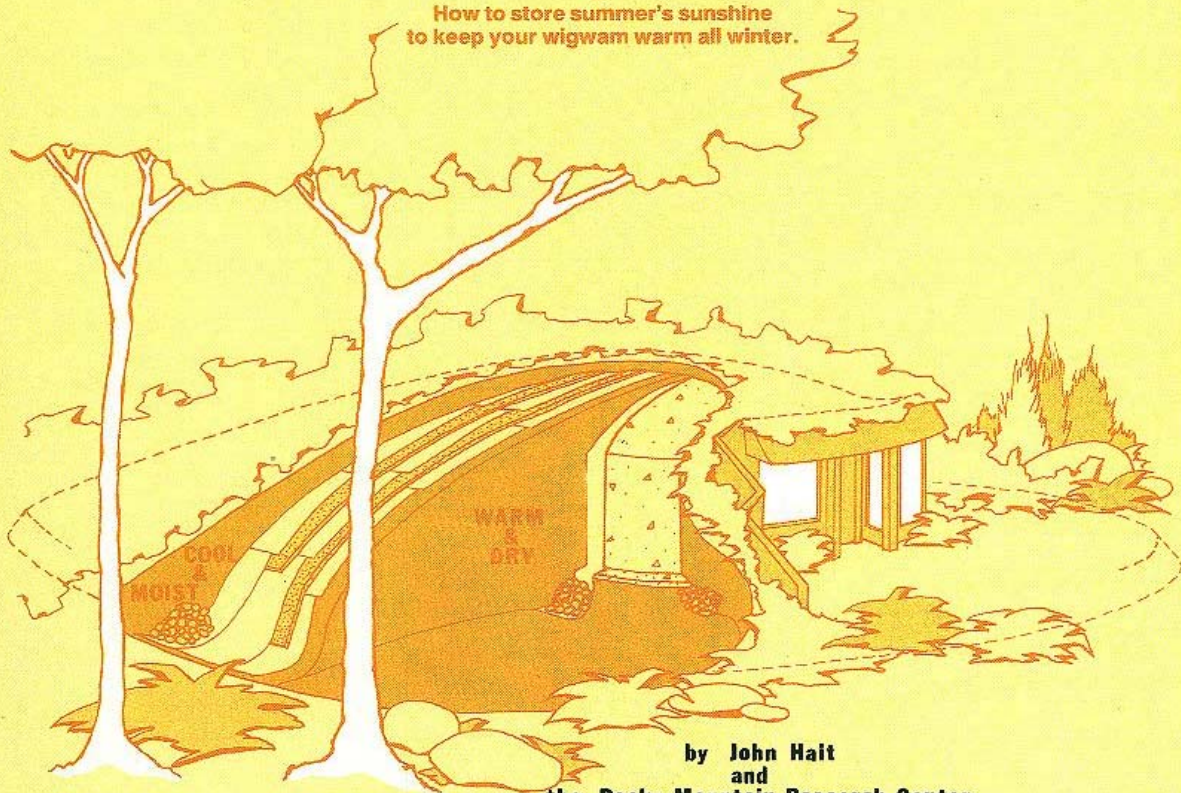


PASSIVE ANNUAL HEAT STORAGE

Improving The Design Of
EARTH SHELTERS

or
How to store summer's sunshine
to keep your wigwam warm all winter.



by John Hait
and
the Rocky Mountain Research Center

Passive Annual Heat Storage
takes solar energy out of the dark ages.

Passive Annual Heat Storage, Improving the Design of Earth Shelters

or
How to store summer's sunshine
to keep your wigwam warm all winter.

by John N. Hait

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FIRST E-BOOK EDITION
1.0

How can you keep your home comfy all year-round...using free sunshine...even in the cold northern climates... if it's cloudy all winter?

How can you produce fresh WARM air ALL WINTER,
and fresh COOL air all SUMMER...without using mechanical equipment?

20 feet into the earth the temperature is constant. How can that constant temperature be inexpensively adjusted to a comfortable 70° and then used to keep your home cool in the summer and warm in the winter?

with PASSIVE ANNUAL HEAT STORAGE of course!

Passive Annual Heat Storage takes solar energy out of the dark ages.

Passive Annual Heat Storage,
Improving the Design of Earth Shelters
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MY WIFE

Alice...no one could write a book without
a very patient and loving wife.



