

# EARTHSHIP

VOLUME II



SYSTEMS AND COMPONENTS BY MICHAEL REYNOLDS

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Front cover photo - **Pam Freund**

Back cover photo - **Bill Acheff**

**My wife Chris...**

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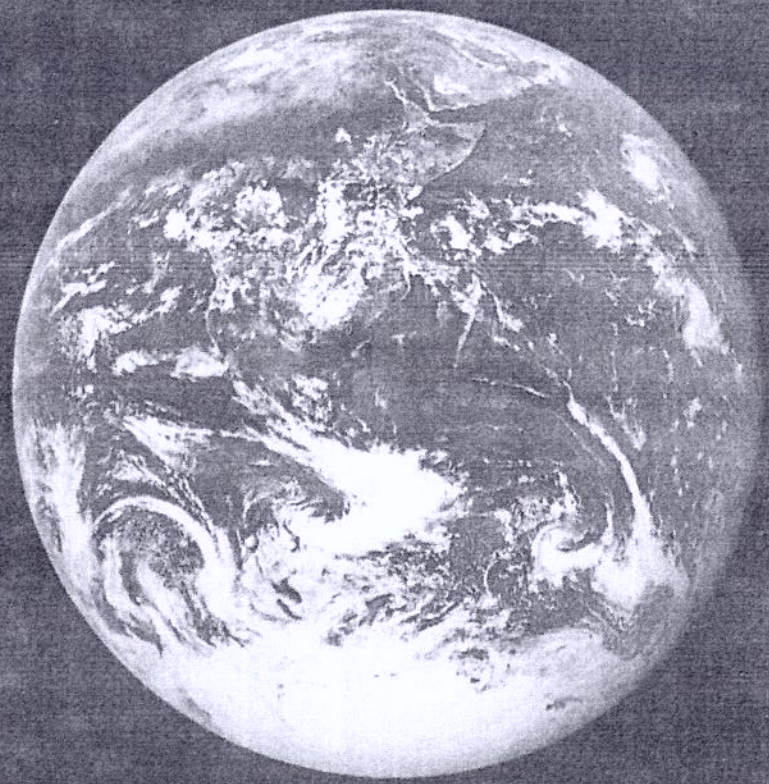
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THEY LANDED IN HUGE VESSELS  
AND SLOWLY WALKED OUT  
ONTO THE LAND. THEY  
DESTROYED EVERY HUMAN IN  
THEIR PATH. THEY MOVED INTO THE  
CITIES. SYSTEMATICALLY AND  
DELIBERATELY, THEY SOUGHT OUT  
AND CONSUMED MEN, WOMEN AND  
CHILDREN. NOTHING COULD STOP  
THEM.

THE ABOVE PARAGRAPH SOUNDS  
LIKE A TYPICAL SPACE INVADERS  
MOVIE IN WHICH WE HAVE  
PORTRAYED THE SPACE INVADERS  
AS THE RUTHLESS ENEMY. THE  
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PARAGRAPH IN A DIFFERENT  
CONTEXT DERIVED FROM A  
BROADER THAN HUMAN VIEW.  
PERHAPS WE SHOULD LOOK AT  
OURSELVES THIS WAY AS WE  
DETERMINE JUST WHO THE ENEMY IS  
AND WHETHER OR NOT WE HAVE A  
FUTURE.

The beings from Alcyone traveled as thoughts. This is much faster than the speed of light. It is instantaneous. Light speed has limits - significant limits relative to the size of our universe. For instance, the closest star to the Earth is thousands of light years away. What good is light speed in a universe of these dimensions? Thoughts, on the other hand, travel instantaneously. There is no need for cumbersome bodies in the world of thoughts. Thoughts are energy and energy travels and penetrates any material barrier anywhere, anytime - instantaneously. Think about it - if you think of the house where you grew up or your room when you were ten years old, how long does it take your mind to take you there? This is how the beings from Alcyone traveled. When many were going to the same place, they traveled as one thought - a phenomenon we have only talked and written about here on Earth. Can you imagine the power and focus of many with the same thought?

