SMT Building Performance Sensor Installation

Project Name: The Living Home
Website: http://www.thelivinghome.ca
Location: Lethbridge, AB
Sensor and Equipment Installation: Dec 2008

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Document History	
Description	**Date**
Release Initial Version	January 26th, 2009
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Introduction

The mission behind *The Living Home* project is to improve residential home design to reduce environmental impact and enhance life-quality. The basic concept is to enhance quality of life in the home and community, while minimizing the environmental impact of the construction, maintenance, and operation of a single-family residential home using proven, economic, and accessible construction practices and technologies.

While improving the design for quality, comfort and environmental impact, care must be taken to ensure the home is protected from moisture damage and leak accidents. Undetected moisture leads to mould accumulation and possibly rework or remediation undermining efforts to reduce waste.

SMT has installed moisture sensors and leak sensors in various areas in the Living Home and is presently gathering data and analyzing these parameters to study the effectiveness of the design and construction.

Due to the flexibility of the SMT data acquisition system, a number of other sensors were deployed in the Living Home in order to assess thermal effectiveness and pressure differential.

Leak Detection in Wall Cavities

Linear Detection sensors were embedded in the wall cavities under the Icynene insulation in order to detect moisture penetration as shown in Figure 1. Linear detection sensors were installed in areas susceptible to moisture intrusion, such as below windows and base zones.

Linear Detection Tape

Figure 1. Linear Detection under Icynene Insulation

The SMT Wireless Data Acquisition (WiDAQ) unit monitors Linear Tape sensors and records a value between 100Ω and 1GΩ upon the detection of liquid water across the sensor. Data is transferred to the SMT Building Analytics monitoring server where the data is converted to a moisture level giving an indication of the level of water accumulation.

Moisture readings are sampled and reported every 15 minutes.