The Geodome. Missoula, Montana, USA
The first working example of Passive Annual Heat Storage

More info: www.rmrc.org

FORWARD

This book is an innovative, yet practical, guide for the pioneer in Passive Annual Heat Storage. It explains in detail the ultimate in year-round energy conservation. Without mechanical equipment or commercial power, Passive Annual Heat Storage inexpensively cools a home through blistering hot summers. It saves those precious BTUs, and then returns them automatically when they are needed to keep the home comfortable through frigid northern winters. Summer's excess heat is, of course, free solar energy. Non-mechanical YEAR-ROUND storage of this abundant natural resource is a whole new technology; its basic concepts, goals, and methods are substantially different from the passive solar heating with which most readers are familiar. This book presents these unique concepts, in a clear and easy-to-understand manner.

In order for such a fledgling science to grow, information must be gathered from the people who use it. Therefore, we invite you to apply the principles of Passive Annual Heat Storage in your own home designs without additional charge or license.

As you begin designing your own Passive Annual Heat Storage home, you will, no doubt, have a million questions...we all do. We expect a deluge of mail, so please read the whole book first, as your question may have already been answered. Some questions, though, can only be answered by further experience. If we all share our experiences we can all benefit. For all pioneers, as Sir Isaac Newton once observed, are "standing on the shoulders of giants."

In the past 20 some years, a number of PAHS homes have been built around the world. And everyone always asks, "Where can I see one?" The problem is that when one opens his house up to the public, the result is a deluge of people. It present there are no homes that I know of where the owners permit visits. We wish there were so we could direct you to them. However, their experience is about universal.

PAHS is basically just a simplified explanation of the laws of physics. So, if the builders have followed the instructions herein, then they will do well. But if they make heat-flow compromises, the performance will be diminished.

As you actually experiment with Passive Annual Heat Storage we would appreciate it if you would drop us a line detailing your design, how easily it went together, and how well it finally works. Such information will help us in preparing any future books so we can all advance together. After all, the field of solar technology is not an old and mature science as some would have us believe, but a pan of hot buttered popcorn...you never know what may pop out next!

You may contact us through our website at www.rmrc.org or email us at pahs@rmrc.org

IMPROVING THE EARTH SHELTER

Chapter 1



The control of underground heat-flow is a steadily expanding technology. Considerable advancement has now been made toward the production of cold-climate homes that require no mechanical heating or cooling whatsoever. By using a new process called Passive Annual Heat Storage, heat can be collected, stored and retrieved, over the entire year, without using energy robbing mechanical equipment.

Plain old dirt is the ideal heat-storage medium. Heat is stored naturally in the earth as it soaks up the warm summer sunshine. The earth retains this heat until cold weather arrives, then it slowly relinquishes its store to the open air. The summer-long heating up and the winter-long cooling off produce a year-around constant temperature twenty feet into the earth. Interestingly, this constant temperature mirrors the average annual air temperature.

An earth sheltered home designed with the principles of Passive Annual Heat Storage, controls the summer heat input and winter heat loss to establish a new average annual inside air temperature, which in turn, will produce a new constant temperature in the earth around the home. The home and the earth will work together to remain within just a few degrees of this average all year long. In this way, the environment around the earth sheltered home can be climatized to any suitable temperature. Of course, a home set comfortably in a nearly constant 70° (21°C) environment needs neither air conditioners or furnaces.