It is easy to think about someplace you've been and to allow your thoughts to take you there. The real masters of thought travel can explore places *they haven't been before*. This opens the whole universe to exploration. This is what the beings from Alcyone were doing. They were exploring the universe with much the same ignorance and innocence that we are currently (in the twentieth century - Earth) exploring our solar system.

The incidents that are documented in the following pages describe what they found and how they reacted to what they saw.

A group of three beings had merged into one thought and were cruising in a spiral galaxy. They drifted into a solar system that had what appeared to be nine or ten planets orbiting around one sun. The sun was a fairly stable main sequence star. They observed different phenomena and beings on the different planets. On the third planet out from the sun there existed a beauty the three beings had never imagined or seen before in their travels of the universe. There was such a delicate balance and harmony of intertwined existence that the whole planet seemed to be a single living creature.

In the world of the three beings from Alcyone, time was not much of a factor. They watched and observed the planet for thousands of Earth years and actually grew to love it and visit it as often as one would visit a friend. They saw the waters running and talking. They saw the trees dancing and laughing. They saw the animals participating in one overall pulse of existence that was woven like a tapestry throughout the planet. The three Alcyonites were very careful not to interrupt the slightest feather of this existence as they recognized the beauty of the balance.

At some point in their observations of this planet they began to see the emergence of another creature. This creature was very similar to some of the animal creatures on this planet but it was different. The invisible threads that wove the animals to the planet did not exist for these new creatures. They were not part of the tapestry. They were aliens to this beautiful world. They came from somewhere else. They were invaders. The Alcyonites watched ever growing numbers of these tiny parasites attack their friend. *Imagine watching a good friend attacked and eaten by thousands of carnivorous ants.*

The Alcyonites were very alarmed and began to study their friend, the blue/green planet, much more closely. They watched these new creatures cut the green trees - at first just a few - then, as the creatures prolifically multiplied, serious numbers of trees disappeared from the planet leaving huge bald scars on the mountains. They watched the slaughter of animals of every kind, again, just a few at first then progressing until many animal species were totally wiped out. This new creature seemed to consume or destroy all other life on the planet. It also produced some of the most awful, knarly substances the Alcyonites had ever seen. Much of the beauty and life of their friend was being destroyed. Not only were the new creatures destroying the animals, plants and, consequently, the balance and pulse of the

planet itself, they were also trying to destroy each other, bringing about even more devastation in the process. To the Alcyonites, these new creatures appeared to be the most hostile, aggressive and ruthless beings they had ever observed in the universe. They found themselves just watching while their friend was being consumed by these hostile new creatures. Their friend, the blue/green planet, was very strong and enduring but these new creatures were multiplying very rapidly. The Alcyonites began to see the obvious - *their friend, if it survived, was already losing something in this process that it might never regain.* The Alcyonites began to wonder - Do these new creatures have the right to do this? Do they have the right to take the beautiful blue/green away from this planet?

The Alcyonites returned to their galaxy and reported what they had seen to an intergalactic "committee" of ancient and wise beings. They decided (based on broad observation) that the new creatures which had appeared on the blue/green planet in the spiral galaxy were, in fact, a hostile, aggressive, galactic virus which should be destroyed before it spread to other planets and galaxies. A small band of destroyers was sent to the planet to wipe out the hostile virus. They left as a single thought and upon arrival they manifest into the very fears and elemental hallucinations of the virus itself...

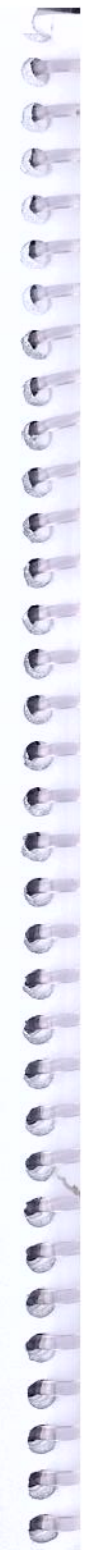


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Following photos: Distant views of the REACH  
community.