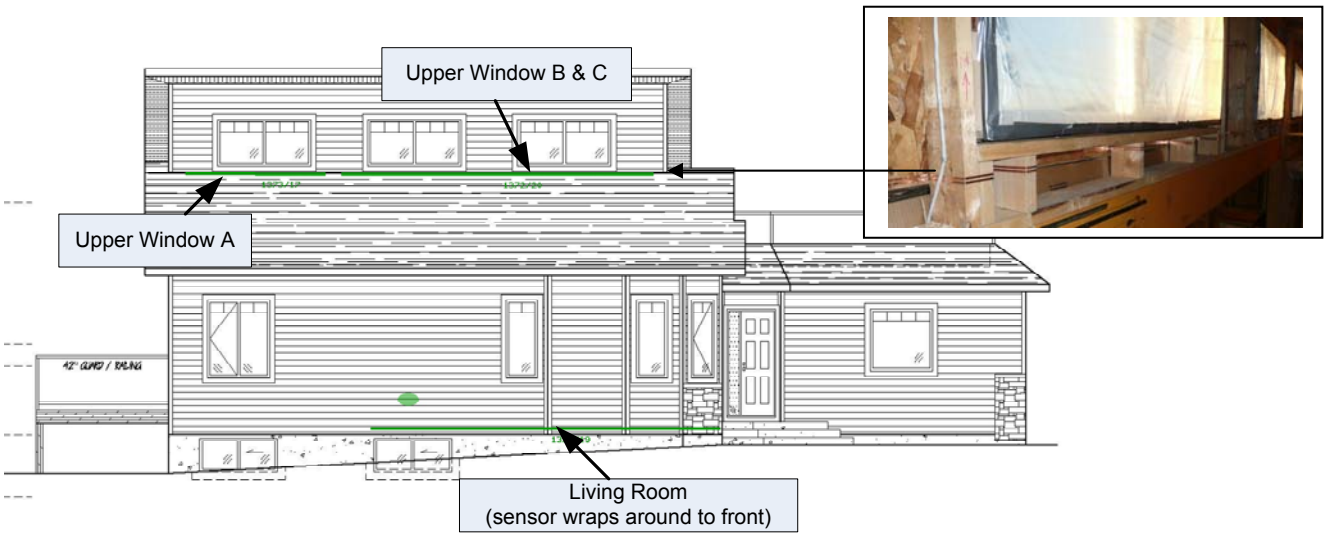


Figure 2. Linear Detection Sensor Locations

Leak Detection in Wall Cavities

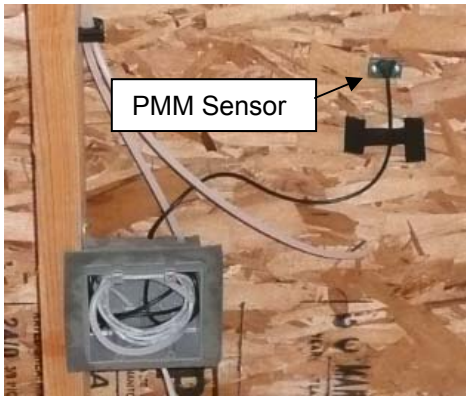


Figure 3. PMM and pressure tubing

Point Moisture Measurement (PMM) sensors were installed on all wall facings, as shown in Figure 5, in order to record the moisture absorption properties of the wood itself. Using the integrated temperature sensor, resistance readings are converted to moisture content using temperature compensation and wood species compensation.

The WiDAQ monitors the PMM and records a value between 100Ω and 1GΩ every 15 minutes. The Building Analytics software converts this into moisture content and displays a value between 8%MC and 45%MC. Values greater than 28% MC are wet and are susceptible to sustained mould growth as illustrated in Figure 4.

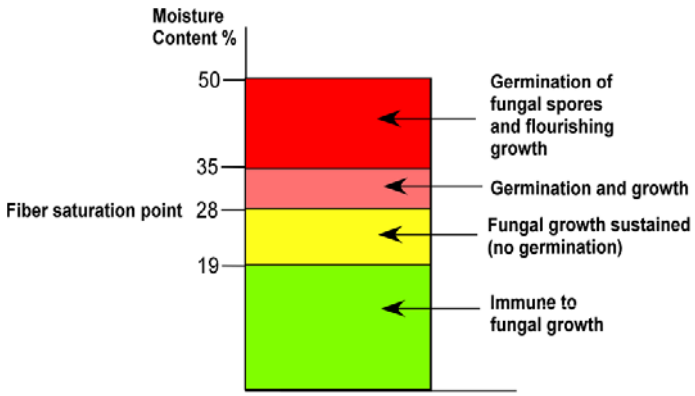


Figure 4. Fungal Growth in Wood (CMHC)