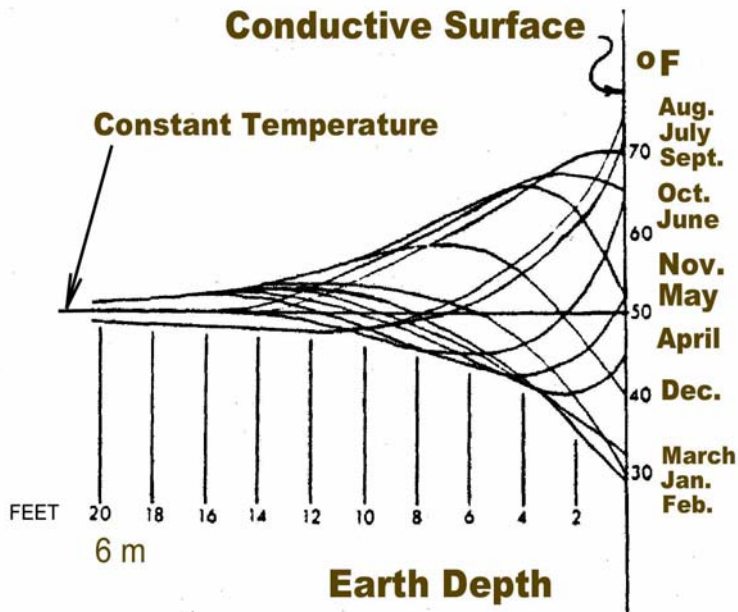
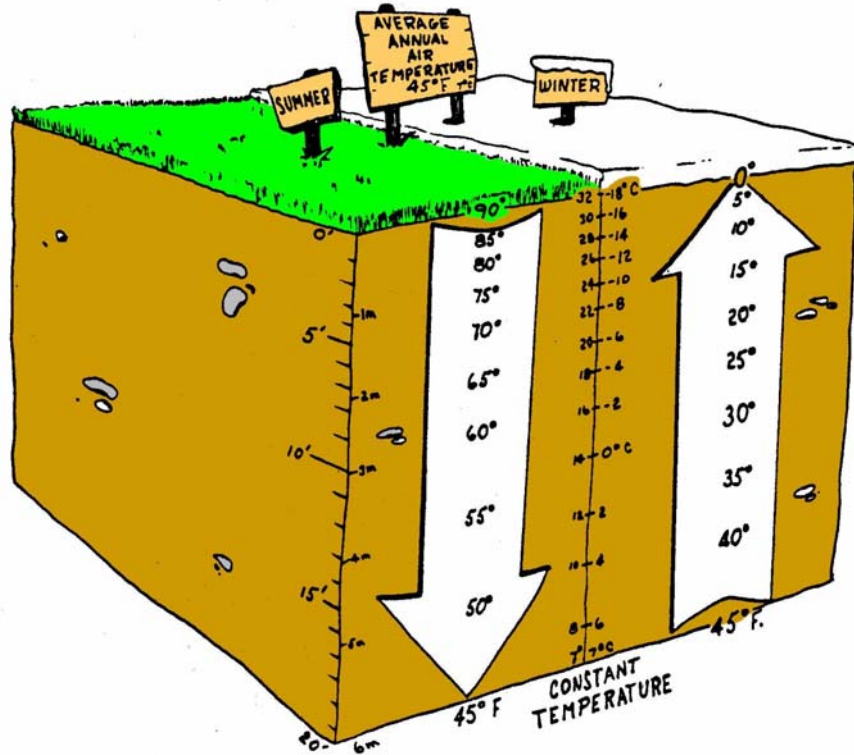


Figure 1 Monthly natural underground temperatures are averaged as they slowly soak into the soil from the out-of-doors until, at about 20 feet deep, the whole year's temperature changes become a SINGLE AVERAGE.

