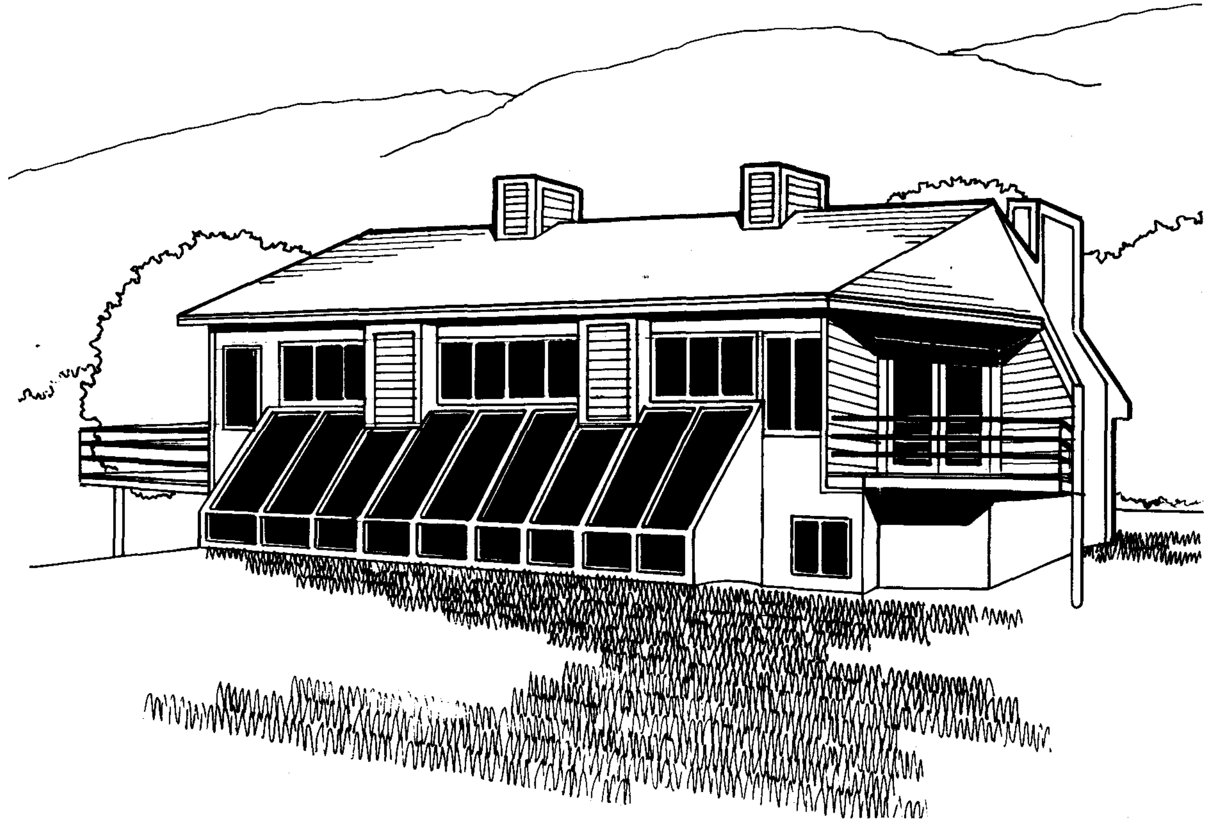
Middleton, WI



Builder: Northland Country Homes, Inc., Middleton, WI

Designer: North Design Architecture/Engineering/Planning, Middleton, MI

Solar Designer: Bruce D. Kieffer

Price: $79,500

Net Heated Area: 1788 ft²

Heat Load: 83.5 x 10⁶ BTU/yr

Degree Days: 7721

Solar Fraction: 52%

Auxiliary Heat: 2.95 BTU/DD/ft²

Passive Heating System(s): Indirect gain, isolated gain, sun-tempering

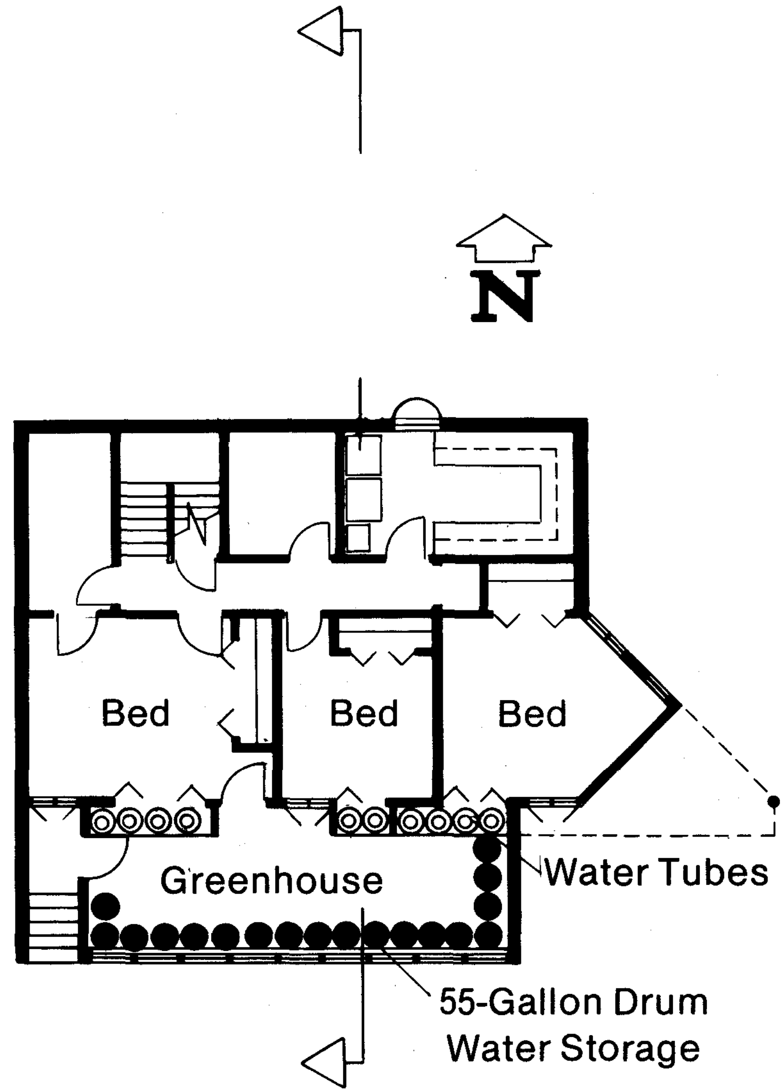