# INTRODUCTION



This volume of the EARTHSHIP series will deal mostly with systems and components of the vessel. With regard to these systems and components, we must realize that we, the users of the vessel, are part of the vessel. This is much the same as we, the users of the Earth, are part of the Earth.

When children play jump rope, the rope is turned by two children, one at each end. The child who is going to jump stands beside the turning rope and begins to move with the motion of the rope to align herself with the rhythm before she jumps in. It doesn't take a child long to learn that the rhythm of the rope prevails if you want to be good at jump rope. The child learns that it must become part of the system.

When you are pushing someone in a swing, you don't just push them whenever you want to, you wait until they swing all the way back and gravity is just about to take them back the other way. You join with gravity to give them an extra boost in the direction that gravity was already pulling them. Your push aligns with the pendulum motion of the swing. You apply your force as an integral part of the system.

In both of these examples the existing system prevailed without challenge and the person became part of the system in order to benefit from it. This is much the same way a chameleon

takes on the surrounding colors to hide from predators. This is the posture of the EARTHSHIP and all its systems. **The EARTHSHIP is a participant in the prevailing systems of the planet Earth. It causes no conflict, no stress, no depletion, no trauma.**

For us to live in EARTHSHIPS is as simple as a child stepping in to a turning jump rope. The child was a "chameleon" - it adopted the rhythm of the rope. Can we adopt the rhythms of the planet? This is our dilemma. We are unwilling or unable to drop our preconceived, arbitrary, "synthetic" rhythms for those of the planet. This is like the child trying to get the rope to adapt to her rhythm or a chameleon trying to get a leaf to change to it's color. **The chameleon who waits for the leaf to change colors will get eaten.** We are making synthetic energy, burning fossil fuels and ruining natural balances trying to get the *leaf to change to our color*. It would be much easier and more healthy for us and for the planet if we changed ourselves to the color of the leaf. Our "synthetic rhythms" are born out of our socioeconomic structure which is based on dogmatic religions, corrupted politics, hollow economics, fear, greed and basic lust for power. There is a lot of "gravity" in this socioeconomic structure that demands so much of us. An over view of this structure could very well *make us look like the enemy*. This and the fact that our

socioeconomic structure is obviously flailing should make us look to the "rhythm of the rope" - "the color of the leaves" - "the patterns of the planet. If we can step into the "rhythm of the rope", we can cruise free and comfortable in EARTHSHIPS for thousands of years to come.

We definitely need comfortable temperatures, light, electricity, hot water, food, sewage treatment, etc. These necessities are all available within the framework of a certain "rhythm" in the EARTHSHIP concept. The more we are able to align our priorities and needs with the prevailing rhythms of the planet, the easier and less expensive (both in terms of economics and ecology) they will be to obtain.

Some basic examples of this alignment present the following questions:

Do you need to do a wash whenever you want to or can you exist only doing washes on sunny days?

Do you need limitless hot water all the time or can you survive using hot water between 11 a.m. and 11 p.m. on sunny days?

Do you need three square meals of meat and potatoes each day or can you graze from a year-round greenhouse?

Do you need limitless electricity for hundreds of plastic gadgets or can you exist with a small

amount of electricity for a few special tools and appliances?

Do you need hot water instantly at your tap or can you wait a few seconds for it to get there?

Do you need three showers a day or can you survive on one every other day with sponge baths between?

Do you need to flush away five gallons of water every time you use a toilet or can you use a compost toilet?

Do you need to keep your house at 78 degrees all the time or can the temperature drop to 68 degrees some times?

Do you need five-hundred gallons of water every day or can you exist with 20 gallons some days?

