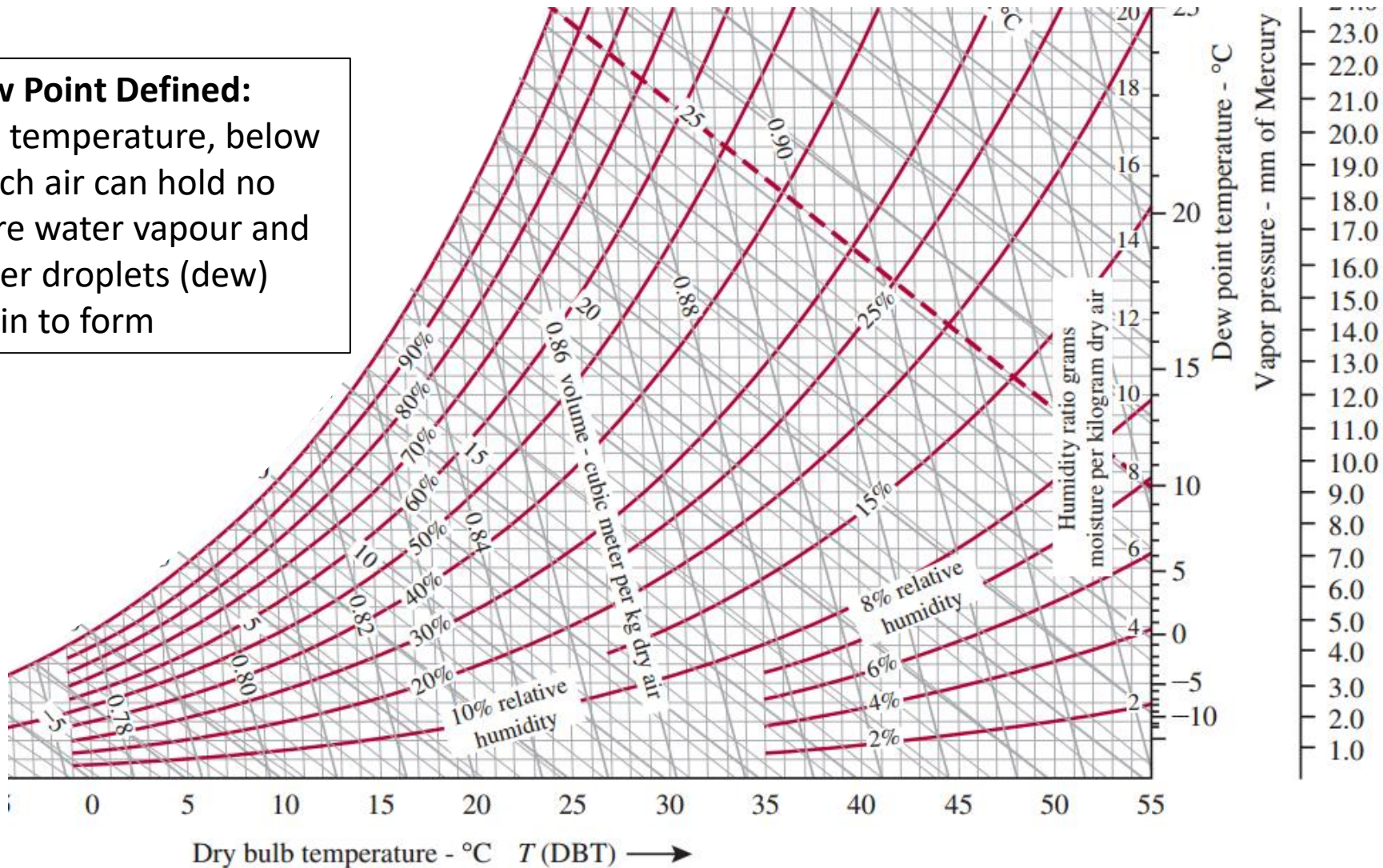




# Psychrometrics: Determining Dew Point Temperature

## Dew Point Defined:

The temperature, below which air can hold no more water vapour and water droplets (dew) begin to form