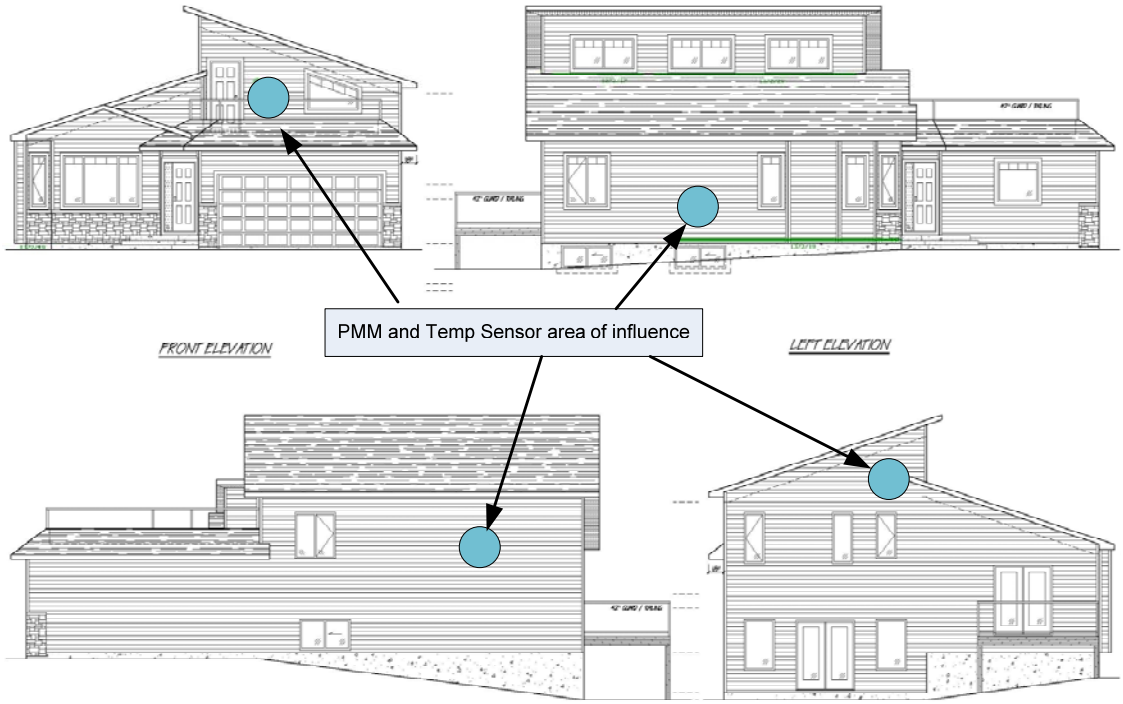


Figure 5. PMM sensor locations

PMM Overview

General Description

The Point Moisture Measurement (PMM) Sensor is used to perform a direct contact measurement of moisture content in a material susceptible to moisture absorption. The PMM can be used to sense the moisture content of wood or moisture level of gypsum, concrete or masonry.

The design of the PMM ensures moisture probes are spaced apart consistently and contains an integrated temperature sensor for temperature correction of moisture content readings.

Sensor data is transported to the Building Intelligence Gateway where temperature compensation and wood species correction factors are applied.

Features

1. 3.5mm Audio Interface interfaces to SMT Mobile WiDAQ unit.
2. Leaded version interfaces to SMT Industrial WiDAQ unit.
3. Sealed and rugged design allows for deployment in harsh construction environments
4. Built in temperature sensor allows for temperature compensation.
5. Temperature data is transmitted and recorded along with Moisture Content Data
6. Low profile design allows for easy deployment.

Leak Detection

Linear detection tape was installed in areas prone to leaks due to hot water tank leaks, sump pump failure, washing machine overflow, kitchen sink leaks etc. As shown in Figure 6 and Figure 7 the tape circumvents the test area.

WiDAQs that monitor flood zones continuously sample and report the instance water is detected across the tape. In addition to continuous sampling, the WiDAQ sends it's regular "heartbeat" reading at the same frequency of the other sensors (every 15 minutes).

