Foundation Heat Transfer Modeling

John Shonder, ORNL

Foundations Experts Meeting
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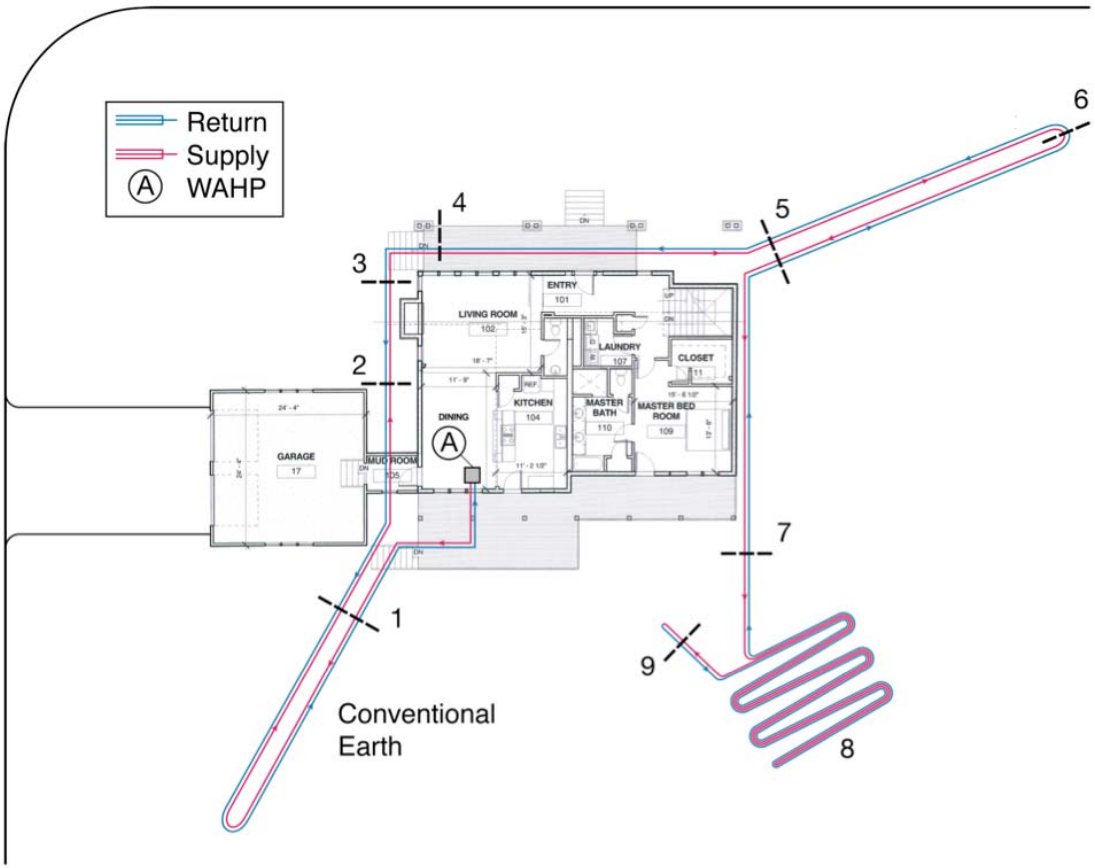
Managed by UT-Battelle
for the Department of Energy