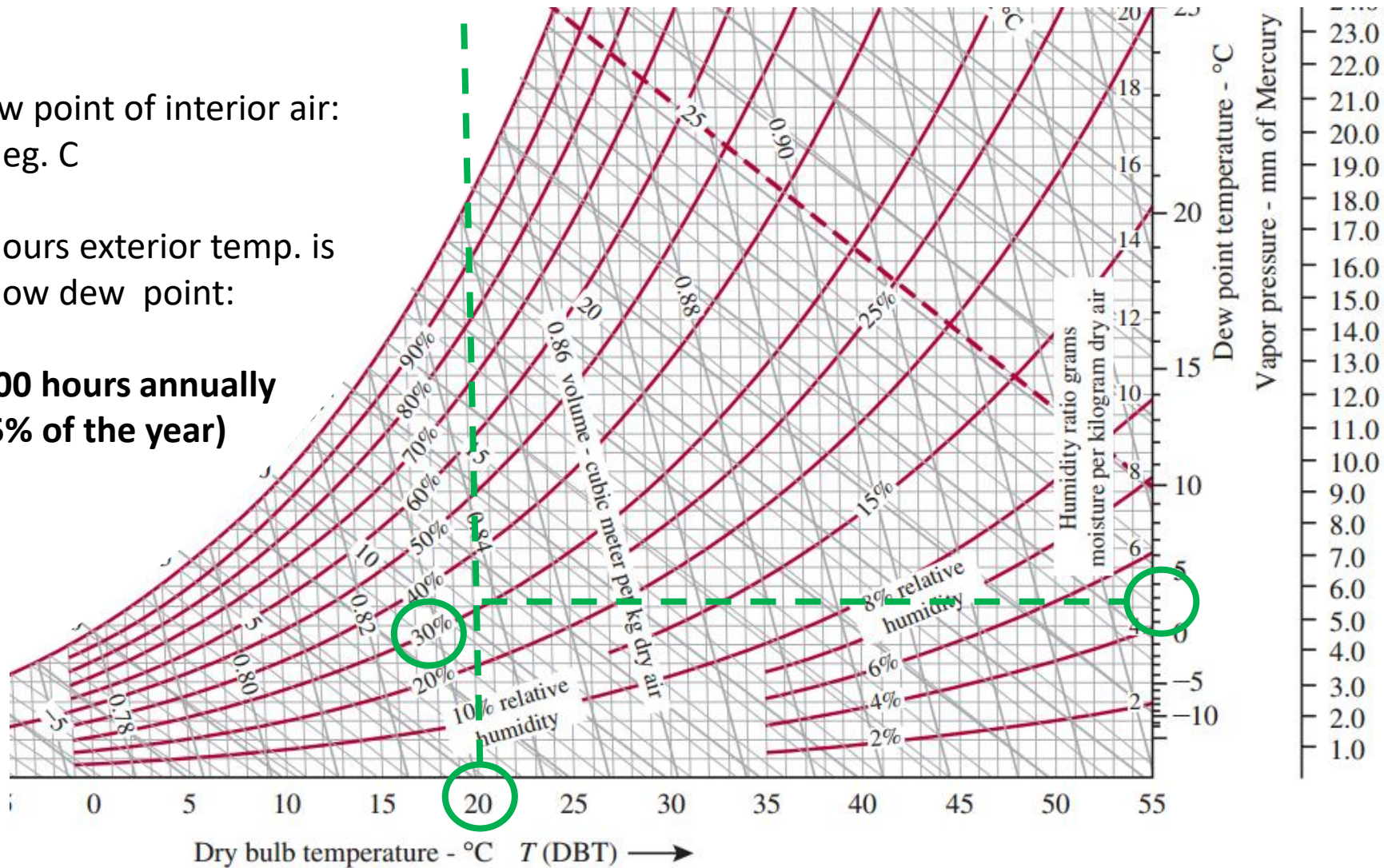


# Example 1: Average House in Toronto in Winter

Dew point of interior air:  
3 deg. C

# hours exterior temp. is  
below dew point:

**3000 hours annually**  
**(35% of the year)**



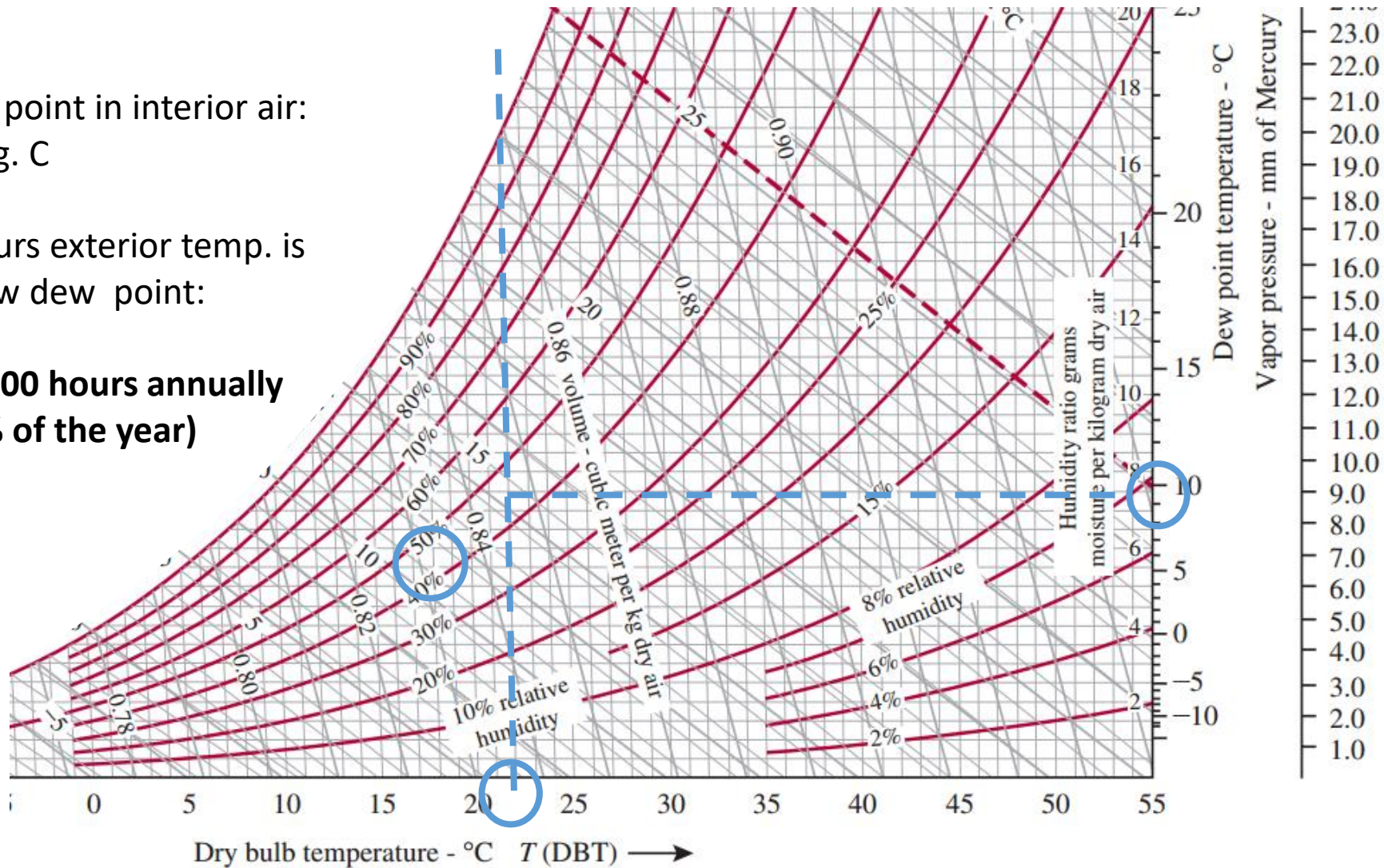


# Example 2: Over-crowded House in Kashechewan in Winter

Dew point in interior air:  
9 deg. C

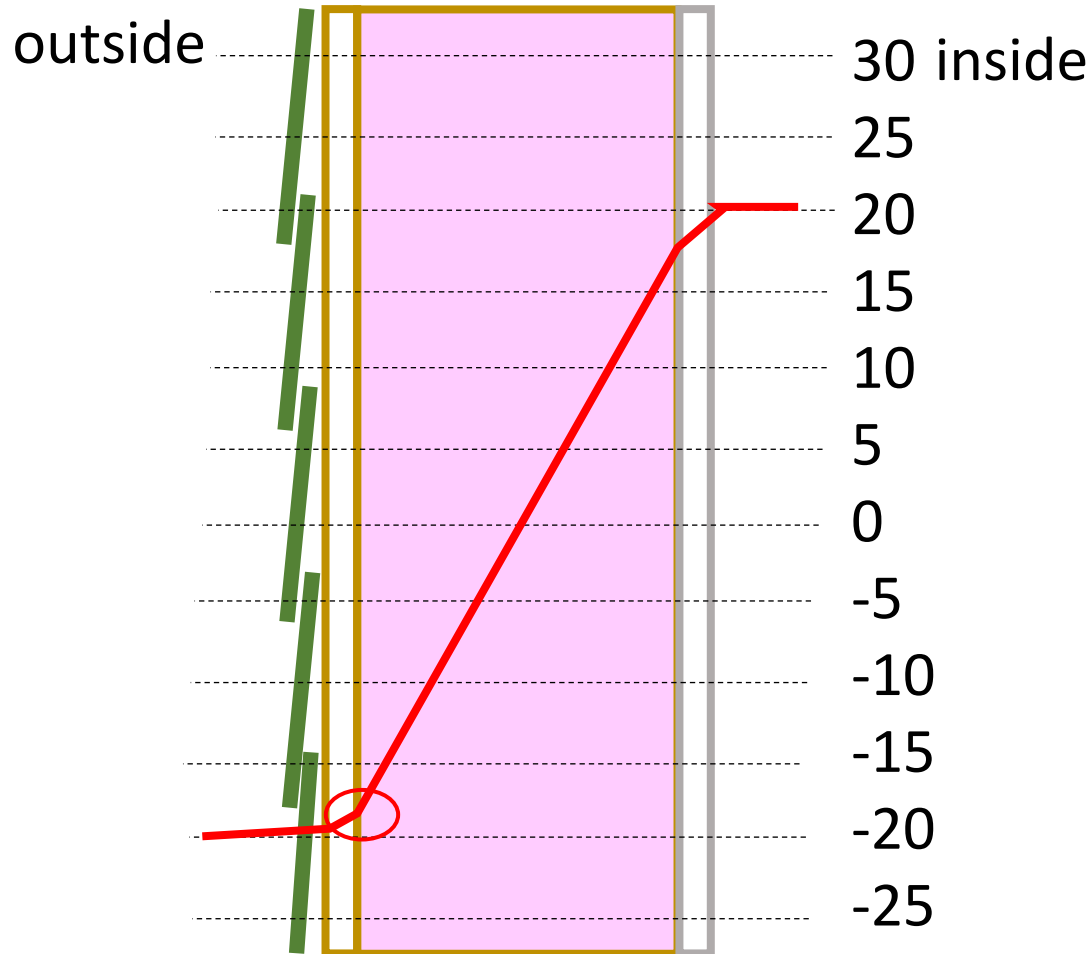
# hours exterior temp. is  
below dew point:

**> 6100 hours annually  
(70% of the year)**



# Interstitial Condensation:

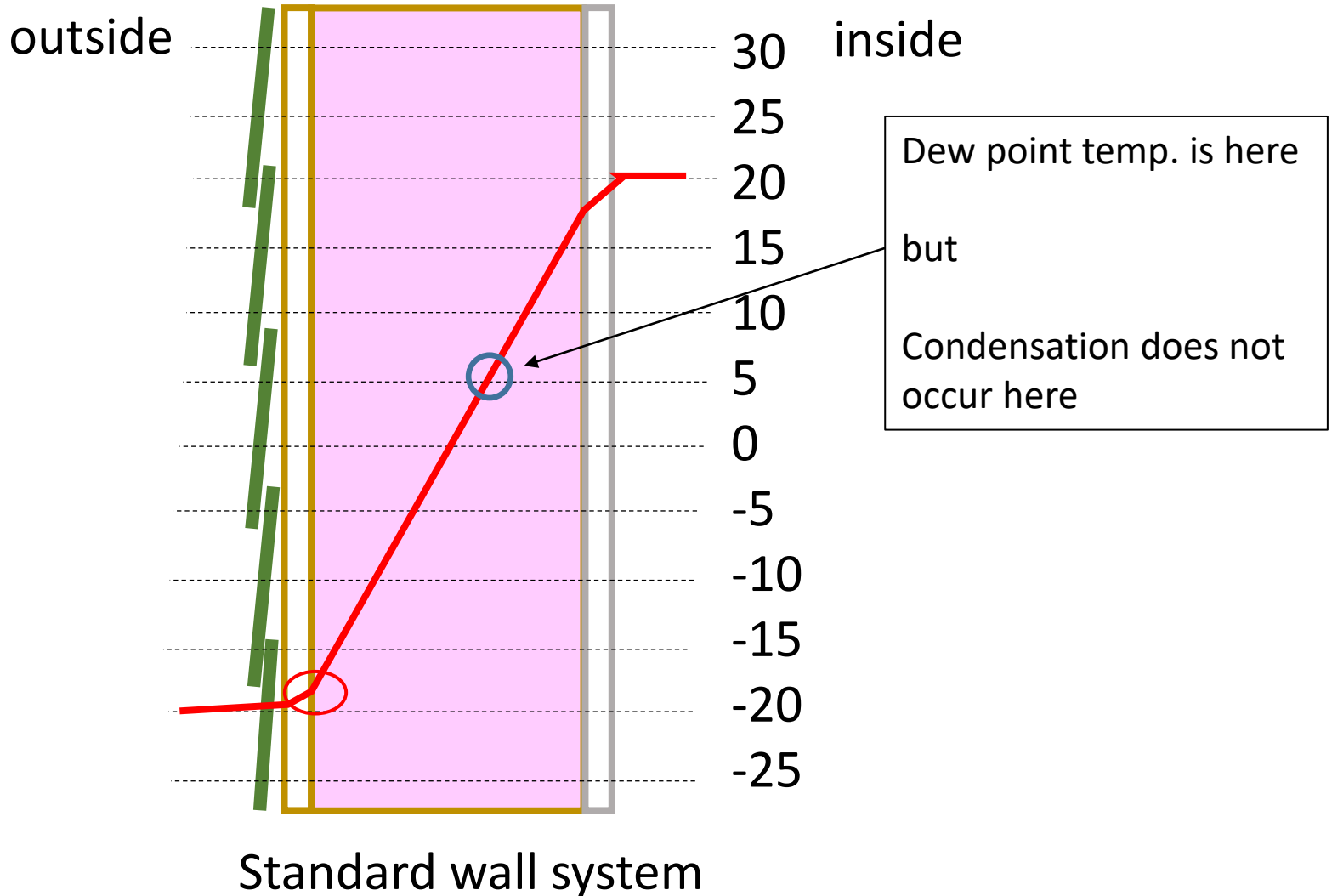
Temperature gradient through standard wall system



Standard wall system

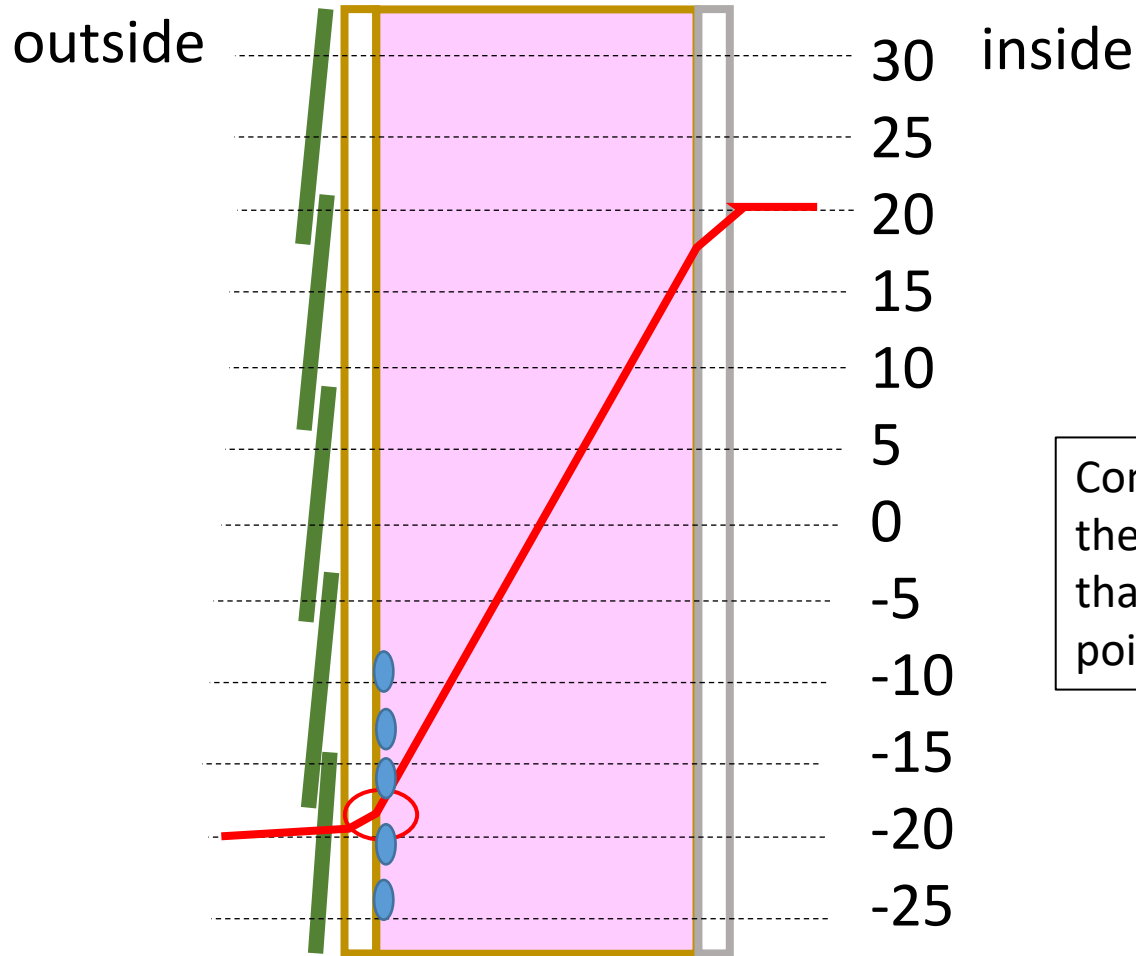
# Interstitial Condensation:

Temperature gradient through standard wall system



# Interstitial Condensation:

Temperature gradient through standard wall system

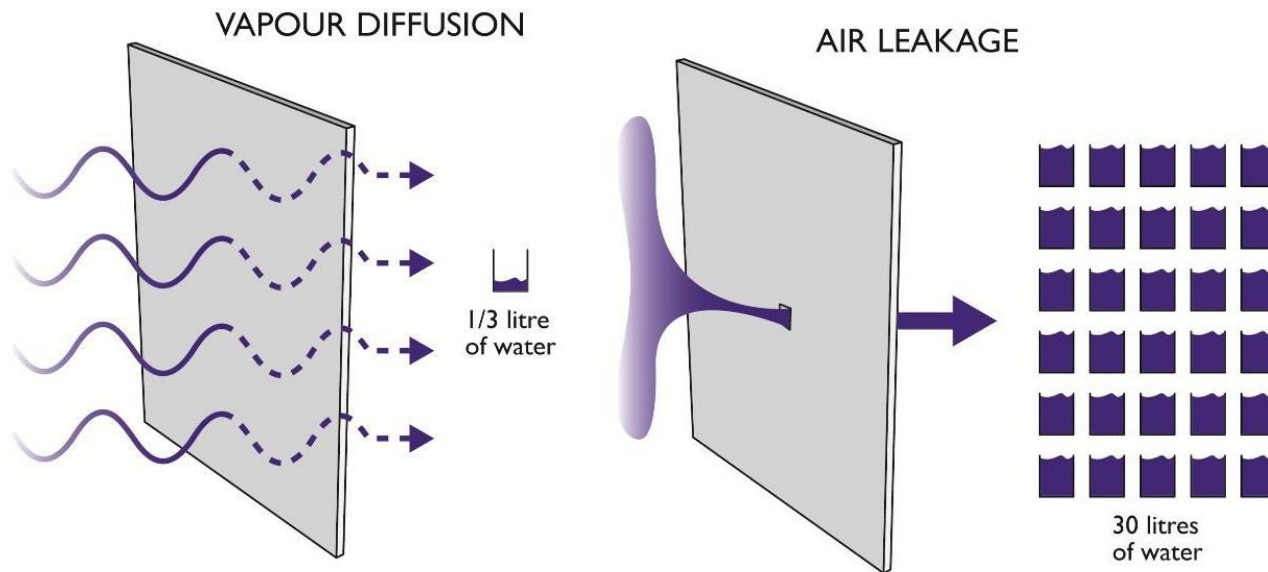


Condensation occurs at the first solid surface that is below the dew point- ie. the sheathing

Standard wall system

# Interstitial Condensation:

Can be a result of vapour diffusion or air leakage



The amount of water vapour transported by Air-leakage is more than an order of magnitude than that typically moved by vapour diffusion



# Air Barrier vs Vapour Barriers

- Vapour Barrier (Retarder)–
  - Slows water vapour flow
    - may or may not allow air to pass through
  - Does not need to completely stop water vapour
  - Holes are OK
  - No more than 1



- Air Barrier –
  - Stops air flow
    - may or may not allow water vapour to pass through
  - Needs to have no holes
  - More is better

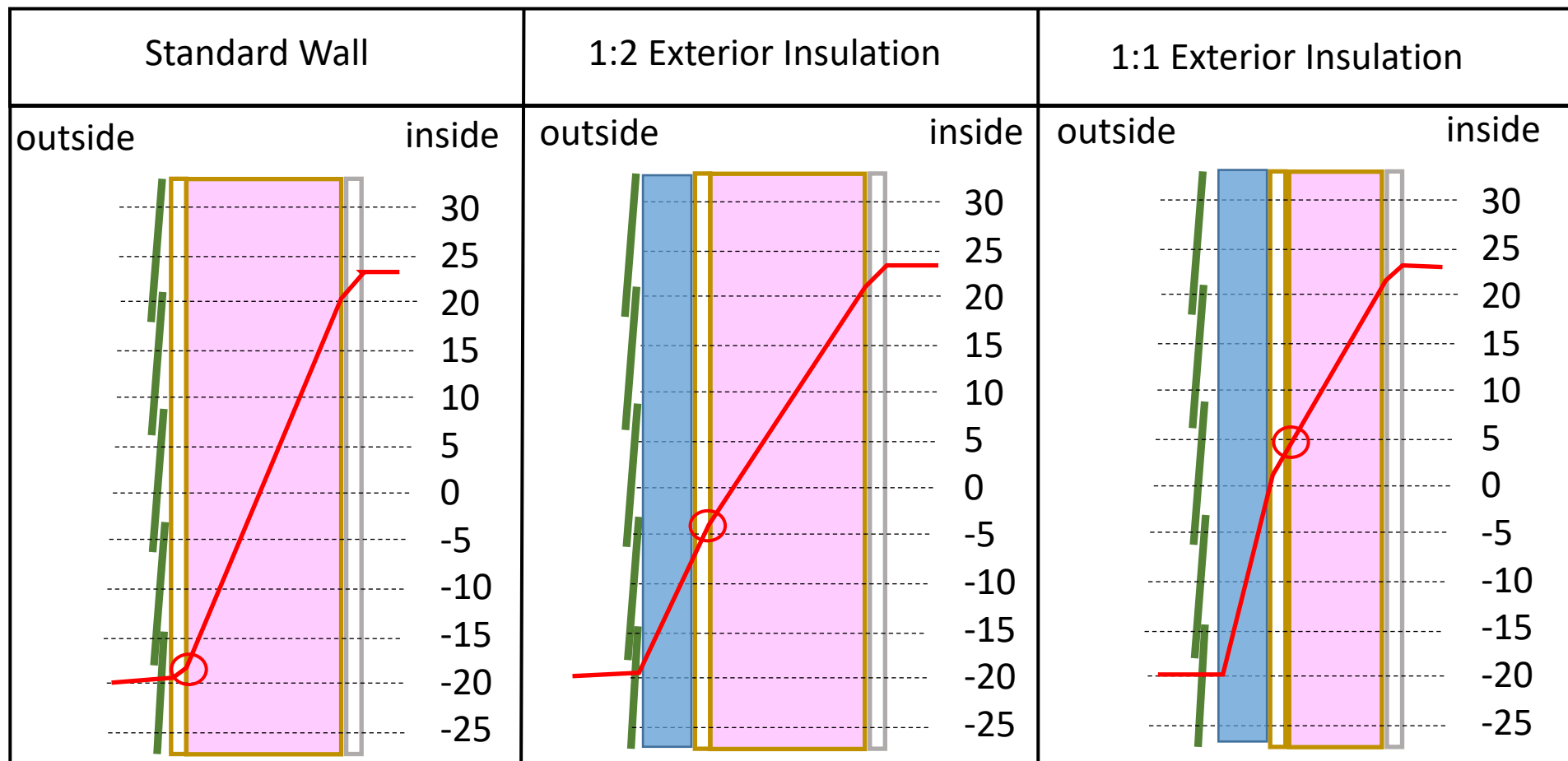




# Decreasing Interstitial Condensation

- 1) Reduce vapour flow into wall
  - Easy- just install a vapour barrier
- 2) Reduce air flow into wall
  - Difficult- air barrier needs to be almost perfect
- 3) Decrease interior RH
  - Reduce moisture generation (over crowding)
  - Reduce interior RH with ventilation
- 4) **Increase surface temperatures**
  - Utilize exterior insulation strategies

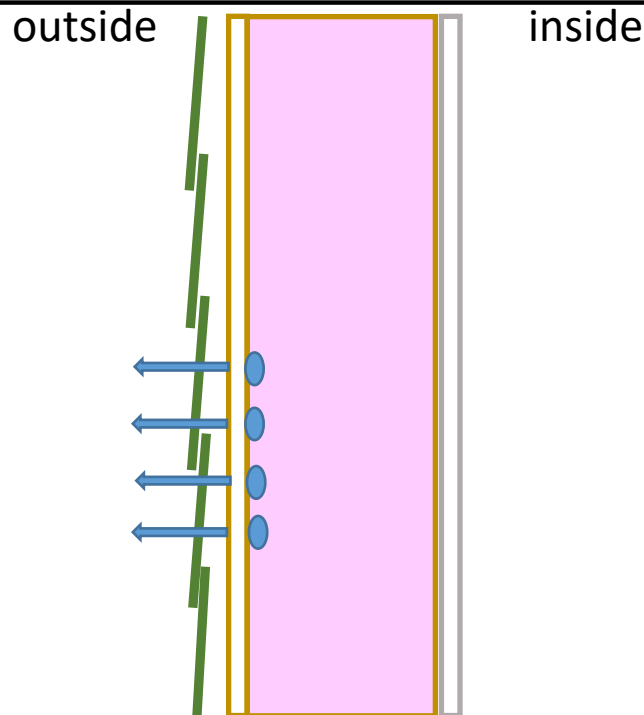
# Increasing Surface Temperatures with Insulation



