Creek House Project:

Architect: George Acock Associates
Builder: Ralph Fallon Builder Inc.
Mechanical: Geo Source One Inc.
Plumbing: D & L Plumbing
Electrical: DLC Electric

Mechanical Equipment:

- Two WaterFurnace 4-Ton Synergy 3-D combination hydronic / forced air geothermal systems
- One WaterFurnace 5-Ton Synergy 3-D combination hydronic / forced air geothermal system
- One Water Furnace 5-ton EW series hydronic geothermal system
- One WaterFurnace 1.5-ton NCW Envision Console geothermal system
- Two WaterFurnace Intellizone zone control panels
- One NTI Ti200 condensing boiler (by plumbing contractor) as DHW and emergency heat
- One Heat Transfer Products CB120 stainless steel hydronic system thermal ballast tank
- One 3,600 cfm. glycol fresh-air make up coil with Johnson 350 series proportional temperature control and modulating control valve.
- One Honeywell T 775 four stage temperature control
- One Grundfos Magna 40-120 master hydronic system pump
- Six Grundfos UP 26-99 series pumps for Geothermal units, snowmelt and emergency heat/ boiler loop injection pump
- Three Honeywell Truesteam HM512 steam humidifiers
- Two Aprilaire 1160 steam humidifiers
- Two GEA brazed plate heat exchangers for isolation between boiler, DHW, and radiant circuits
- One Bowman cupro-nickel shell and tube heat exchanger for swimming pool
- One Bacchus Cellar Systems wine room auxiliary cooling system
- Clipsal home automation communication system (Schneider Electric, by electrical contractor)

Nestled into a wooded ravine near Columbus Ohio is, perhaps one of central Ohio's most comfortable homes. Designed through close association between the client and architect, the home conforms rigidly to a classic "Country French" architectural style. In keeping with the architectural design of an old world stone structure while meeting the "R" value necessary for modern code compliance, an exterior surface of locally quarried limestone is backed by a standard 2" x 6" R-19 wall, followed by an interior second layer of natural limestone to provide deep window sills typical of centuries old European construction. To a casual observer, the home appears as a century old solid stone structure suitable to be included on the national register of historic buildings; hidden between the stone surfaces is the energy efficiency and warmth of a modern home.

In keeping with construction and the ambiance of an "old world" Country French residence, the home is constructed with a total of seven wood burning fireplaces. Four fireplaces employ gas logs. Three are used as "open fireplaces" throughout the winter season.

The client's project design goals address the following criteria:

- Provide radiant heat throughout the structure
- Provide zoned air-conditioning
- Air exchange / make-up air for fireplaces
- Manage interior humidity to maintain comfort conditions
- Snow melt for driveway access
- Heat for swimming pool in summer
- Maintain a wine storage room at 58 degrees
- Interface controls with an emergency heat system that creates minimal demand on a 12 Kw generator.
- Control system without visible thermostats

Through a series of meetings between client, architect, and builder, Geo Source One Inc. presented a series of energy simulations for the structure. The mechanical system was modeled with both conventional and geothermal equipment. Overall energy usage to support heating, cooling, make-up air requirements, snowmelt and pool heating made geothermal equipment the clear choice for this project.