If our lifestyles can conform more to the patterns of the planet than to our socioeconomic system, we can reduce the stress on both ourselves and the planet. This is easier said than done due to the "reality" and the "gravity" of mortgage payments, utility bills and the generally high cost of eating and living. Most of us have no choice. We have to be places at certain times looking certain ways in order to make the money needed to make those payments. However, many people have built EARTHSHIPS themselves and ended up with little or no mortgage payment. They also have little or no utility bills and their ability to grow food year-round inside the EARTHSHIP has greatly effected what they have to spend on packaged,

processed foods. *This is approaching the freedom this country was founded on.* I do not think we are a hostile, aggressive virus on this planet. We have simply built a trap and now we are caught in it. Our efforts to survive in this trap make us appear ruthless, hostile and aggressive. The EARTHSHIP and the EARTHSHIP concepts can begin to free us from this trap. Then we will have the mental space to make choices. As it is, most of us have no choice. **When the wolf is at your door, there is little time to think of anything but survival.**

Freedom from our trap is as available as the bus that you catch down on the corner. You must make the small journey - *take the small step* - to go down to the corner to catch the bus. The same is true for aligning with (catching) the rhythms of the planet. We have to take the small journey to a *position* where we can align with natural phenomena. The journey to the bus-stop is on foot. The journey to alignment with natural phenomena is in our minds. To go to the bus-stop, you must walk outside your living room, on to the street and down to the corner. *Then you simply ride the bus.* To get to the "EARTHSHIP-stop" you must walk outside your dogma, on to the Earth and into its natural patterns. *Then you simply ride the Earth.* The exit from our dogma (the trap we have created) is guarded by a dragon. This dragon is

not just a dream, it is very real. Some say our reality is just a reflection of our dreams and vice-versa. Dream therapists say that you are everyone in your dream. If a dragon is chasing you in your dream, you are both yourself and the dragon. The dragon is an aspect of your psyche. Dreams show us that one aspect of ourselves can create problems for another, i.e. we are our own worst enemies. **We are the dragon that is guarding our exit from dogma.**

*I had a dream that I was an angel. I knew how to fly. While cruising around, high in the sky, I saw flames coming out of a cave in the ground. I glided down closer and saw a dragon come out of the flaming cave. He followed a riverbed down to a small town and I watched him begin devastating the town. Then he looked up and saw me flying. I could see his orange eyes, with the thin vertical black slit for a pupil, looking up at me. He began communicating with me telepathically. I was amazed. He wanted to learn how to fly. Thinking fast, I agreed to teach him to fly if he would quit devastating the town. Apparently flying was more interesting to him than devastating the town so he agreed. I taught him to fly and the last thing I remember was flying beside him looking over into his orange eyes and seeing a happiness in those once angry, violent, orange eyes.*

According to dream therapists, I was both myself and the dragon. I was both the devastator and the teacher. We, as a society, are, in fact, both our devastators and our teachers. Half of the distance we must go to learn to live in peace and harmony with the Earth (and each other) must be traveled in our own minds, between ourselves and our dragons. *We must teach them to fly.* There is definitely a part of us that simply wants to consume, however, like the dragon in my dream, maybe flying would be more interesting. The EARTHSHIP concept explained in Volume One greatly reduces the emphasis on consumption and proposes alignment with limitless natural phenomena. This results in a freedom not unlike flying when compared to the restrictions placed on the average dependent consumer in today's society.

If you want to fly, you must learn about riding *on* the wind - not harnessing the wind - not capturing the wind, but *riding the wind*. If we want to sail on the seas of tomorrow, we must learn about *riding* the Earth - not harnessing the Earth - not capturing or exploiting the Earth, but *riding the Earth*. Astronauts *ride* their space module. They have learned about its "rhythms" and they religiously relate to them lest they be stranded in space. They don't tear their space module apart making pieces to entertain themselves on their journey - they would be committing suicide if

they did this. Buckminster Fuller was one of the first to call the Earth a space ship. Its rhythms are our only hope of survival. If we tear it apart to amuse ourselves on our journey, we are committing suicide. The systems and rhythms of a NASA space module evolved for the purpose of sustaining the lives of the astronauts. The astronauts themselves evolved through training relative to these systems. The same is true for our space module - the Earth. We were originally born out of its systems and rhythms and they will sustain us through millennia, not a big power plant with a big pile of plutonium. If the astronauts found themselves cold in their space module, would they gather up paper to build a fire on the floor? If they did, they would not be able to breathe then they would blow up. Does this sound familiar?