# What if you don't use enough exterior insulation?

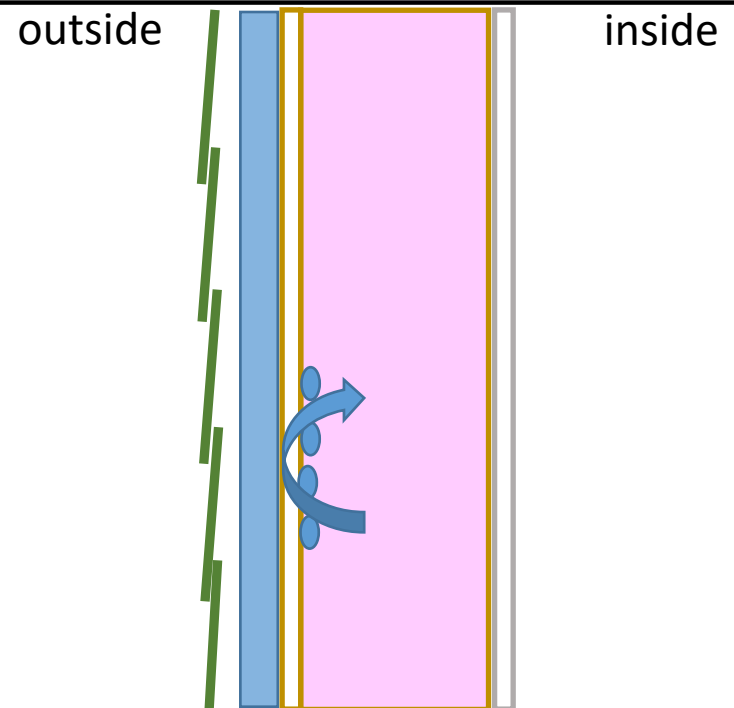
## Standard Wall-

- Condensation occurs
- Can dry to the outside



## Wall with foam board ext. insulation-

- Condensation can still occur
- Double vapour barrier- can not dry readily to the outside



# Measuring Moisture Content

Monitoring Standard Wall in Nunavut

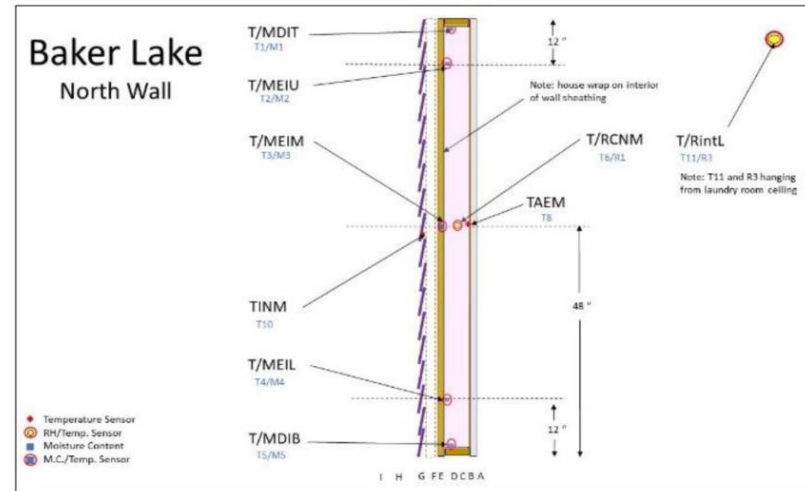


Figure 3- The wall system and monitoring sensor positions for the wall in Unit A

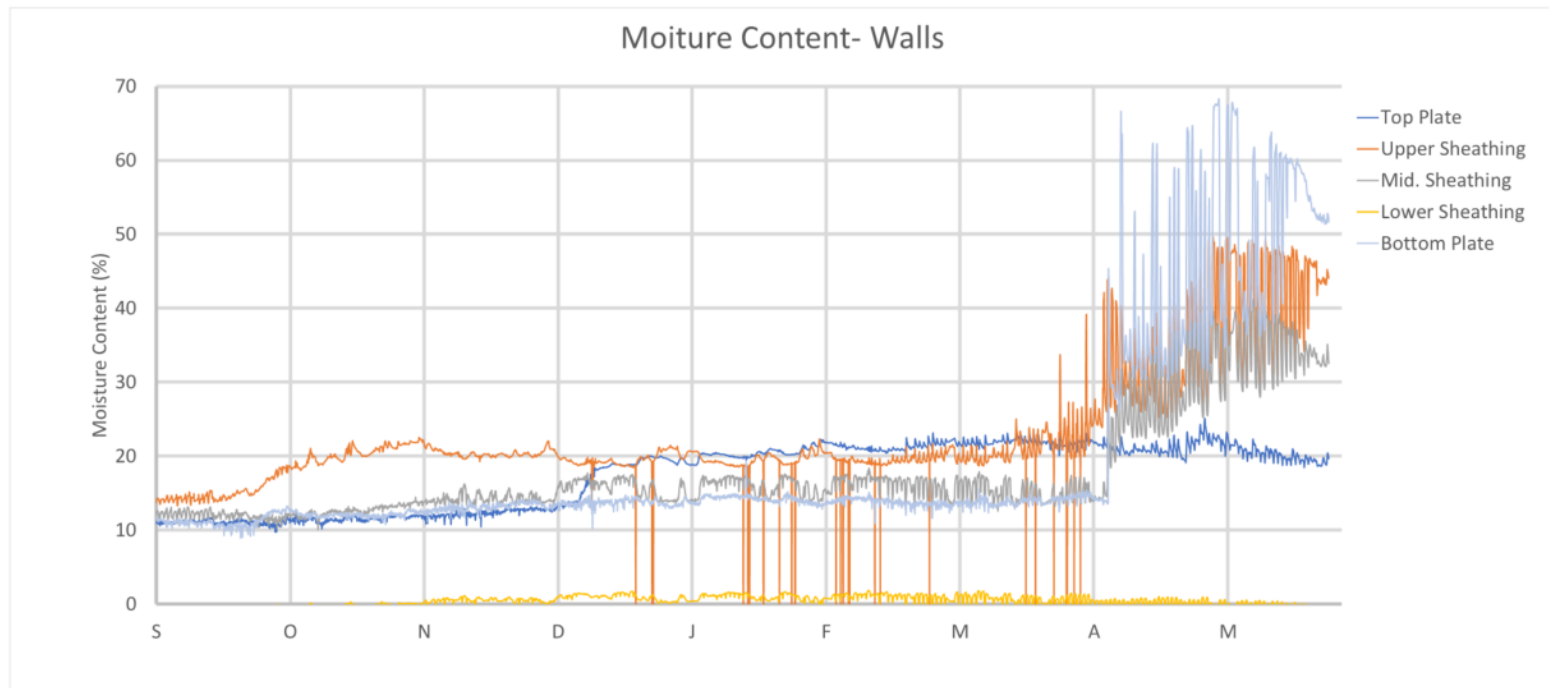
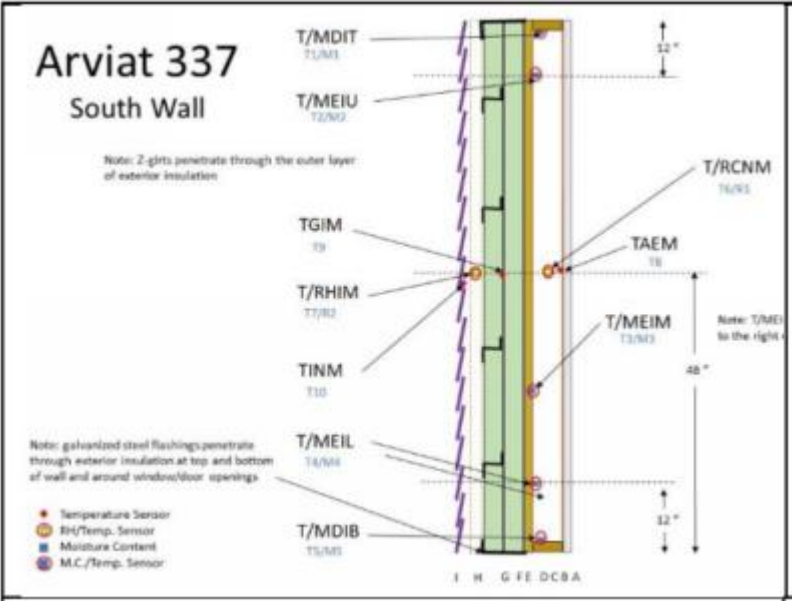


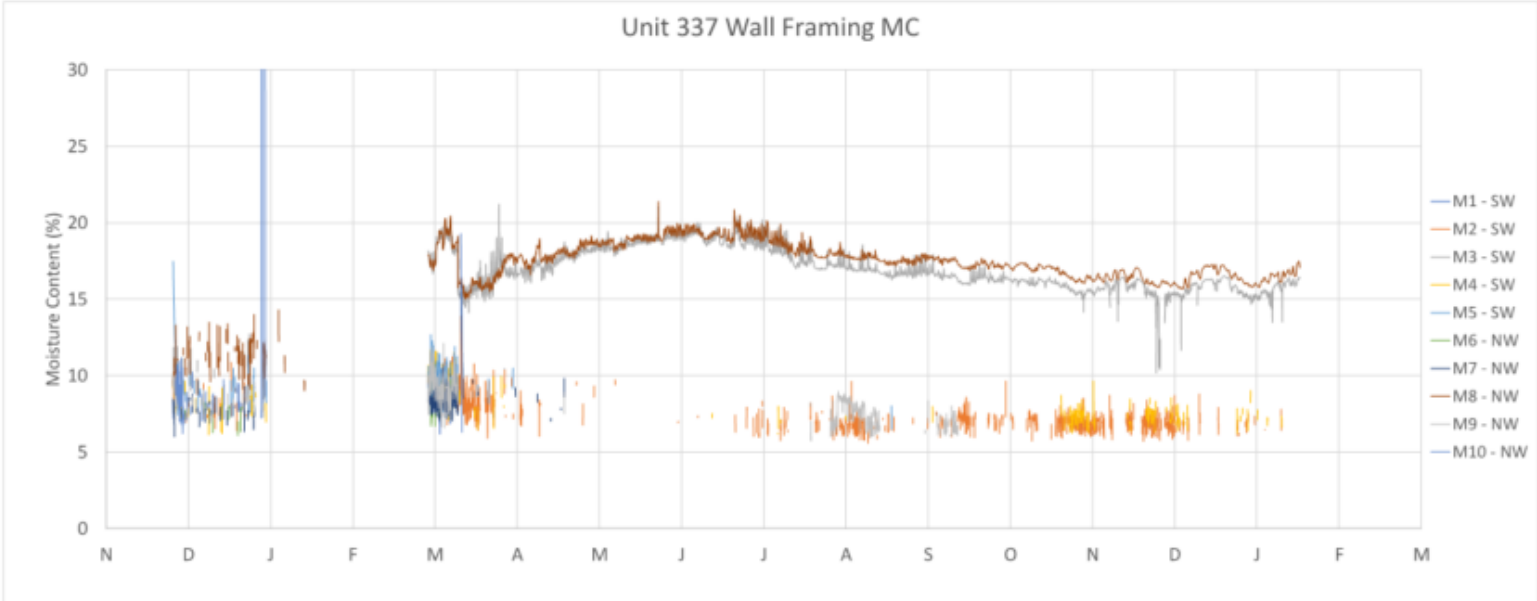
Figure 8- Measured wall framing moisture content for the wall system in Unit A

# Measuring Moisture Content

Monitoring Exterior Insulated Wall in Nunavut



## Wall Framing Moisture Content:



# Determining Appropriate Assemblies with Modeling

- Models should be validated with measured data before using them to make critical decisions
- Research is required to determine the appropriate conditions and material properties to use in the models
- Test hut and/or occupied unit enclosure monitoring is still required to validate the models



# How to Determine the right amount of exterior insulation

- Dew point analysis is an over-simplification
- Hygrothermal modeling can help
  - Still need to understand:
    - Climate
    - Interior Conditions
    - Air-tightness of the building
    - The materials within the assembly
    - Properties of those materials
- Beware of GIGO!