Recognition Factors: Collector(s): South-facing double glazing, 343 ft² **Absorber(s):** Greenhouse concrete slab floor, water tube surface, concrete block wall **Storage:** Greenhouse concrete slab floor, water wall, concrete block wall—**capacity:** 9600 BTU/°F **Distribution:** Radiation, natural convection **Controls:** Vents, registers, operable thermal doors, fixed overhangs, insulated shade

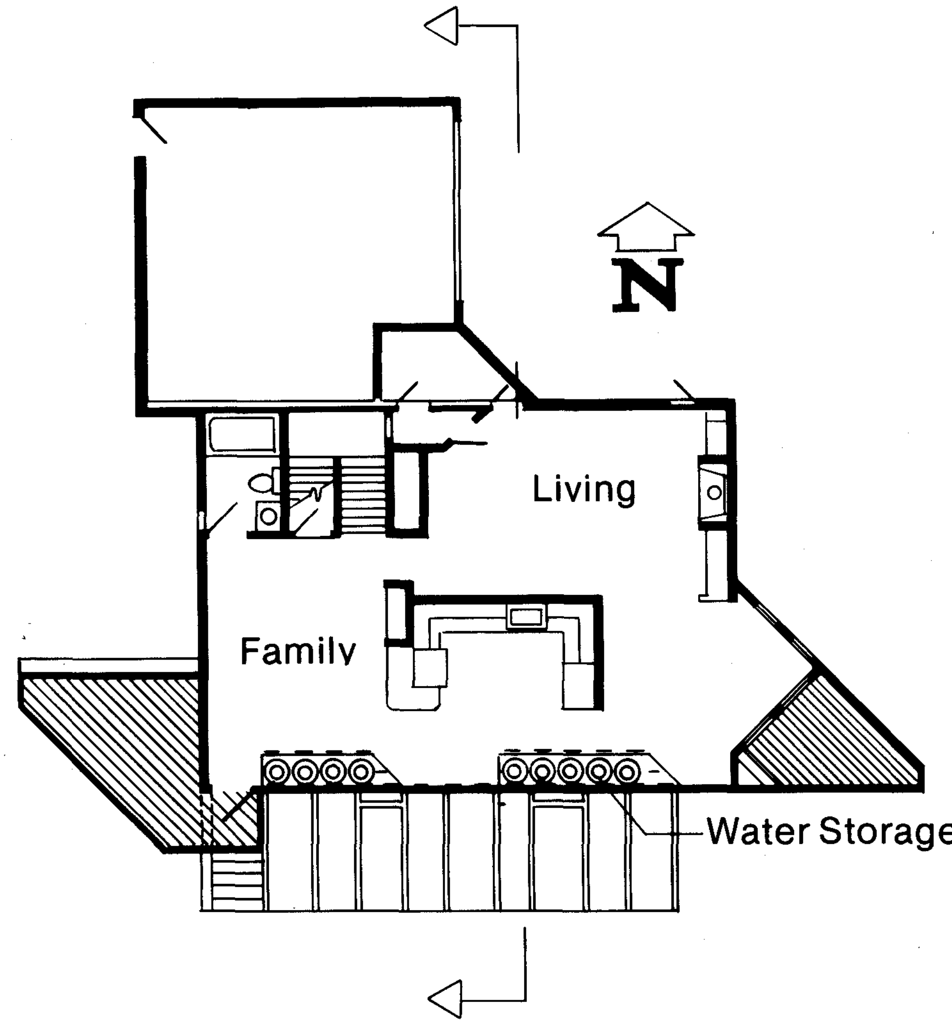
Back-up: Gas furnace (64,000 BTU/H)