The Earth is our space module flying through space. We are riding it. The EARTHSHIP concepts serve as our operator's manual. We can self-destruct shortly after launch or we can sail into the future on the wings of universal energy patterns.



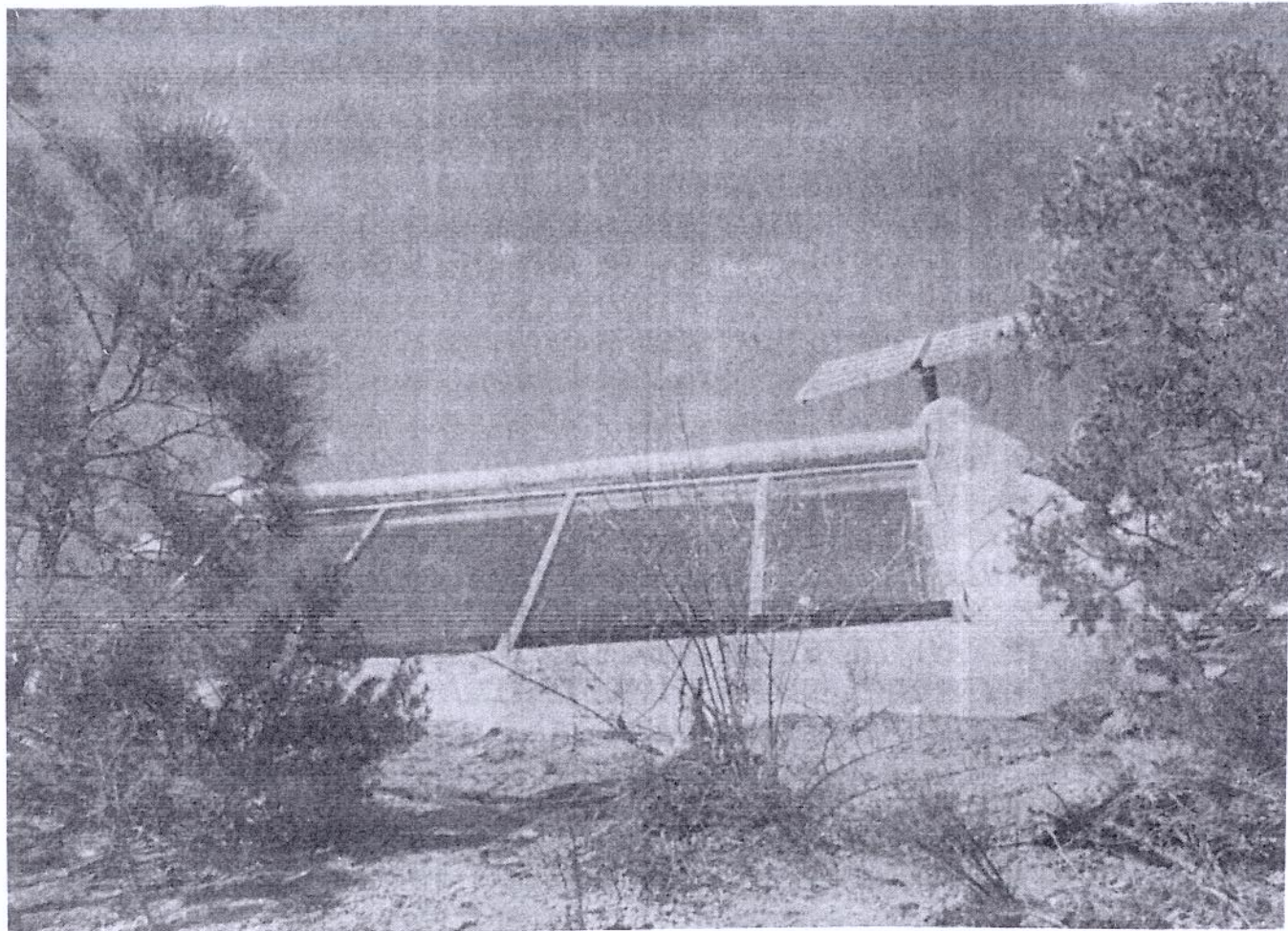
CAN YOU TOUCH THE GLOW OF MORNING AS IT DRIFTS INTO A DAY  
CAN YOU BE THE MIGHTY MOUNTAIN WHEN YOU NEED TO BE THAT WAY  
CAN YOU SEE THE GOD OF THUNDER AS HE ROLLS ACROSS THE SKY  
CAN YOU SEE HE'S DROPPING FLOWER PETALS DOWN ON YOU AND I  
CAN YOU FEEL THE REELING ENERGY FROM EVERY LIVING THING  
CAN YOU SEE IT MAKES US HAPPY  
CAN YOU SEE IT MAKES US SING