# Analysis

Using WUFI 5

Developed and validated  
with funding from NRCan

# Project/Case: Wall Types 2, 3 and 7/PIC Wall-Mid RH

Assembly/Monitor Positions

Orientation/Inclination/Height

Surface Transfer Coeff.

Initial Conditions

Layer Name

Thickn. [m]

Fibre Glass for thesis

0,1397

Exterior (Left Side)

Interior (Right Side)

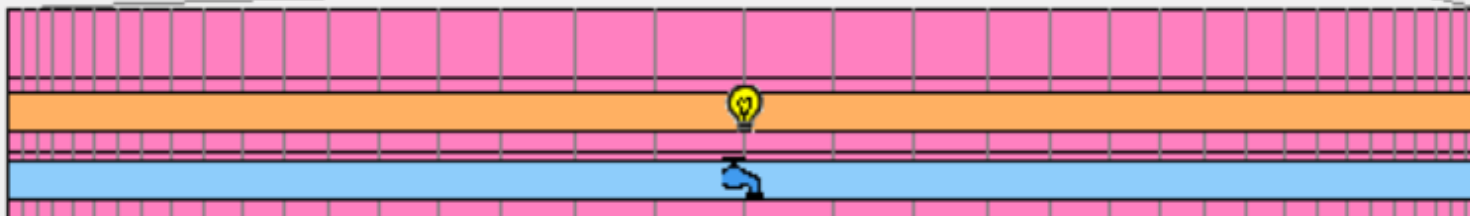
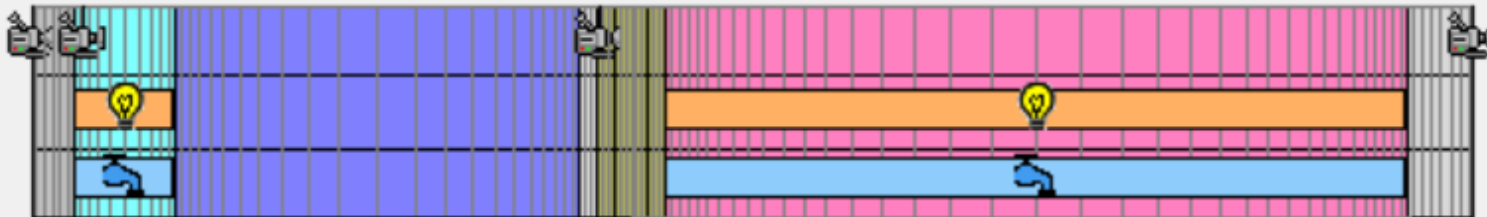
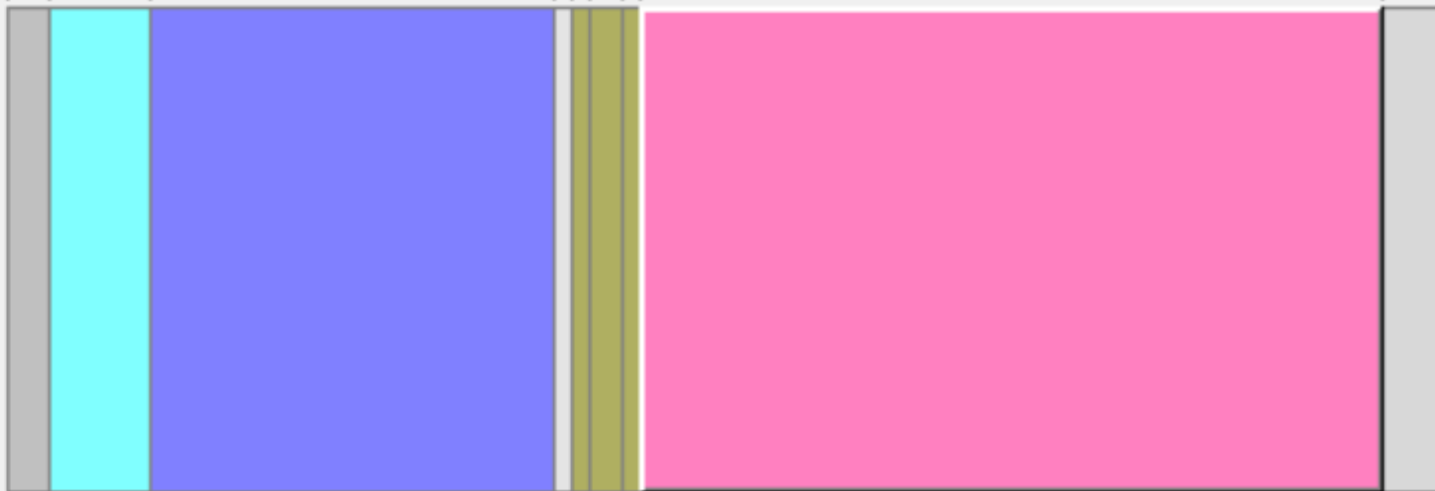
8E-0019