Passive Cooling Type: Earth-cooled underground pipes, natural ventilation

This compact, 2-story, rectangular house is set into a south slope. It has mixed coniferous planting on its north side for protection from prevailing winter winds and a species of rapidly growing maple on its west side that will shade it from the hot, late afternoon, summer sun. Earth berms and the garage on the north and west sides will also deflect winter winds away from the entry and the upper floor spaces. The house faces 13 degrees east of south to encourage quick heat intake.

An innovative plan reduces heating needs by two methods. First, an inverted floor plan is used. This plan places active spaces (living room, dining room, family room, and kitchen) on the upper, entry floor and the quiet spaces (bedrooms, utility room, and laundry) on the partially, below-grade, lower floor. This strong break with conventional house planning half buries the bedrooms and service areas in a cool, viewless part of the house, while placing the view-related, daytime kitchen, family room, living and dining rooms at the sunny top of the house. Second, rooms are placed for solar orientation. The lower floor bedrooms all receive direct sun while service functions-closets, bathrooms, laundry and utility-are relegated to a buried rear placement. The more active rooms of the upper-floor kitchen, family room, and dining room also are on the warm south side while a bathroom, stairway, and living room are on the cooler north side.


N
Bed
Bed
Bed
Greenhouse
Water Tubes
55-Gallon Drum
Water Storage


N
Living
Family
Water Storage

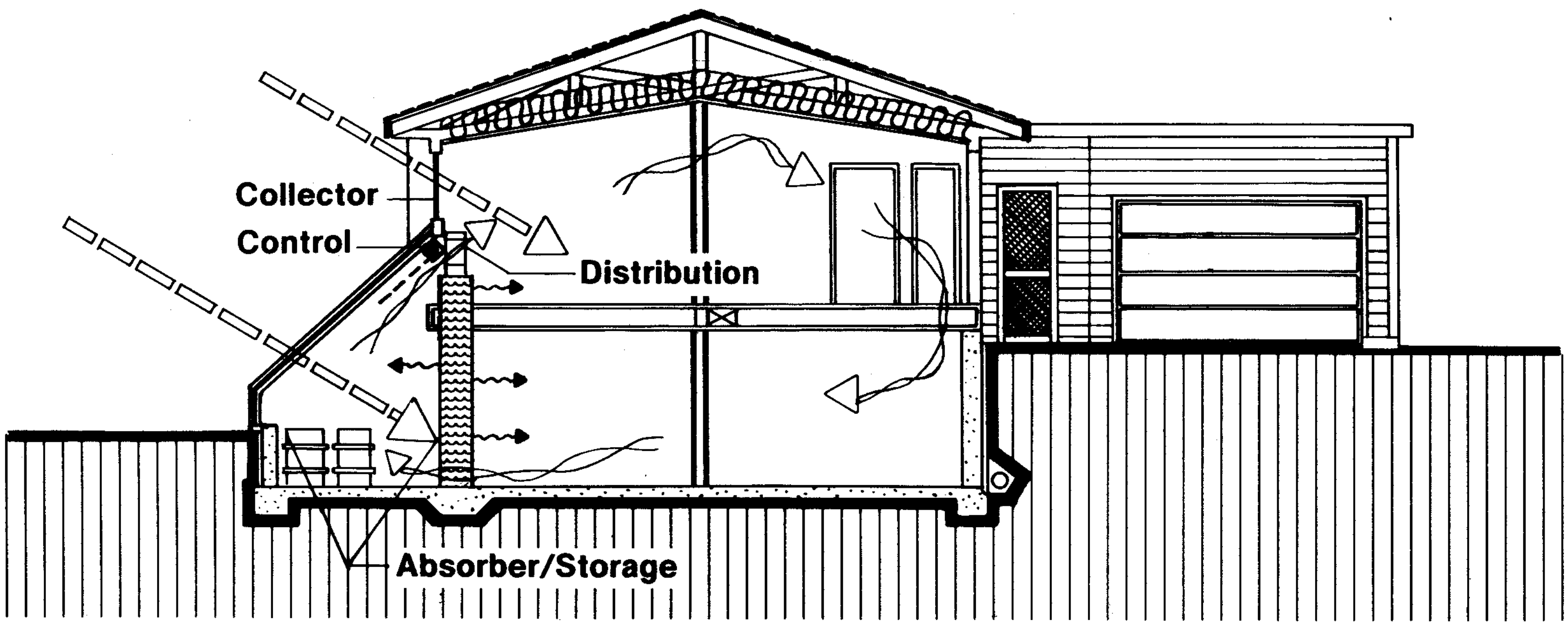
An extremely well-insulated building envelope is another energy asset. The wall construction has a composite R-value of 24, including: 2 x 6's with R-19 fiberglass plus 1-inch Styrofoam™ sheathing and a 4 mil vapor barrier. The roof has an R-value of 42 including 1 foot of blown cellulose and a 6 mil vapor barrier.