Figure 6. Hot water tank

Figure 7. Sump Pit

Figure 8. Analytics Screen shot showing Monitored Locations

Figure 9. Kitchen Sink

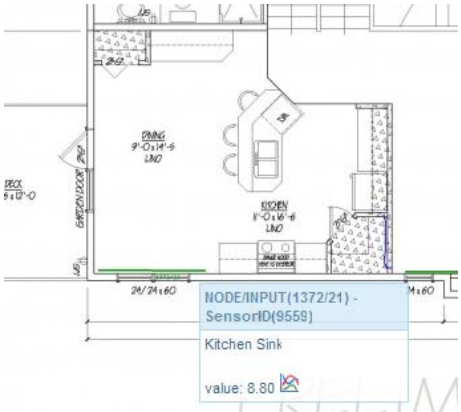


Figure 10. Analytics Screen Shot of Kitchen Sink Flood Zone

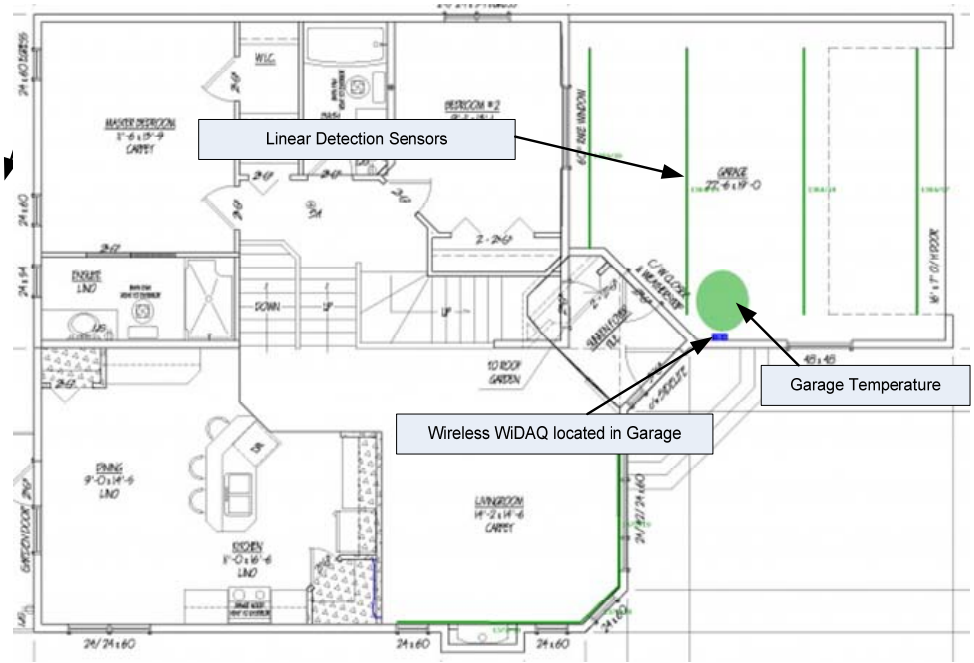
Green Roof Moisture Detection

The Living Home has a green roof located above the garage. Water is intentionally retained on the roof in order to sustain vegetation. Monitoring the roof for leaks is important as this roof is more susceptible to water intrusion due to the fact that water is intentionally retained. Also, finding a leak using a conventional method is expensive and often requires removal of the garden.

Four strips of linear detection sensors were installed from the bottom of the roof with the detection conductors facing towards the roof deck. This method is a unique method being field tested by SMT and is patent pending as of this article publication. Typical installations have the sensors placed from the top, these sensors are easily damaged due to their exposure to other trades during construction.

The WiDAQ monitors the Linear Detection sensors from under the green roof and records values between 100Ω and 1GΩ. The Analytics software converts this into moisture content and displays a value between 8%MC and 45%MC. Values greater than 28% MC are wet and indicate a potential leak.

Data is sampled and reported every 15 minutes. The WiADQ located in the garage is wireless and is battery powered. Batteries level is remotely monitored as well.



Pressure Sensors

The location of the Living Home is on the edge of a development with the back of the house facing a clear large field. Extreme winds often pound the house creating severe pressure fluctuations in the home. Pressure differential is an important factor to understand the direction of moisture flow throughout the building cavity as well as indoor air quality, dust ingression and fresh air intake.

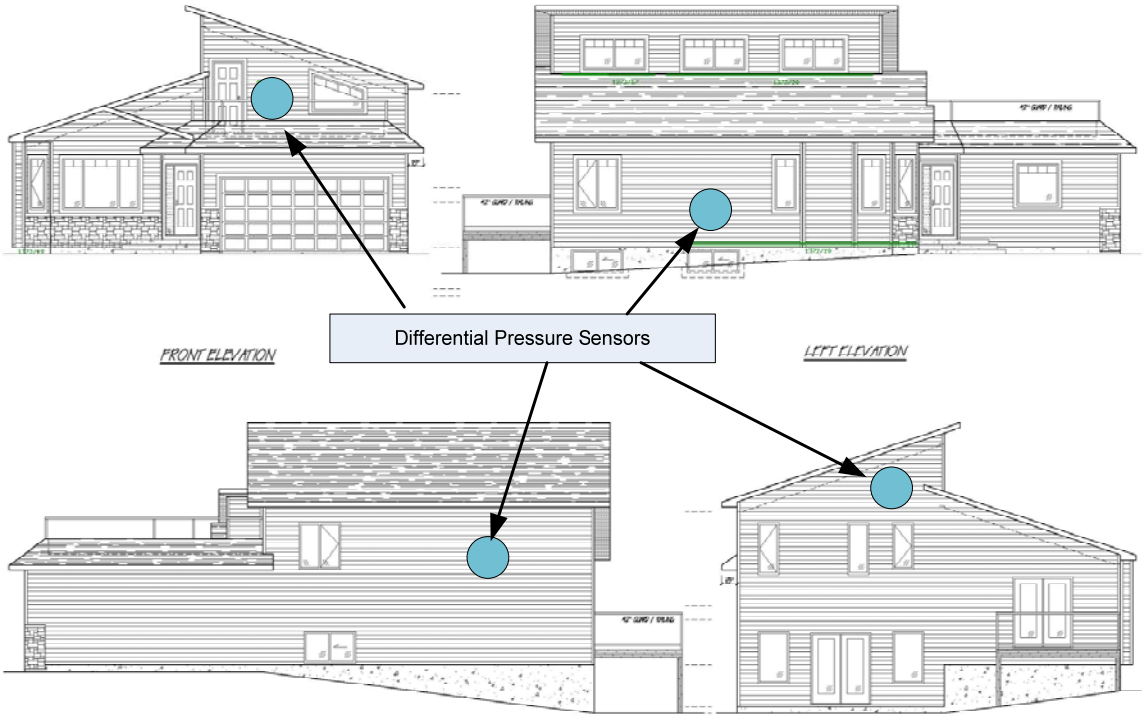


Figure 11. Pressure Sensor Locations

Figure 12. All Sensors Pressure Sensor

Pressure sensors used are the All Sensors 0.5 INCH-D-4V. Resolution is < 2Pa.