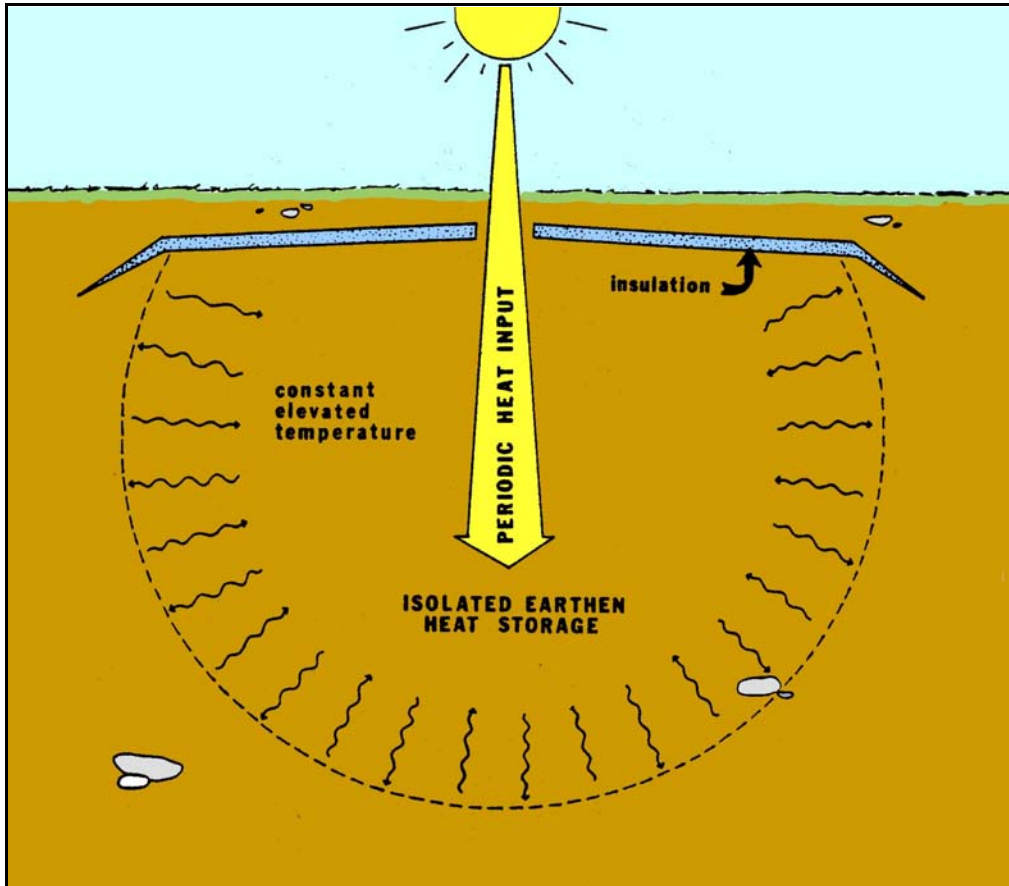


Figure 2 Thermal isolation of a large body of earth using an insulation umbrella, which eliminates encasing the whole thing in insulation.

THE FIRST WORKING EXAMPLE

This unique heat control method was still in its infancy in January of 1981, when a major feature of Passive Annual Heat Storage (an insulation/ watershed umbrella) was incorporated into the design of an earth-sheltered home that was being built in Missoula, Montana USA. This home, called the Geodome because of its shape, has its insulation/watershed umbrella extended into the earth about 10 feet (3 m) beyond the walls of the house, and encloses a two-foot (.6 m) deep portion of earth on the roof. (fig. 4)

The building is monitored by 48 temperature, and 5 moisture sensors. By the autumn of '81, the temperature 10 feet (3 m) under the surface, 12 feet (3.7 m) behind the north wall, and 2 feet (.6 m) beyond the insulation itself, had been heated by excess summer heat from its usual 45° to 64° (7-18° C). The two-foot (0.6 m) deep portion of insulated earth on the roof was warmed up to 77° (25° C), while two feet under the floor it was 68° (20° C). Throughout the first year, the north wall temperature on the second floor of the home varied