Two passive **collection** methods are used: (1) approximately 100 square feet of south facing double glass **collects** heat for all major living spaces on both floors except the living room; (2) approximately 250 square feet of 40 degrees sloping, tempered, double glass, form the roof of a greenhouse that occupies over 27 feet of the lower-floor south wall.

Absorbers include two major surface areas: a concrete floor slab in the greenhouse is the first, and the south faces of the 12-inch and 18-inch diameter vertical water tubes form the second absorber.

Storage for the direct radiation is the 3-inch concrete floor slab in the greenhouse as well as the 154 cubic feet of water in the water tubes. Twenty-two 55-gallon drums are used for **storage** of indirect radiation and as extra thermal mass to dampen temperature fluctuations in the greenhouse. An insulated, 8-inch concrete block wall in the greenhouse and the carpet-covered concrete slab on the lower floor also help store heat and dampen temperature variations.

Radiation and natural convection **distribute** heat throughout the house. During winter daylight hours, sunlight penetrating the glass warms the south side surfaces directly in its path. These surfaces then warm the



air which comes in contact with them, causing that air to rise and be replaced by cool air settling on the north side. This winter daytime convection current allows heat collectedin the lower-floor sunspace to be circulated throughout the upper-floor living spaces. During the winter evening, a similar convection current occurs. Heat stored in the lower-floor water tubes is released to the air; this air also rises to the upper floor providing a night-long source of warmth. In addition, radiation from these water tubes provides heat for the adjacent lower-floor bedrooms, when insulated, bi-folding doors are open.

The strongest point of the **distribution** system is its excellent ability to respond to a normal daily-use pattern. This **control** is accommodated by both the plan of the house, a manually operated system of vents and registers, and a full complement of other control devices, including: (1) operable low and high vents designed to capture breezes and keep the sunspace from overheating during the summer; (2) operable, thermal doors on the south side of the water-tube wall to prevent unwanted summer heat gain; (3) bi-fold doors and the bedroom side of the water tubes control radiation; (4) fixed overhangs to provide 100 percent shading of south-facing glass from May through August; (5) a north-side underground tube that provides cool earth-tempered air to the house during the summer; (6) a high south-side induction vent linked to the attic and four wind turbines mounted on two thermal chimneys for venting of warm air during summer; (7) manually moveable, shade insulation (R-5) on all south-facing glass including the greenhouse to prevent heat loss during winter nights.

Completing this house's package of energy-conserving systems is a carefully selected group of conventional appliances. Included are: a refrigerator with a switch for de-activating its automatic defrost cycle; a pilotless gas oven/range; a dishwasher with a cycle for air drying; a range hood that exhausts heat to the outdoors during the summer and recirculates it through a filter during the winter; separate switching and a backdraft prevention bag on the bathroom exhaust fan. Also part of the design is a back-up furnace with an automatic flue damper, electric ignition, and an outside combustion of air source and a circulating air fireplace with an outside combustion air source, and tight-fitting glass doors.

This plan is from the book
"Passive Solar Homes – 91 new award-winning, energy-conserving single-family homes",
The U.S. Department of Housing and Urban Development, **1982**

The solar homes designs in this book were the winners of HUD's fifth (and final) cycle of demonstration solar homes. The 91 winning home plans in the book were selected from 550 applications from builders.

This was a time of great interest and activity in the passive solar home designs – many of the winning homes show a level of innovation not found in most of today's passive solar designs.