Pressure data is sampled every 10 seconds

Data Acquisition and Gateway

Sensors throughout the Living Home are wired to the utility room and connected to the Data Acquisition equipment (WiDAQs). Wired WiDAQs communicate over a Controller Area Network (CAN) bus and are powered. One of the four WiDAQs acts as a clusterhead and routes data from a wireless WiDAQ located in the garage to the gateway computer.

The devices used in the network from sensor to internet are shown below:

Sensors (PMM, Tape etc.) → Acquisition (WiDAQ) → Gateway (BiG) → Internet (Analytics)

Figure 13. WiDAQs and Building Intelligence Gateway Installed in Utility Room

Results and Data Analysis

Current data can be viewed by accessing Building Analytics from the following address:

Web Address: http://analytics.smt-research.com
Please consult SMT or one of the local administrators for userid and password.

Data from April 1st, 2009 to June 30th, 2009 is graphed below in Figure 14 to Figure 15. Each graph also has an inset showing more granular data for three to four days. Firmware upgrades and adjustments were made to the system that significantly improved its accuracy.

Sensors are grouped in the following categories

1. Moisture Content – PMM sensors
2. Green Roof Sensors
   - No significant wetting. Gaps are when batteries need replacement.
3. Flood Sensors
   - Living room is showing some constant wetting. Investigation is recommended.
4. Pressure Data
5. Temperature Data
   - Device temperature are temperature readings at the sensor locations
   - Other temperature readings are taken at the PMM location.