CAN YOU SEE INTO THE RAINBOW  
CAN YOU SEE INTO THE WIND  
CAN YOU SEE INTO THE STARLIGHT  
CAN YOU SEE INTO YOUR FRIEND  
CAN YOU YIELD INTO THE MOONLIGHT  
CAN IT PENETRATE YOUR EYES  
CAN YOU SEE IT MAKES US PEACEFUL  
CAN YOU SEE IT MAKES US HIGH

CAN YOU PEEL AWAY YOUR DOGMA  
CAN YOU PEEL AWAY YOUR FEAR  
CAN YOU SEE YOUR JOURNEY'S ENDING  
CAN YOU SEE IT STARTED HERE  
CAN YOU PASS INTO THE SPIRIT  
CAN YOU SEND IT WITH YOUR EYE  
CAN YOU SEE IT MAKES US RISE UP  
CAN YOU SEE IT MAKES US FLY

*COME FLY WITH ME*

PART ONE  
SYSTEMS OF THE EARTHSHIP



SOMETIMES IN NEW MEXICO WE GO UP INTO THE MOUNTAINS AND CUT STANDING DEAD TREES FOR OUR ROOF BEAMS. WE DRIVE THROUGH THE MOUNTAIN ROADS LOOKING FOR THEM. THEY ARE EASILY VISIBLE, AS THEY HAVE NO FOLIAGE. WHEN WE SPOT A STANDING DEAD, WE CUT IT, TRIM THE LIMBS OFF AND DRAG IT TO THE TRUCK. OFTEN, THESE ARE 18 TO 20 FOOT LONG LOGS ABOUT 12" IN DIAMETER. THEY ARE QUITE HEAVY AND IT USUALLY TAKES THREE OR FOUR PEOPLE AND/OR A WINCH WITH A HUNDRED FOOT CABLE TO DRAG THEM TO THE TRUCK. IN TERMS OF MONEY (IF YOU ARE PAYING THOSE WHO HELP YOU), THIS CAN GET EXPENSIVE. THERE WERE TIMES, BEFORE I HAD A WINCH, WHEN I DIDN'T REALLY HAVE THE MONEY TO HIRE HELP, AND I NEEDED LOGS. I WENT ANYWAY. I DROVE UP INTO THE MOUNTAINS AND FOUND SEVERAL STANDING DEAD TREES ON THE UPHILL SIDE OF THE MOUNTAIN ROAD. AS THE PRIMITIVE ROADS WERE CARVED OUT OF THE MOUNTAIN SIDE, A VERTICAL CLIFF SOMETIMES TEN TO TWELVE FEET HIGH WAS FORMED. I BACKED MY TRUCK (WHICH HAD HEAVY DUTY RACKS), RIGHT UP INTO ONE OF THESE CLIFFS. UP THE MOUNTAIN SIDE I WENT WITH MY CHAIN SAW AND CUT SEVERAL STANDING DEAD TREES, TRIMMED THEM AND SIMPLY GUIDED THEM DOWN THE MOUNTAIN. I HAD A FRIEND WHO HELPED ME FOR FREE - GRAVITY. THERE ARE MANY FRIENDS LIKE GRAVITY WHO CAN HELP US LIVE FOR FREE. THEY WERE OUR DESIGN CONSULTANTS FOR THE EARTHSHIP, AND NOW THEY WILL BE OUR CONSULTANTS FOR THE SYSTEMS OF THE EARTHSHIP.