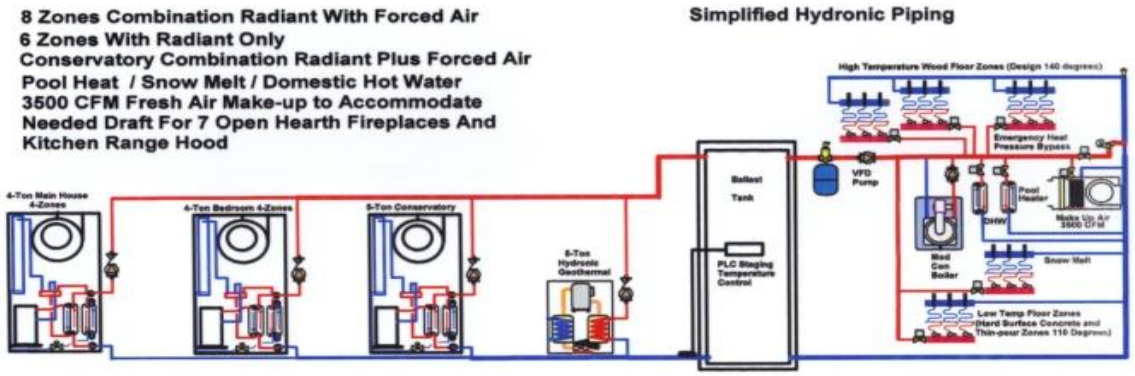
1 Main mechanical room

The resulting design for the home includes 16 thermal control zones of radiant floor heat. Radiant design methods were adapted to the construction of each area of the home and to their respective floor surfaces and anticipated "R" value of the surface covering. The home uses a combination of radiant zones in concrete, thin pour, sub-floor reflector plates, floor assemblies (Warm Board) and ceiling reflector plates (Wine Room cooling). Home radiant heating loads are managed primarily with a 5-ton WaterFurnace EW series hydronic geothermal system which functions as the "first on – last off" hydronic system.

2 Grundfos Magna Pump

To simplify the project and reduce pump energy consumption, this project operates with a variable speed Grundfos Magna 40-120 pump. The magna pump takes the place of up to 16 individual zone pumps and automatically adjusts its rpm and pressure to maintain proper flow from the smallest to the largest load.

3 Simplified Hydronic Piping



In a simplified description of the hydronic design of the system a hydronic manifold connects four geothermal systems with a 120 gallon hydronic ballast tank. A Honeywell T 775 four stage digital temperature control manages the geothermal systems to maintain tank temperature. Downstream from the tank is the variable speed Grundfos Magna pump followed by a secondary auxiliary boiler injection loop. The variable speed Magna pump serves a multitude of variable hydronic loads. In addition to traditional radiant floor zones, are zones for snowmelt, make-up air heating, and swimming pool heat. System design and piping is structured such that in an emergency situation in which the home must operate from a 12Kw generator, power will be available for controls, the variable speed pump and boiler with home heat receiving the priority for heat before any residual heat is rejected to make-up air or to snowmelt functions.

The hydronic system fluid, which circulates to all radiant zones, consists of a non-toxic propylene glycol solution mixed with deionized water. This antifreeze solution allows the geothermal equipment to operate directly with all house loads plus a fresh-air make-up coil and snowmelt. Direct operation allows for higher fluid temperature supply to the glycol coil and to snowmelt and eliminates efficiency losses created through the use of intermediate heat exchangers and secondary pumping systems. However, direct operation requires special care to use deionized water and an inhibited non-toxic propylene glycol antifreeze as the primary circulating fluid. System leak testing prior to the antifreeze fill is critical as is the necessity to provide the ability to valve off any circuit or manifold should there ever be a need to make a repair or add onto a manifold. As freeze protection for the snowmelt and make-up air coil, this system uses a solution of 60% deionized water and 40% inhibited propylene glycol.

The forced air ducting system is divided into 9 forced air zones. Forced air is used principally for air-conditioning and for the distribution of humidified air during the winter months. Seven of the nine zones are managed with WaterFurnace Intellizone zone control panels which interface with the two 4-

ton Synergy 3-D geothermal systems. Clipsal (Schneider Electric Corporation) automation controls are programmed to direct the first stage heating signal to radiant heat while all other forced air heat and cool signals report to the Intellizone panels.

The wooded ravine provides an exquisite setting for this classic home. However, the location and steep driveway approach present a challenge for the design of a snowmelt system that can maintain an open access at all times. Snow melt for a turn-a-round area and tire tracks for a 400 foot uphill grade, is managed by a combination of outdoor and radiant slab thermal sensors. The radiant slab is maintained at idling temperature any time the outdoor temperature falls below 38 degrees. A manual over-ride and 12 hour timer allow the client to elevate slab temperature for extended periods for the melting of heavy snowfall and in severe weather conditions. Snowmelt can consume massive amounts of energy. For this application, the snowmelt is limited to cover only the essential areas and in amounts that may be managed with the applied mechanical equipment and system loads.