OAK RIDGE National Laboratory

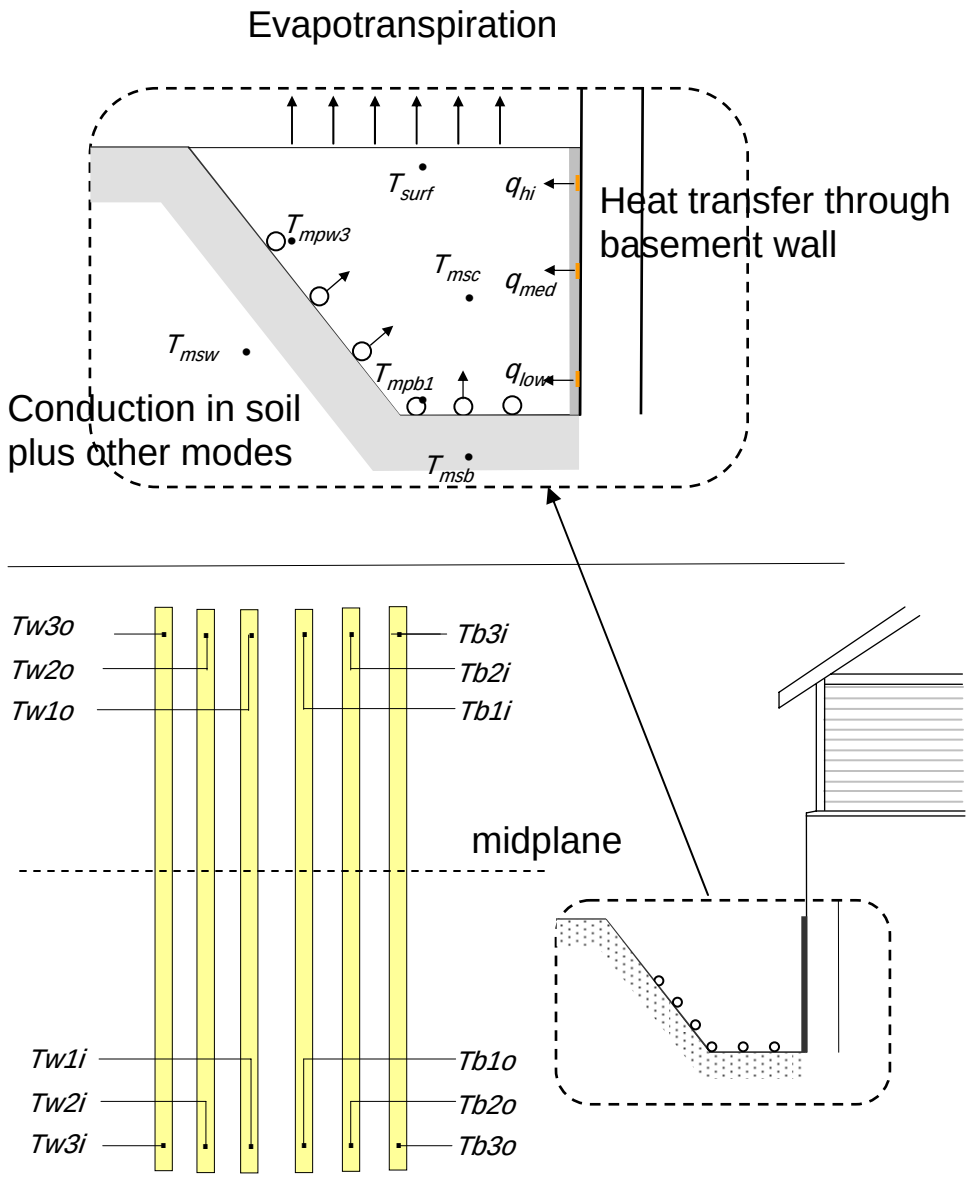
Foundation Heat Exchanger

- **Objective is to reduce installation cost of ground source heat pumps**
- **Minimize need for excavation associated with ground heat exchangers**
- **Utilize excavations made during construction:**
  - **Foundation/basement overcut**
  - **Runouts to water and sewer**
  - **Below basement floor**
- **In zero-energy homes, only modest (or no) additional heat transfer required**

Schematic of foundation heat exchanger



Project Develops/Validates FHX Design Tool & EnergyPlus Model



At simplest level, this is a parameter estimation problem

- **Develop finite difference conduction model**
- **Drive it with time-varying heat flux from**
  - **HX piping**
  - **Basement wall**
  - **Solar**
- **Determine**
  - **Surface heat transfer coefficient**
  - **Soil thermal conductivity**
- **Such that squared error (between predicted and measured temperatures) is minimized**

Model refinements

- **How does conductivity change during the course of a season (with rainfall, etc.)?**
- **Will a simple model suffice for the surface effects?**
- **What are the corner effects?**
- **Accurate simulation of ground loop enhanced heat rejection methods**
- **Accurate simulation of heat supplementation to the ground loop**

Goal is design/simulation method for GSHP/Foundation integrated loops

- **Existing ground loop design software insufficient**
- **Most work has been done on vertical bore**
- **Horizontal heat exchanger models exist, but need better understanding of**
  - **Near-foundation geometries**
  - **Surface effects**
  - **Moisture**

Project is a collaborative effort between ORNL and OSU

- **Experimental Team (ORNL)**
  - **John Shonder**
  - **Jeff Christian**
- **Modeling Team**
  - **Jeff Spitler (OSU)**
  - **Simon Rees (DeMontfort University, UK)**

Status of project

- **Modeling work began October 08**
  - **Graduate student assigned to project**
  - **Initial efforts focused on improving an existing 2-D model (GEMS)**
  - **Model now incorporates Kusuda relation to account for seasonal changes in soil temperature with depth**
  - **Some limited testing has been performed using data from Oklahoma soil monitoring network**
- **Temperature and heat flux sensors purchased, being calibrated in laboratory**
- **Aug09: onset of data from 2 walkout basement FHXs**
- **Dec09: onset of data from two crawlspace FHXs**
- **FHXs driven by actual HVAC and WH loads**
  - **Vacant (simulated occupancy)**
  - **Separate W-to-A and W-to-W HPs initially**
  - **GS-IHPs when available**