# 1. SOLAR ELECTRIC

## S Y S T E M S

THE OPERATION OF A SAILBOAT REQUIRES AN UNDERSTANDING OF THE CONCEPTS AND SCHEMATICS OF SAILING AND *KNOWING THE PATTERNS AND NATURE OF THE WIND*. THERE ARE MANY DIFFERENCES BETWEEN THE OPERATION OF A GASOLINE POWERED SPEED BOAT AND A WIND POWERED SAILBOAT. THE MAJOR DIFFERENCE IS THAT IN A SAILBOAT YOU WILL *NEVER RUN OUT OF GAS*. OTHER DIFFERENCES INVOLVE POLLUTION, NOISE, WEAR AND TEAR, AND REPAIR OF MOVING PARTS. THE DIFFERENCES BETWEEN CONVENTIONAL ELECTRICITY AND SOLAR ELECTRICITY IN A HOME ARE SIMILAR TO THE DIFFERENCES BETWEEN A SPEED BOAT AND A SAILBOAT.

THIS CHAPTER WILL COVER THE CONCEPTS AND SCHEMATICS OF SOLAR ELECTRIC SYSTEMS FOR EARTHSHIPS. IT WILL ALSO DISCUSS HOW TO USE A SOLAR ELECTRIC SYSTEM RELATIVE TO THE *PATTERNS AND NATURE OF THE SUN*, AS DISCUSSED IN CHAPTER TWO OF EARTHSHIP VOLUME I. LITTLE ATTENTION WILL BE GIVEN TO SPECIFIC WIRING DETAILS, AS THESE ARE COVERED IN MANY ELECTRICAL WIRING MANUALS ALREADY IN PRINT (see Appendix, Chapter 1). THE OBJECTIVE HERE IS TO PROVIDE THE EARTHSHIP OWNER WITH AN UNDERSTANDING OF THE *NATURE* OF SOLAR ELECTRICITY, HOW IT IS COLLECTED AND STORED, AND HOW TO LIVE WITH IT.

A major design factor of airplanes is to reduce weight so that not as much expensive fuel will be required to fly. A major design factor of solar powered dwellings is to reduce the electrical load demand so that not as much expensive equipment will be required to live. It is not a matter of doing without. It is a matter of **energy-conscious design** resulting from careful preliminary analysis of both the owner and the dwelling.

### PRELIMINARY ELECTRIC ANALYSIS

Photovoltaic electric systems can be very complicated and almost prohibitively expensive for conventional "energy hog" housing. **Earthships** are a result of energy conscious design and, by their very nature, come a long way toward reducing the electrical requirements of living. Owners, via **energy-conscious living**, can come the rest of the way. The dwelling and the owner must be carefully analyzed in terms of electrical requirements placed on the photovoltaic electric system, *before design of the photovoltaic electric system begins*. The purpose being to **reduce the electrical requirements to a minimum via other inherent design features of the dwelling**. The result of this is a minimal solar electric system that will be economically within the grasp of the average homeowner. We can begin this analysis by looking at the systems required for a typical

house. We will see why and how they use electricity and then see if we can find a "friend" to provide this energy for free.

### **HEATING AND/OR COOLING SYSTEMS**

Many domestic heating and cooling systems are powered electrically. These systems consume tremendous amounts of electricity. It is not practical to try to get this electricity from the sun with current technology. This would be like trying to pull a train with a huge team of horses - possible maybe, but not practical. Most gas fired domestic heating and cooling systems require electricity of some sort, regardless of the fact that they are fueled by gas. This electricity powers pumps, fans, control panels, etc. These present a *continuous* draw of electricity which would tax a solar powered electrical system. Heating and cooling i.e. (maintaining temperatures near the accepted comfort zone) are **inherent qualities of the Earthship design**. The initial design of the Earthship allows the natural phenomenon of Thermal Mass (one of our "friends") to prevail and thereby presents the reality of *avoiding a heating or cooling system of any kind*. Specifically, if you don't break too many of "the rules" outlined in EARTHSHIP Vol. I, you can totally avoid the necessity of a heating or cooling system, and therefore cut out any requirement of electricity for such a system.