4 Driveway Snow Melt Piping

A total of seven chimney flues and their make-up air requirements create a special situation for the mechanical system. Combustion air to meet the 0.8 ft. /sec. /sq. ft. of face area required by the Rumford fireplace design, presented challenges that are typically seen only in commercial projects. Design conditions called for 3,600 cfm of raw make-up air. Included with the high volume of fresh air was the need for filtration and a heat source to raise the cold air up to house temperature (270,000 BTUH required at full volume design conditions), before introducing it into a common return air duct for the forced air geothermal systems. To manage this load the three Synergy 3-D systems and auxiliary heat boiler are controlled by a four stage Honeywell T 775 controller. Under normal usage, make-up air averages 1,200 cfm and the load is managed totally with the geothermal systems.

Humidity control to adapt to the clients comfort standards proved to be one of the projects most demanding issues. Initial pre construction perceptions were that fireplaces would be in intermittent use and with dampers closed when not in use. Post construction, when gas logs were fitted, it was discovered that the log design required a “fixed open” damper with lock stop to prevent its closure. Daily fires kept in two of the larger Rumford fireplaces added substantially to the make-up air load. Each Rumford fireplace is designed for 1200 cfm exhaust. It was quickly discovered that the three

5 Steam Humidifiers

12 gallon per day steam humidifiers were totally inadequate to maintain the clients requested minimum 30% relative humidity. Follow-up calculations of make-up air psychrometrics called for an astonishing 96 gallons of water per 24 hour period. To meet the additional demand for extra moisture and prevent low humidity stress to the client and wood furnishings, two Aprilaire commercial steam humidifiers were installed to pick-up the bulk load when fireplaces are in active use. (Lessons learned: When using commercial size steam humidifiers on residential size zone control systems, care must be taken to assure zone air-flow is adequate for the level of steam production or take measures to reduce or limit steam production to those periods when all zones or major zones can accommodate the extra humidity load. Without this control strategy a small zone, if functioning as a solitary zone, could quickly become a steam bath.)

Swimming pool heat is likely one of the simplest functions provided by the geothermal installation. In a simple process, filtered pool water passes through a cupronickel shell and tube heat exchanger where it is warmed by the 115 to 120 degree hydronic system fluid. Pool controls operate a hydronic zone valve with an end-switch. The end switch completes the control signal for the variable speed Grundfos Magna pump and various geothermal systems cycle to maintain the thermal storage tank temperature.

The wine room (225 sq ft) is cooled by a radiantly cooled ceiling fed with 50 to 53 degree geothermal fluid. The radiant ceiling system was site constructed using two inch blue-board; grooved to accept aluminum thin-fin reflector plates. PEX tube lines (1/2 inch) are pressed into the thin-fin plates. The radiantly cooled ceiling is covered with a green-board drywall product engineered for damp areas. Operation with the radiant ceiling was successful in reducing room temperature into the low 60's. Hindsight shows that had preconstruction approvals been made to include radiant in the floor and walls, total temperature control by radiant means would have been successful. In this regard, an auxiliary cooling system is provided by a ¼ horsepower Bacchus Cellar Systems wine room cooling system. The Bacchus Systems equipment also serves as an emergency system when the home is operating on emergency power.

Fall and winter 2009 – 2010 have provided an excellent shake down test for extreme design conditions excessive snow and cold broke most previous winter records for central Ohio. According to the client this home with radiant heat is by far the most comfortable of any structure they have known. Adjustments to the snowmelt system to increase the idling temperature maintained a clear path throughout the most severe weather on local record. Dealing with unusually high volumes of fresh air make-up brings a new perspective to manage humidification requirements when “old world ambiance” must be met with modern convenience and comfort.