0,0762

236,3E-3

0,1397

0,0125



Material

Sources

New Layer

Duplicate

Delete

Edit Assembly by

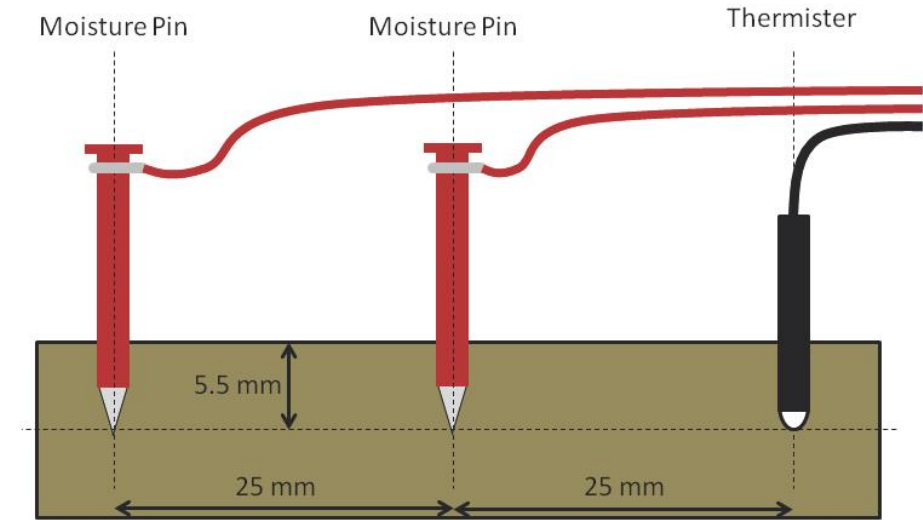
Graph

Table

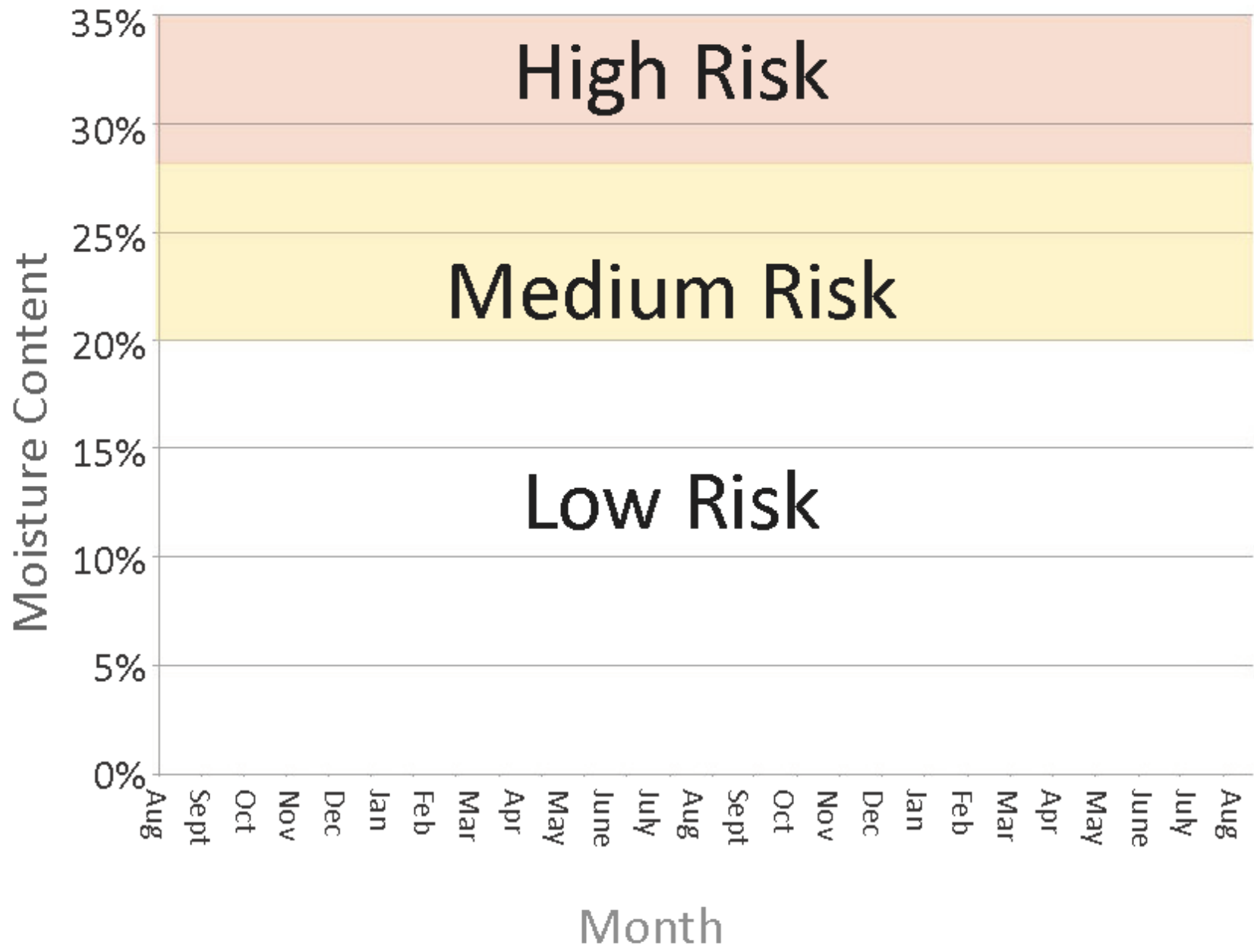
# The BEG Hut



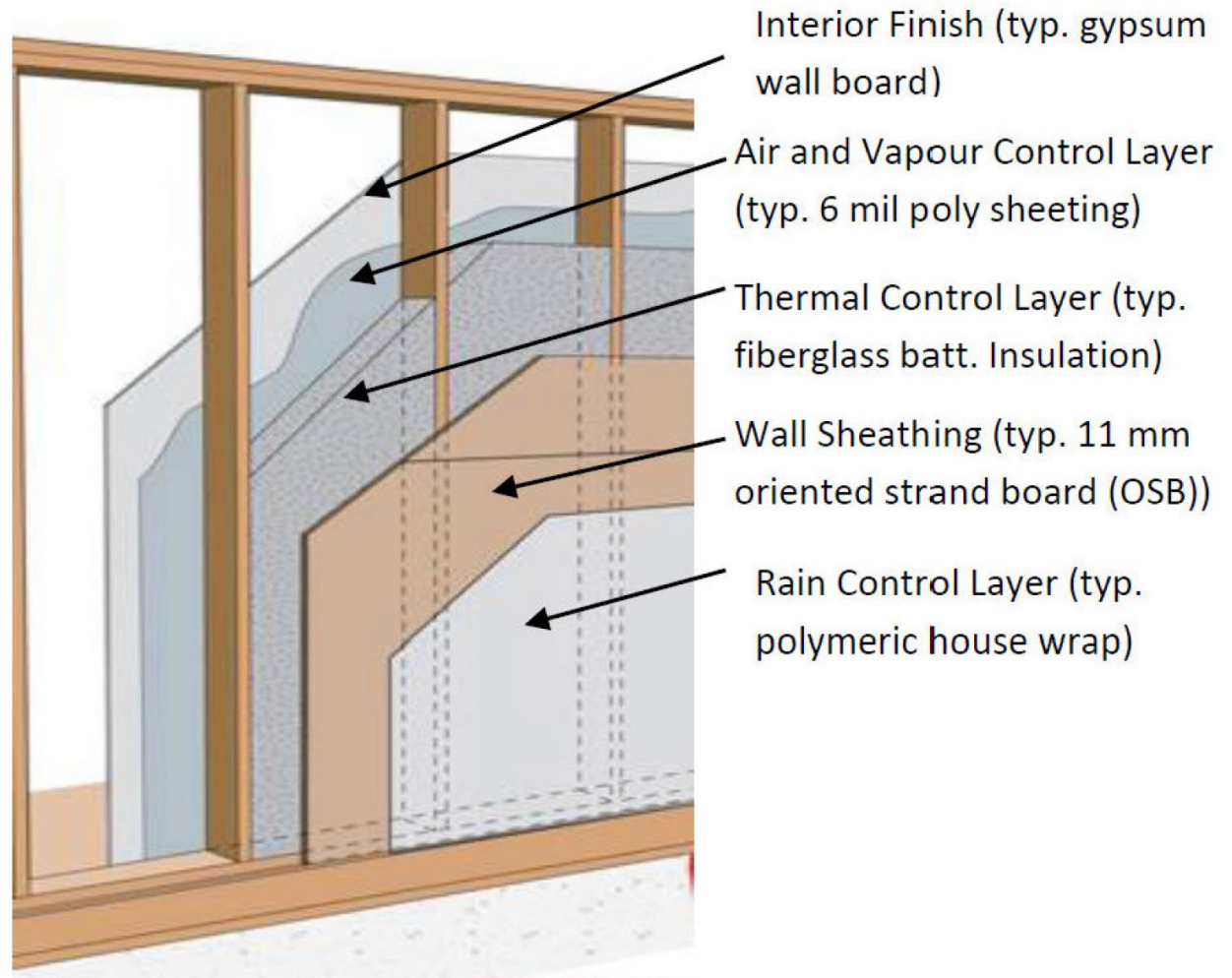
Validated against two years of  
measured data



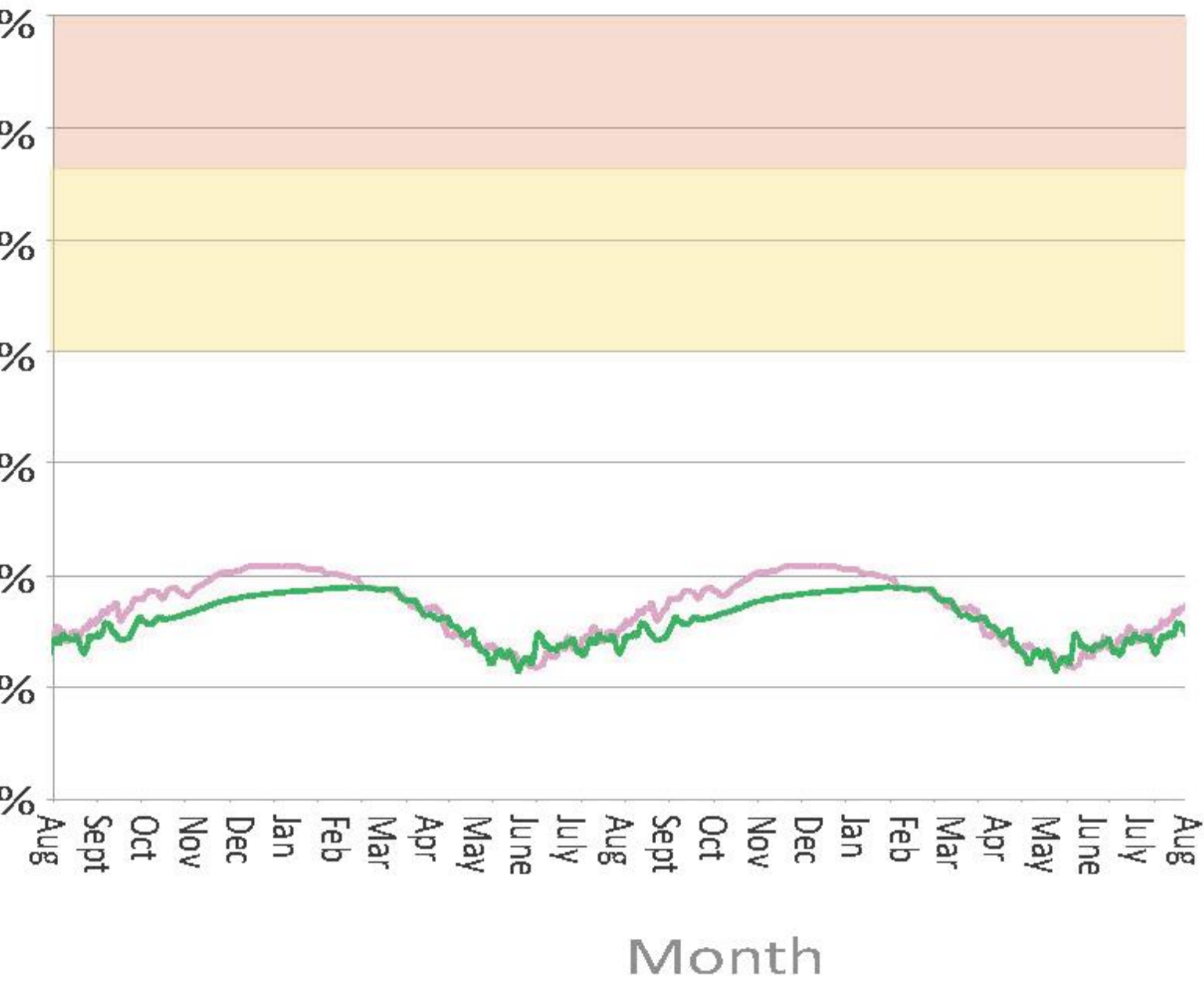
Using moisture content of the sheathing as a measurement of durability and mould growth potential