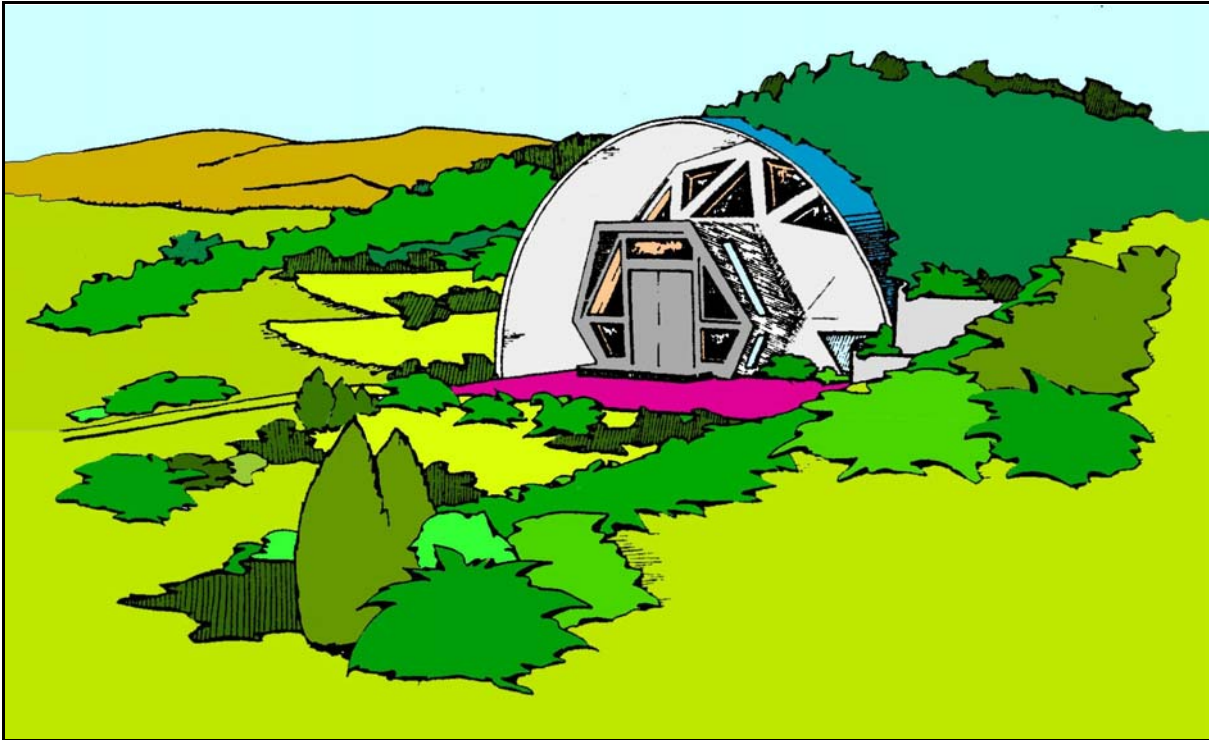


Figure 3 The Geodome in Missoula, Montana USA. The first working example of Passive Annual Heat Storage.

only 6 degrees...from a high of 72° (22° C) in September to a low of 66° (19° C) the next February. Thus the home has been snugly wrapped with a nearly 70° (21°C) layer of earth, several feet thick (1 m), which has kept the home comfortable all winter. Even though the insulation umbrella is only half as big as we now know it should be, the earth around the home remains warm and dry!

This outstanding performance has provided operational proof of the advantages of Passive Annual Heat Storage over conventional earth shelter design methods. As a result, further improvement has been made in the art of long-term-heat-storing.

IMPROVING THE EARTH SHELTER

Earth sheltered homes do enable the non-mechanical methods of passive solar heating to be used more effectively, because earth sheltering is inherently energy efficient. Some solar-heated earth-sheltered homes have worked quite well in selected climates, but even the better, ones have been able to maintain a fairly stable temperature for only a week or so in inclement weather without needing back-up heat. Generally, passive-solar homes of all types, have been able to collect only a portion of their space-heating needs because of one inherent problem: Solar energy simply isn't there when it is needed.