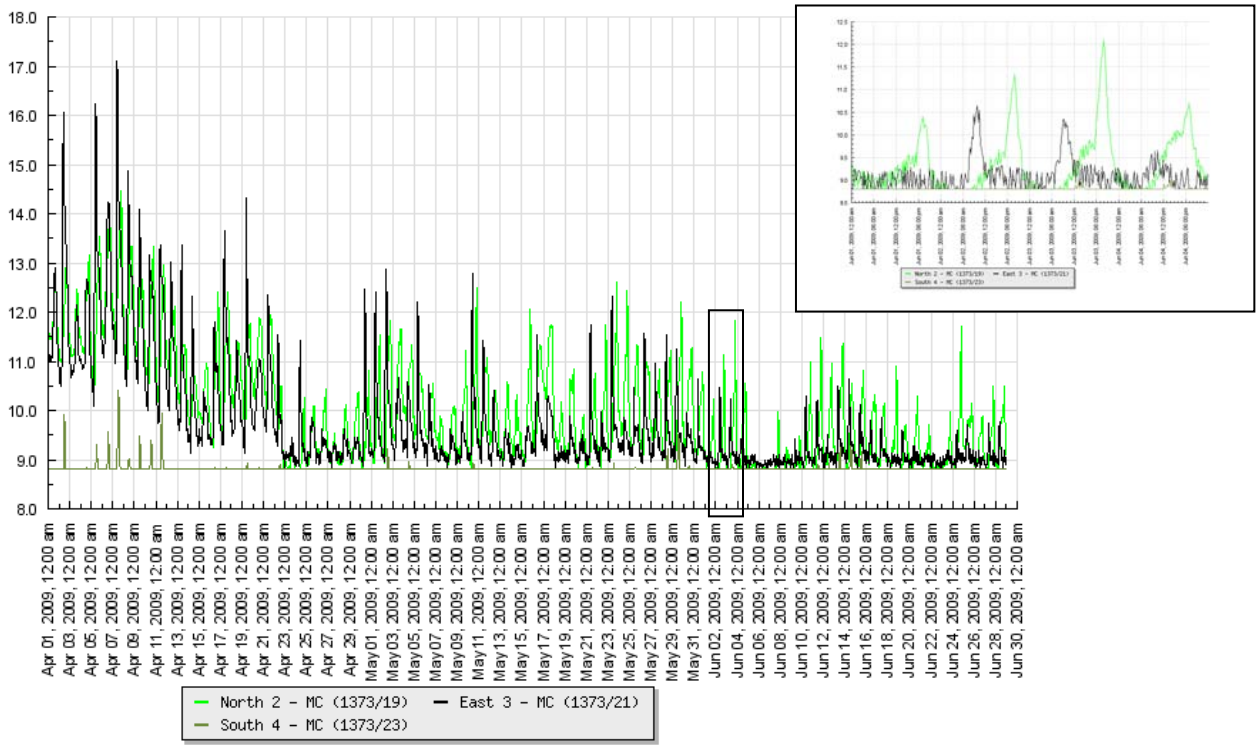


Figure 14. Moisture Content – PMM Zones

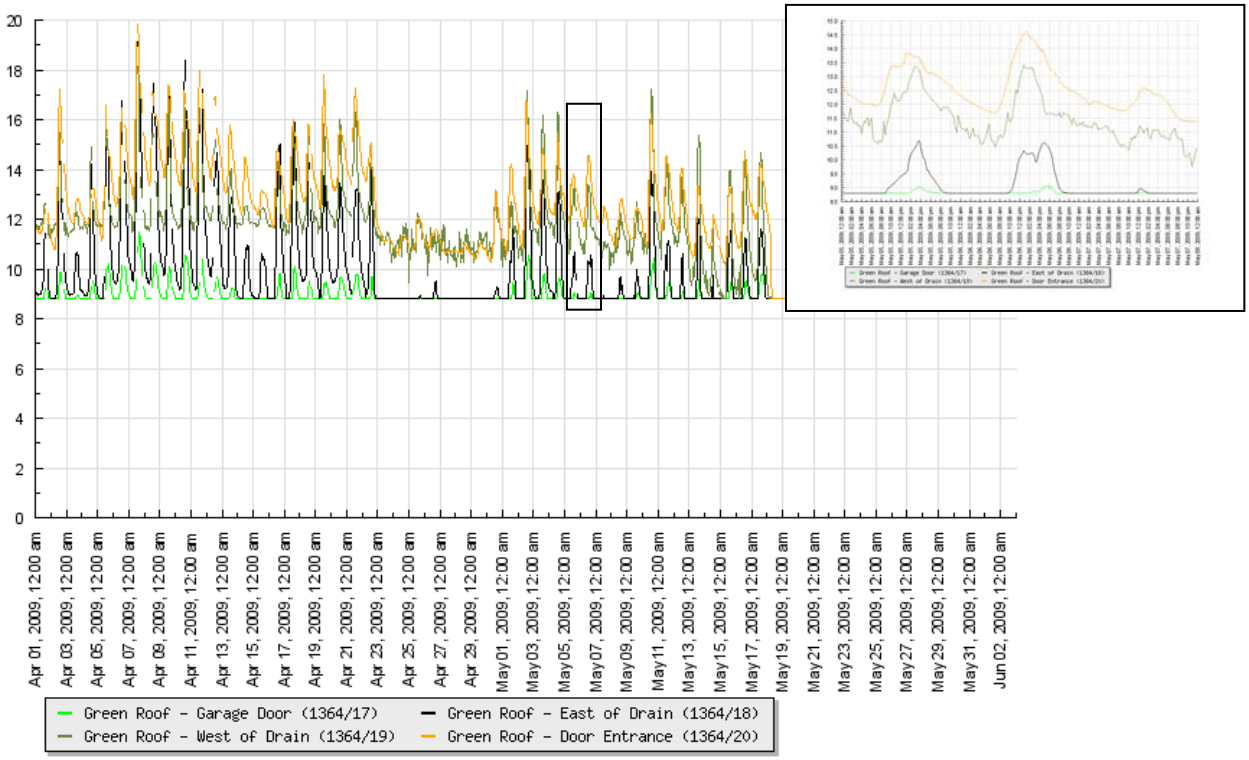


Figure 15. Green Roof