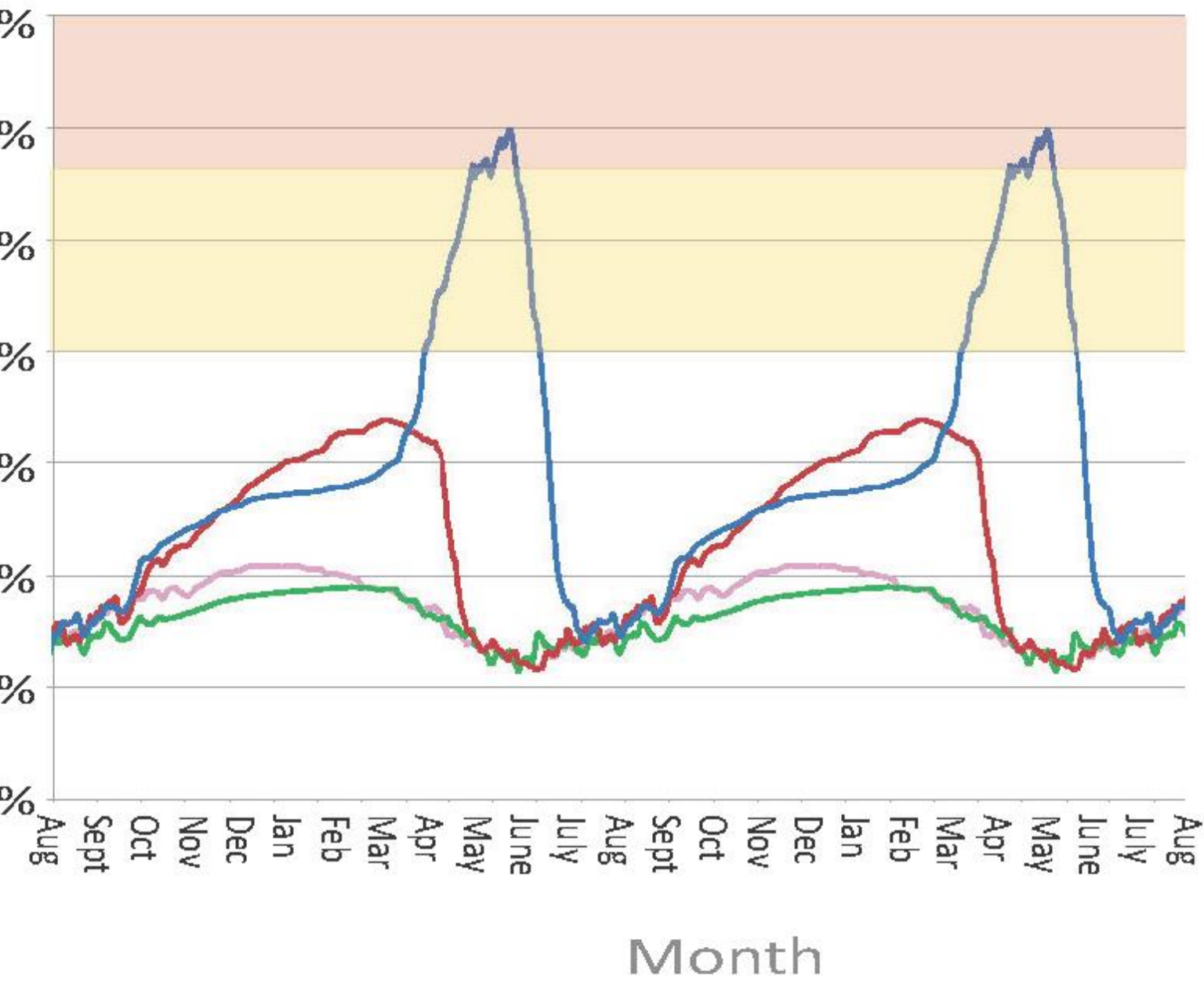


# Building Code “Standard Wall” 2x6 Wall with R-22 Batt Insulation



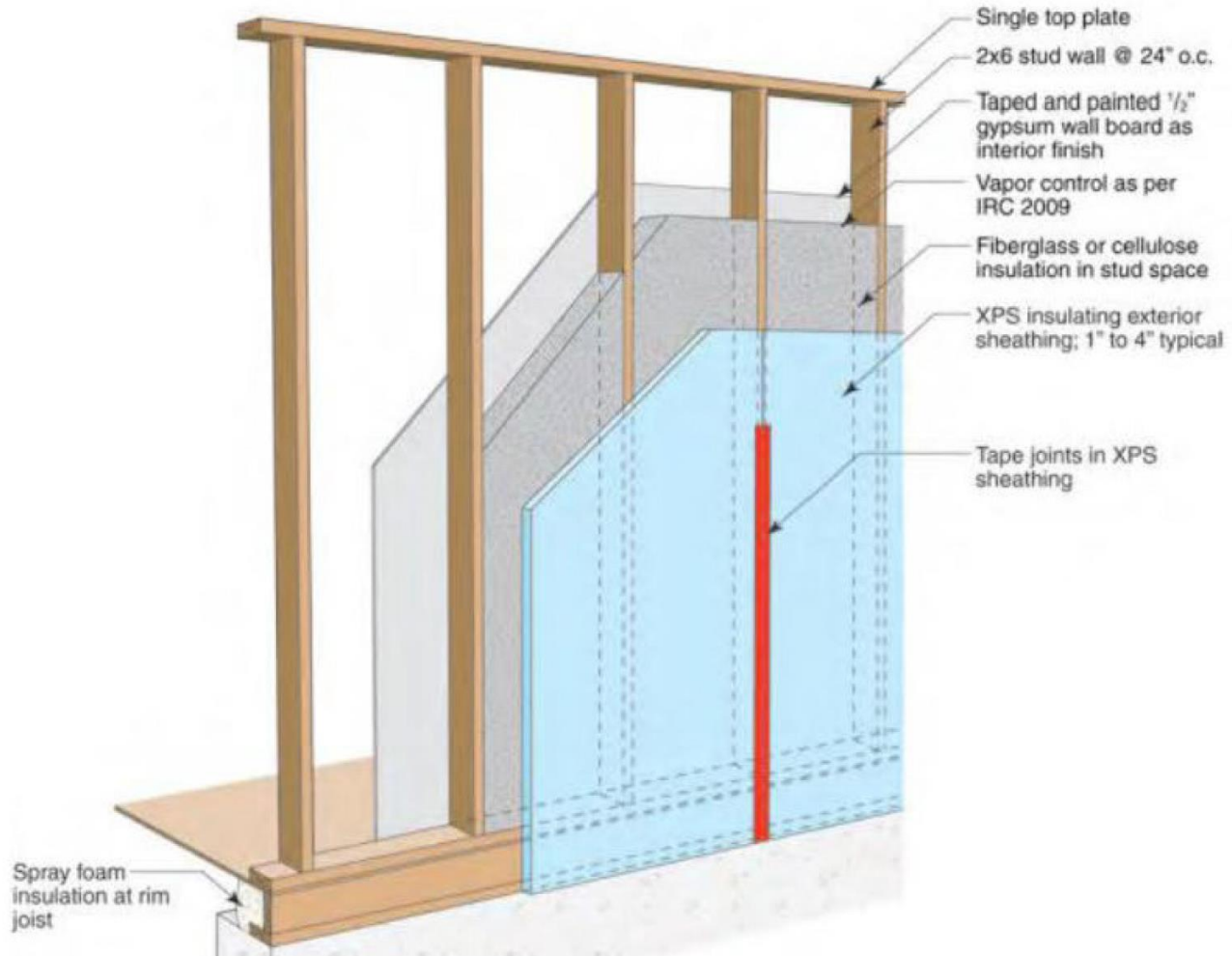
“Stand  
Wal

- Kasheer  
Air-Tig
- Toronto  
Air-Tig

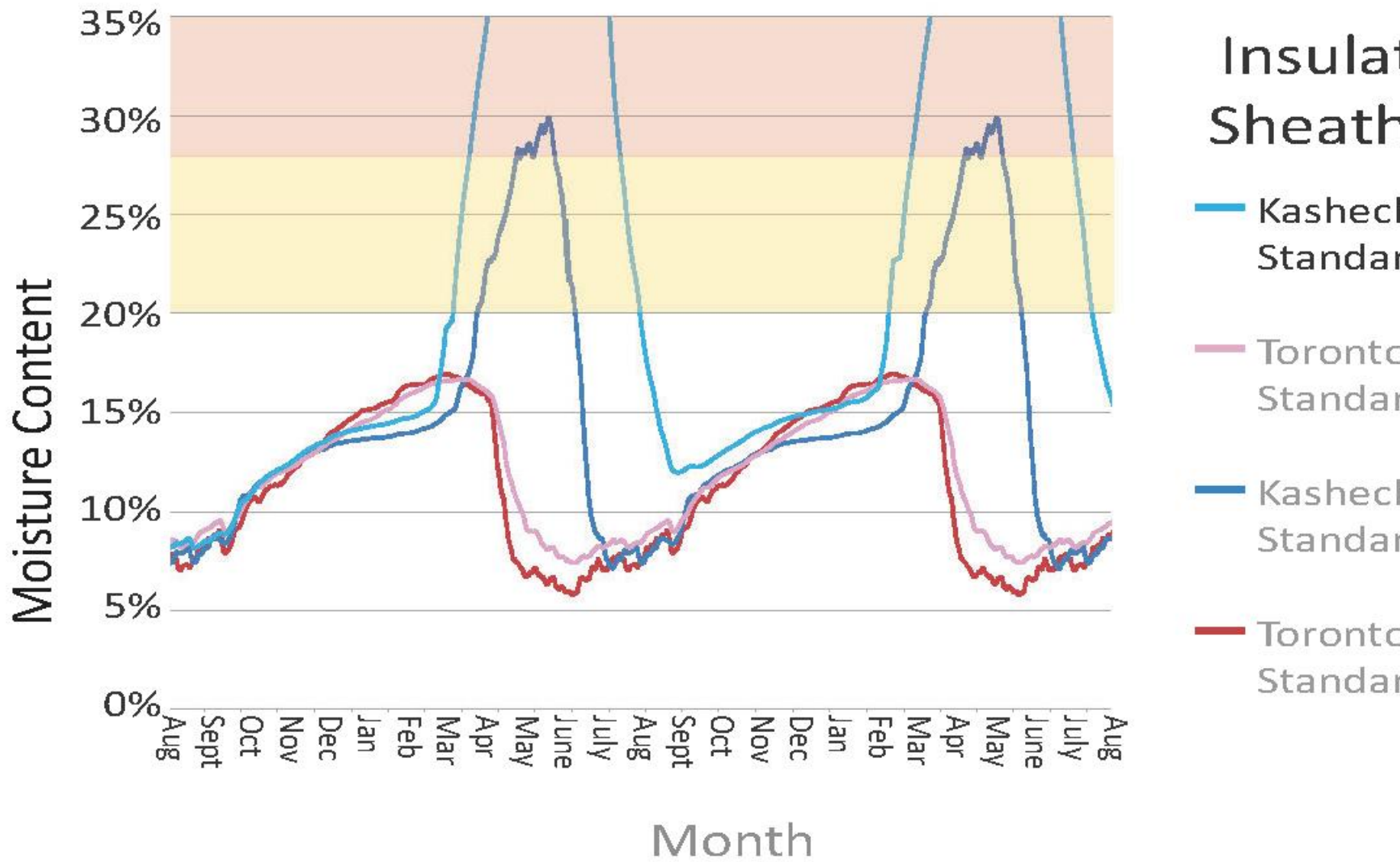


“Stand  
Wal

- Kasheer  
Air-Leader
- Toronto  
Air-Leader
- Kasheer  
Air-Tiger
- Toronto  
Air-Tiger