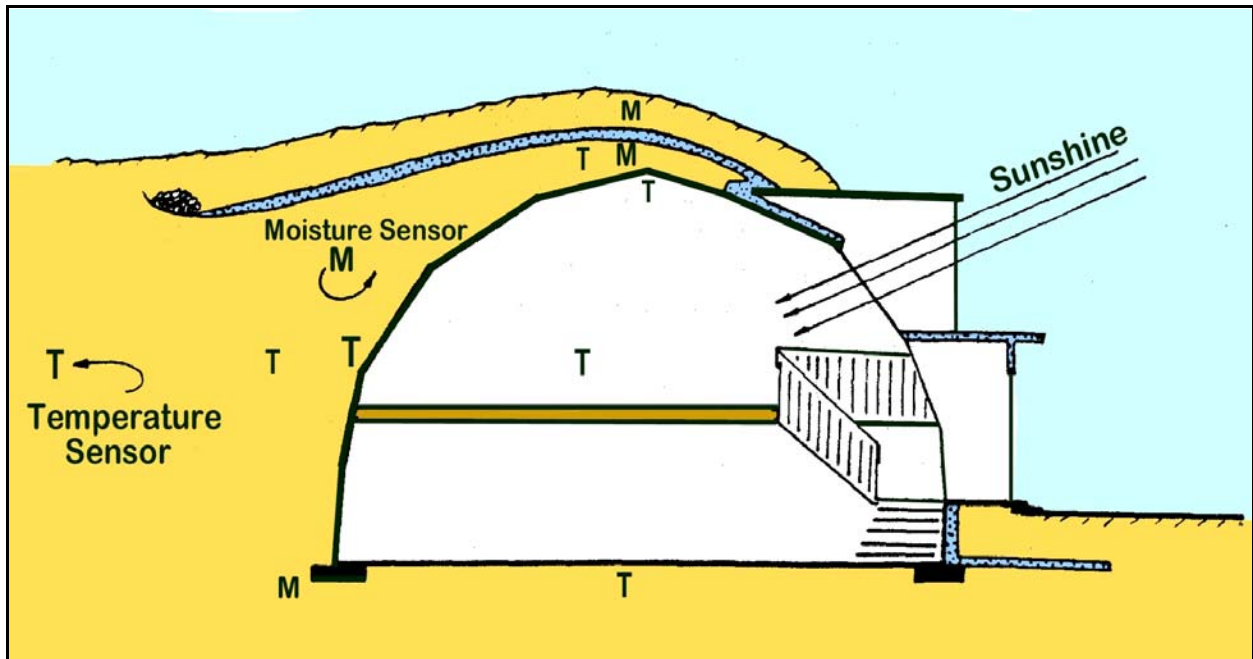


Figure 4 The Geodome cross-section showing the first (although small) insulation/watershed umbrella, and the locations of the important temperature and moisture sensors.

The noon sun is highest in the sky on June 21st, and lowest at the tail-end of December. It provides plenty of heat in the summer, but thanks to short days and foul weather, heat availability all but disappears in the winter... especially in the cold and cloudy Northwest. So, attempting to collect a home's heating needs in the winter-time is like trying to collect milk from a dry cow!

What is needed to bring solar heating out of the dark ages, is an inexpensive method for storing large quantities of heat over the entire year in a simple, natural, passively-operated reservoir...the earth. However, conventional earth-shelter designs do not take full advantage of the fine heat-storing ability (thermal mass) of the earth. A simple heat flow principle tells us why: Heat flows by conduction from warm places to cool places.

Conventional earth-sheltered homes prevent the earth about them from getting warm enough in the summertime to allow the heat to flow back into the home in the wintertime. While the concrete may warm up to room temperature, the earth around the building usually has its heat flow characteristics dominated by the colder outdoor weather conditions, rather than the controlled indoor temperatures. This occurs because the heat-storing earth is usually insulated from the heat-collecting house and not insulated from the, generally cooler, out-of-doors. Therefore the, conventional insulation layout actually prevents the home's average annual air temperature from establishing a sufficiently warm, deep-earth constant temperature.

Storing a large amount of heat, at room temperature, requires a large amount of thermal mass. The relatively small warm storage mass of the conventional solar-heated

earth-sheltered home, prevents the use of the abundant summer heat, since heat can be stored to last for only a week or so in cloudy winter weather before a back-up heater must be turned on. Homes that are restricted by small thermal storage, are thus forced to resort to winter-oriented passive solar heating, which discards the energy-rich summer sunshine by shading. This also limits building locations to those where sunshine is readily available in the wintertime.

For an earth sheltered home to remain warm all winter from heat gathered six months earlier, the heat-storing earth must be kept both warm and dry. When cold rain water is allowed to soak into the ground around the building, as it is in conventional earth sheltering, it not only causes waterproofing difficulties, but it cools off the earth.

Further improvement is also needed in the current methods of supplying fresh air to tight underground structures, because most ventilation methods bring in hot air during the summer and cold air all winter.

Recognizing such problems is the first step toward solving them. Now, all of these problems can be solved by using the principles of Passive Annual Heat Storage.

HOW PASSIVE ANNUAL HEAT STORAGE WORKS

Passive Annual Heat Storage is a new process for allowing summer's heat to be absorbed right out of the home, keeping it cool and comfortable, and storing this heat, at room temperature, in the dry earth around the building. This reserve can then be conducted back into the home any time the indoor temperature attempts to fall, even through an entire winter. So, the home and earth, together, will maintain their comfortable temperature automatically, within just a few degrees.