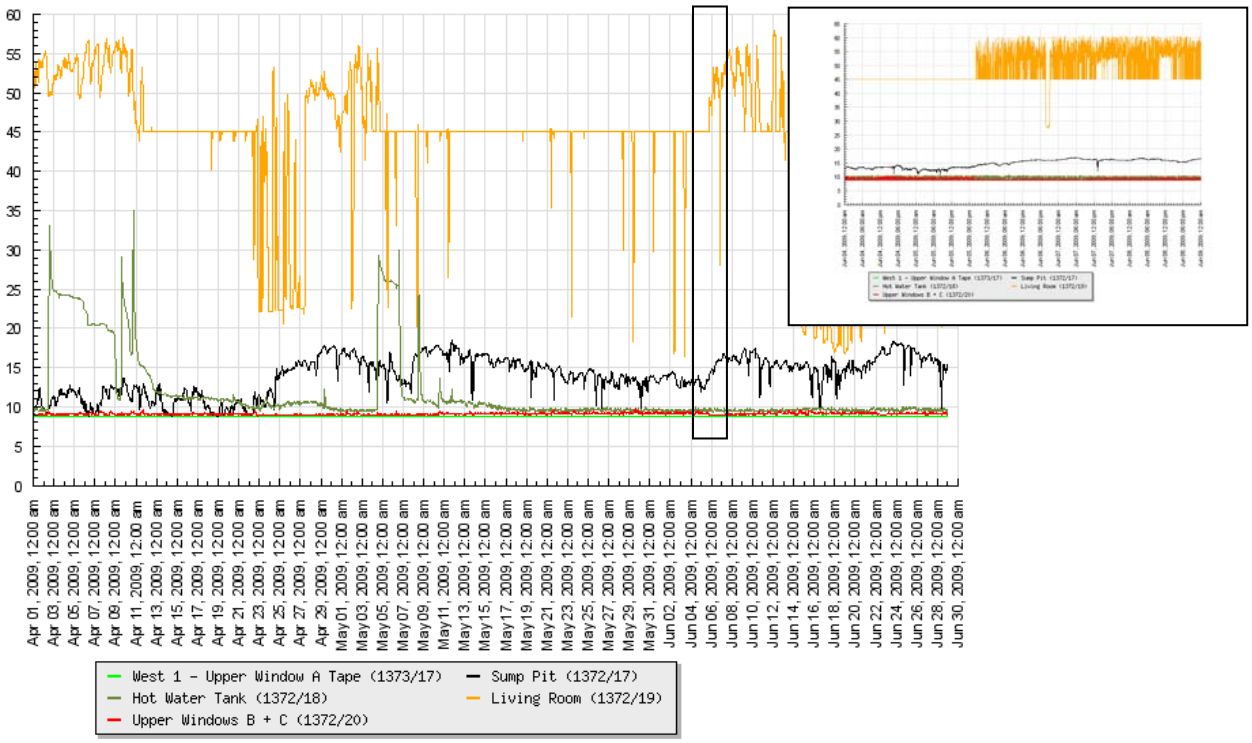


Figure 16. Flood Sensors. Sharp transitions are typically due to direct wetting of the tape