“Standard Wall + R5”  
1” Exterior Foam Sheathing

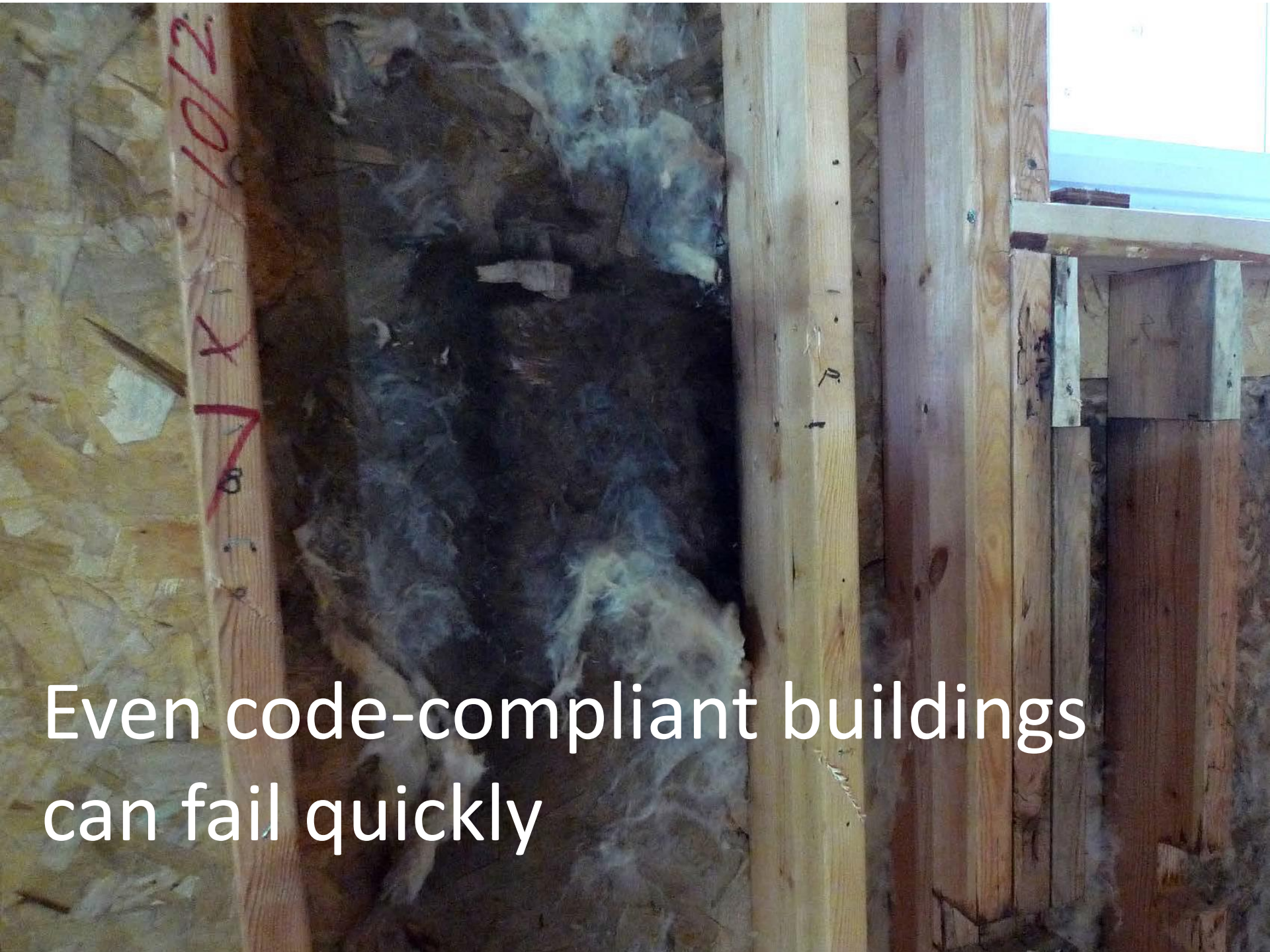






An insulated sheathing wall that works well in Southern Ontario may work in the North





Even code-compliant buildings  
can fail quickly

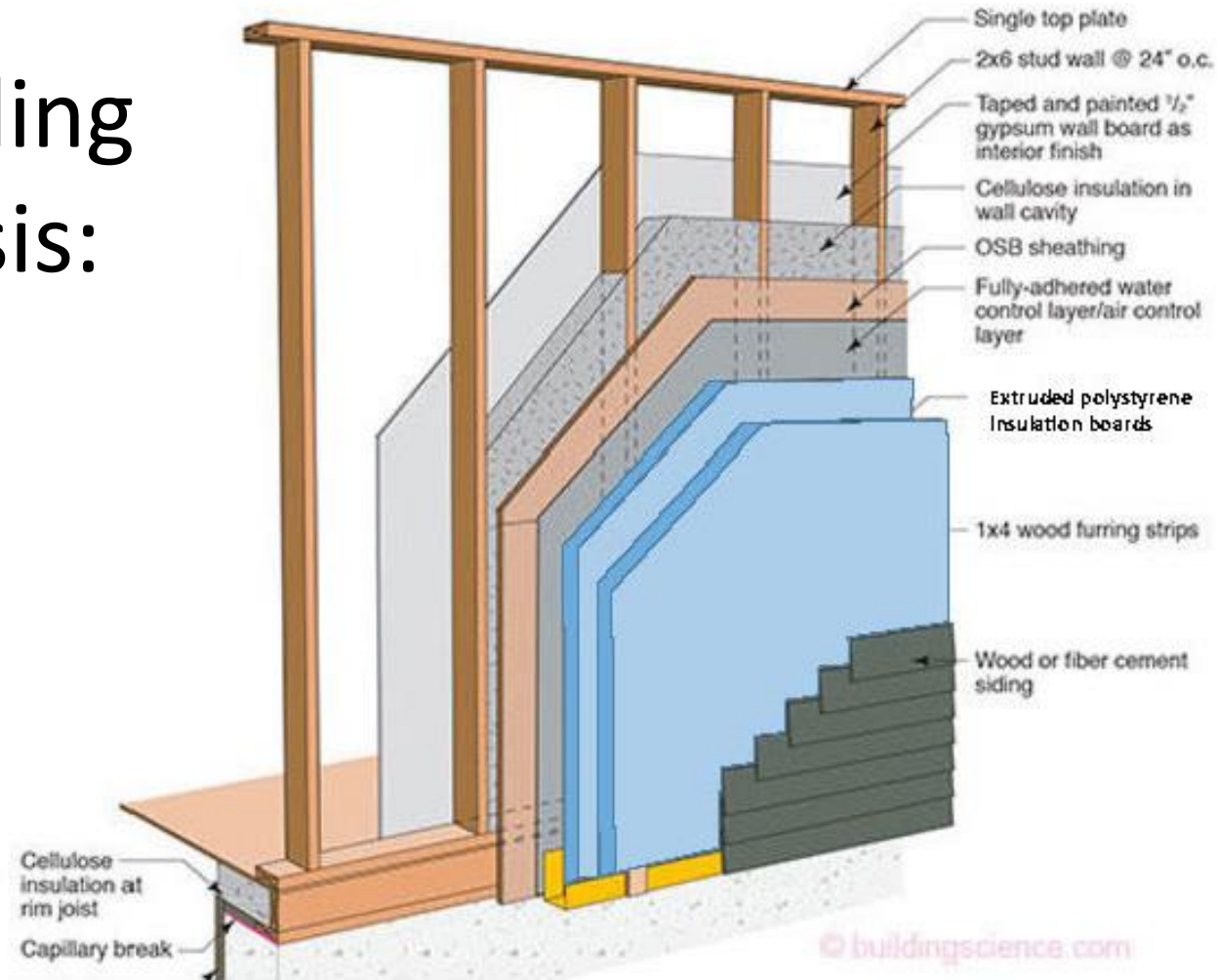


Even Building-Code Compliant  
Housing will fail quickly

We can use models to develop  
more appropriate assemblies



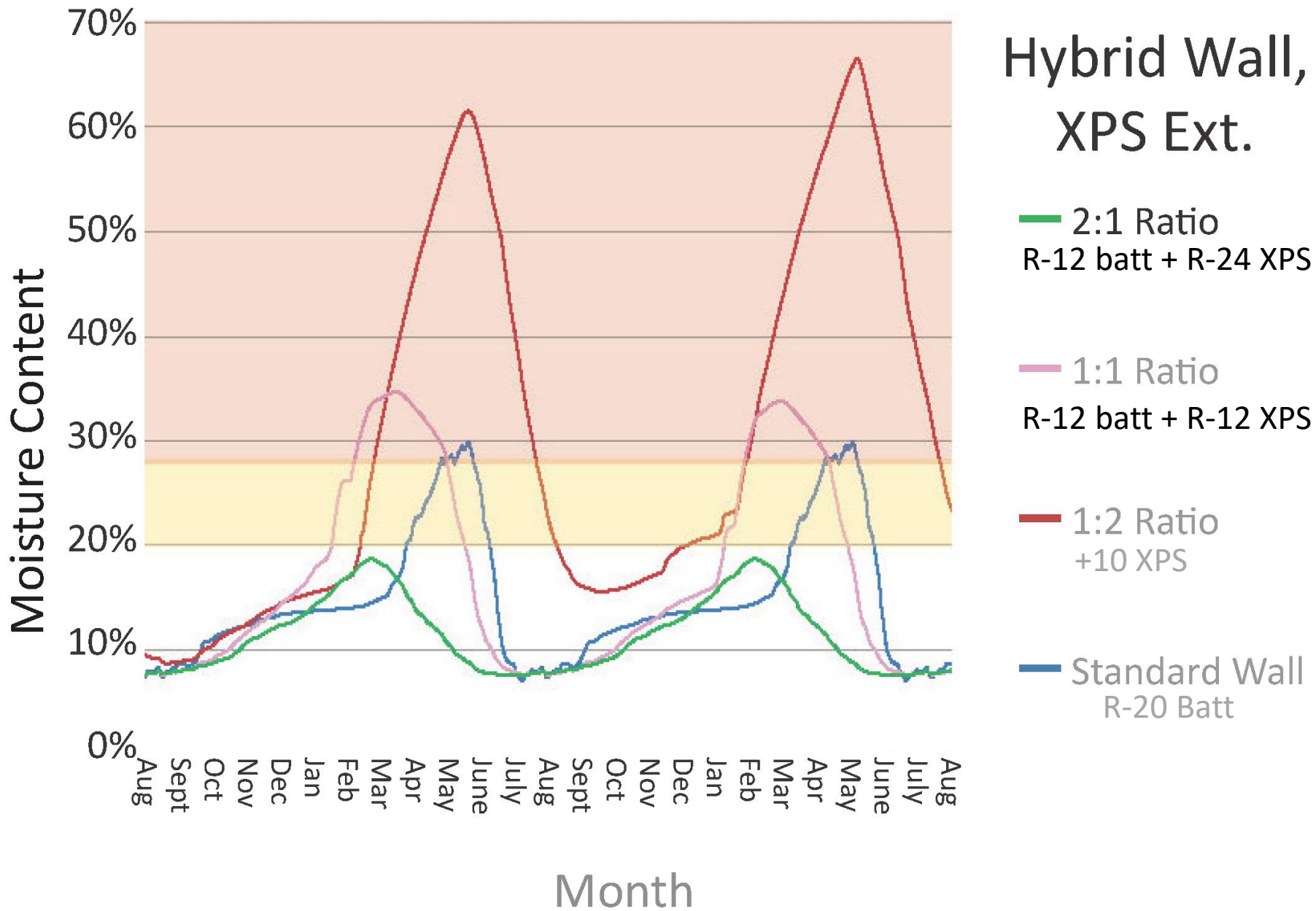
# Modeling Analysis:



## “Hybrid Wall”

2x4 or 2x6 Frame; Batt + Ext. Ins.

# Hybrid Wall, XPS Ext.



# Summary/ Conclusions

- Building science has a critical role to play in the future of northern Indigenous housing design and construction
- While the fundamentals are well understood, there is still much to be understood regarding the specific challenges, limitations and execution
- Ultimately, there needs to be a merger of building science and local, traditional knowledge



# Summary/ Conclusions

- There is much work to be done, and few who are qualified to do it
  - Research
  - Consulting
  - Education
- There seems to be a renewed interest in this area and significant funding available for research and development



# Questions?

Please feel free to contact me directly:

Trevor Trainor  
Building Science Researcher  
RDH Building Science  
[ttrainor@rdh.com](mailto:ttrainor@rdh.com)