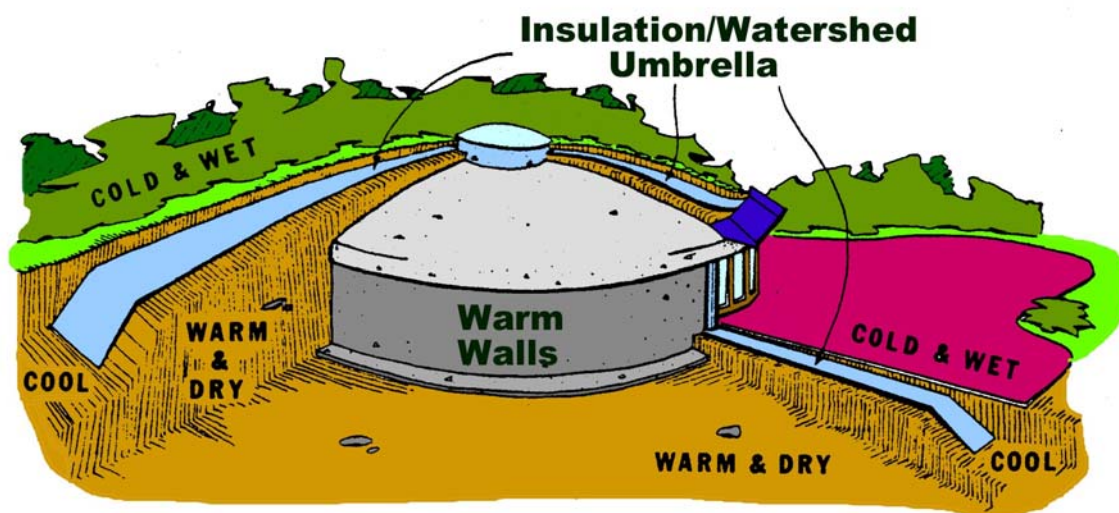


Figure 5 An INSULATION/WATERSHED UMBRELLA on an earth-sheltered home isolates a large body of earth that will have its "constant temperature" raised to a comfortable level.

This unique method for maintaining a deep-earth constant temperature of about 70° (21° C) is based on several principles of physics:

1. Heat flows by conduction from warm places to cool places, and will ONLY return when the original source cools to a temperature which is below the storage temperature.
2. Far more solar heat is available in the summertime than in the wintertime.
3. Earth is an ideal thermal mass for storing heat over time periods well in excess of 6 months.
4. The constant temperature 20 feet (6 m) into the earth is a reflection of the average annual air temperature.
5. It takes six months to conduct heat 20 feet (6 m) through the earth.

Earth shelter technology can be significantly improved by a balanced application of these simple principles.

Passive Annual Heat Storage overcomes the deficiencies of conventional earth-shelter and passive-solar design by isolating a large thermal mass of dry earth around the home with a large insulation/watershed umbrella, so that the earth itself may be warmed up to room temperature. (fig. 5) To contain this heat we must cause the heat to flow between the earth and the home, rather than the earth and the out-of-doors. Therefore, all short conductive paths to the outdoors must be cut off. The insulation need not enclose all of the earth underneath and to the sides of the home because heat which flows 20 feet, or more, through the earth will be delayed long enough so that warm summer weather will arrive before last year's heat can make it all the way out from under the umbrella.

The home will establish its own average annual air temperature by controlling the summer heat input and the winter heat loss. Therefore it will now produce a new deep-earth (20 feet or more) constant temperature all the way around the home. Since heat moving both in and out is under control, the home's operating temperature may be adjusted to any average temperature we wish.

The insulation/watershed umbrella also keeps the entire earth environment around the home dry, preventing the heat in the earth from being washed away and making waterproofing a cinch.

COST

Passive Annual Heat Storage, including the earth tube ventilating methods suggested in this book, are inherently INEXPENSIVE in comparison to the usual cost of building an earth-sheltered home. The insulation/watershed umbrella is made by laminating layers of rigid insulation with at least three layers of polyethylene sheeting. It is, therefore, long lasting and relatively inexpensive to buy and install. Only a little more insulation is needed than with conventional methods of putting insulation on an underground home, since the subterranean surfaces will be left un-insulated. Also, waterproofing costs are reduced considerably, because the home sets in a dry environment.

A little insulation, a little plastic, a little pipe and a whole lot of thought about how they should be installed, make Passive Annual Heat Storage the least expensive energy management system anywhere.

Read on! The principles described in this book will greatly enhance the operation of any earth-bermed or earth-sheltered structure, and with a little design finesse, ANY STRUCTURE, as we shall see.

The rapidly advancing science of underground heat flow has opened the doors to a whole new array of home design methods that will make heaters and air conditioners to homes...what paint is to a beautiful stone wall!