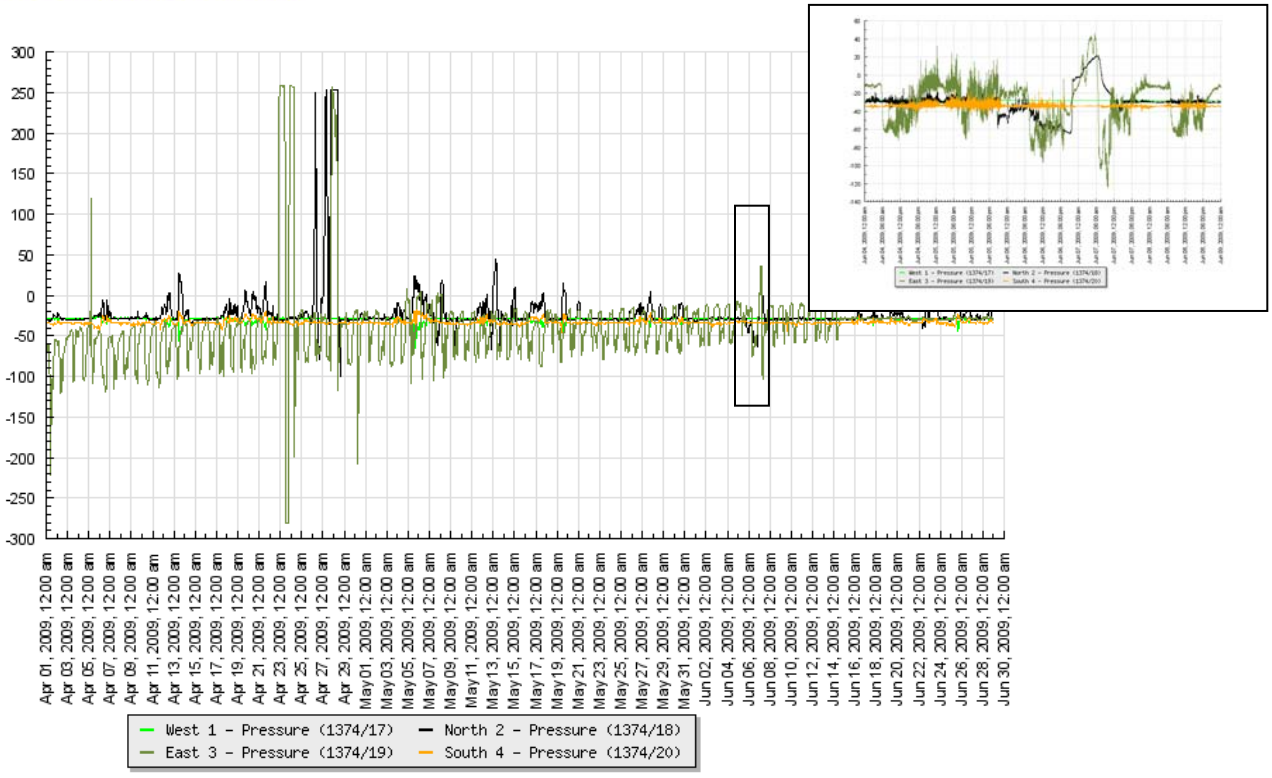


Figure 17. Pressure Data.

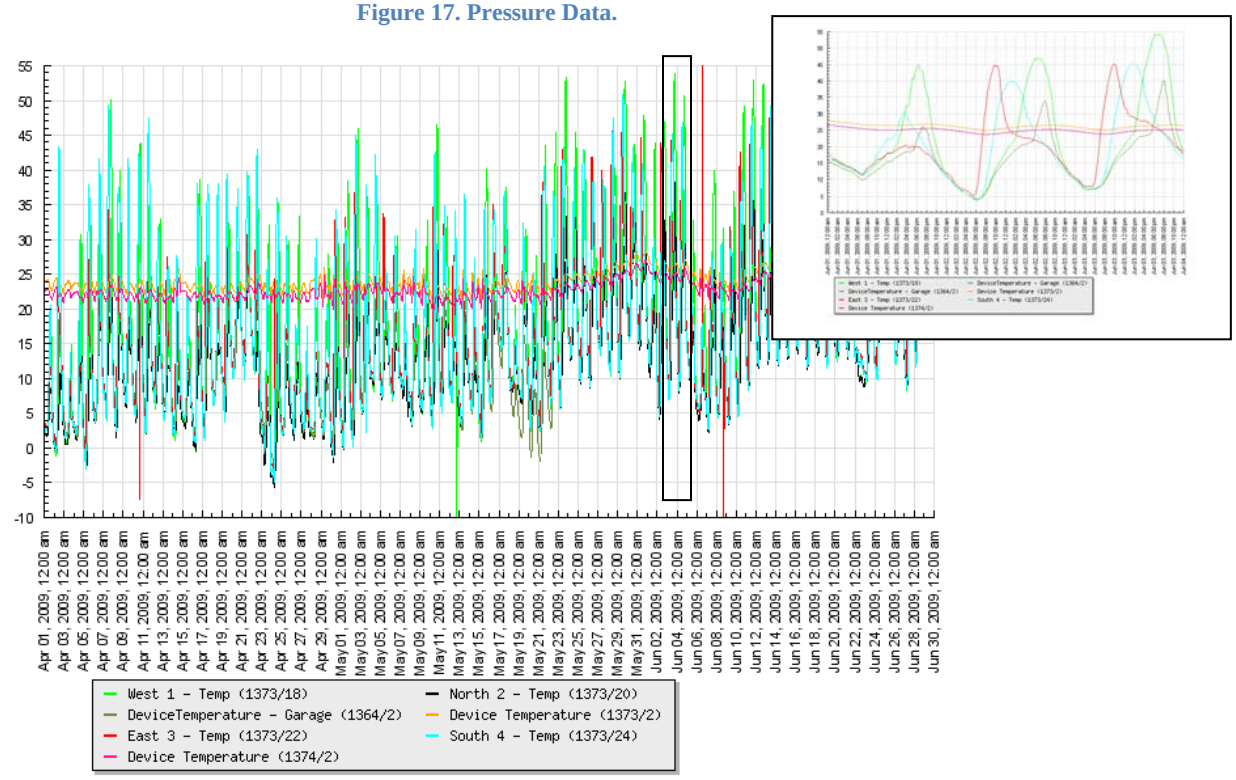


Figure 18. Temperature Data April to June 2009