The initial design of your Earthship plays an important role in determining your electrical needs.

A fireplace, a small, ventless gas heater\* or a minimal wood stove (none of which require electricity), strategically placed and used only on rare occasions, is all that an Earthship should ever need for heating. Cooling is handled by venting, shading and proximity to the thermal mass inherently built into the Earthship. The thermal mass of the Earthship is warmer than the winter air and cooler than the summer air. It is a constant equalizer of Earthship temperatures. In all climates, thermal mass (as explained in EARTHSHIP Vol. I, pages 11-13) is "our friend" - a factor of design that can help us completely avoid the use of electricity for heating and cooling. If you want a car that goes fast, you must let aerodynamics prevail in the design. *If you want an Earthship that requires no heating or cooling systems, you must let thermodynamics prevail in the design.* The severity of your heating and/or cooling needs will determine how seriously you must relate to prevailing thermodynamic phenomena in order to avoid any use of electricity for habitat temperature control. Chapter Eight - GRAVITY SKYLIGHTS, has more discussion on ventilation and cooling via natural phenomenon. That chapter further

\*1 see Appendix, Chapter 1.

illustrates how the Earthship itself is its own heating and cooling system.

## WATER SYSTEMS

Conventional water systems, whether community or individual, always require a significant amount of electricity for pumping and pressurization. Consequently, water use can be one of the major load demands upon a domestic photovoltaic electric system. *Design and location of the Earthship, relative to its water system, can reduce and sometimes eliminate this electrical need.* The methods and approaches to Earthship water system design are covered in Chapter Two. They involve four "friends" - Gravity, Sun, Wind and Rain. Again, the point is that, **the initial design of your Earthship, relative to the free and reliable help from natural phenomena, plays an important role in determining your electrical needs.** In Chapter Two we see how one can completely eliminate (or at least drastically reduce) the electrical load demand of water supply and distribution. This can be done with a catchment system integrated into the Earthship design.

## DOMESTIC HOT WATER SYSTEMS

Domestic hot water is usually produced by either gas or electricity. The first step here would be to choose gas, as it is more efficient and less devastating to the planet to use than electricity.

However, solar hot water systems can produce a significant amount of domestic hot water, especially in the sun-belt areas. Alternative and more efficient hot water systems are discussed in Chapter Four. The issue at hand is for the home owner to produce hot water via gas power, solar power, or a combination of the two, therefore **avoiding the use of any electricity for hot water production or circulation.** This will require certain design features in your Earthship that must be inherent to the Earthship itself as seen in Chapter Four.

### LIGHTING SYSTEMS

The choice and location of lights is a major factor here. Most often, lighting is chosen with aesthetics as the major issue and efficient use of electricity is not even considered. Many light fixtures waste a lot of energy in order to produce "an effect". In a photovoltaic powered Earthship, every light fixture must be examined individually for efficient use of energy and production of light. This will result in dramatic reductions in the energy consumed for lighting. Lighting systems will be discussed in depth in Chapter Five.

The Earthship is inherently flooded with natural light in the daytime via solar windows and skylights. Rarely do any lights need to be used in the daylight hours. This fact, along with careful

selection, design and use of night lighting, can result in the Earthship using a fraction of the usual amounts of electricity that a "normal house" uses for lighting.

### OTHER SYSTEMS

The following systems do not represent major draws of electricity individually, but they illustrate how much everything we do has become dependent upon electricity and their collective effect is significant. *It is amazing just how much electricity a normal house consumes from various gadgets, pumps, timers, minor systems, and other devices even when no one is at home.*

#### Telephones

Since electricity is taken for granted, many phone systems have become dependent upon electricity. A simple telephone does not require household electricity, however, the combination phone/intercom systems, cordless phones, and other auxiliary gadgets related to the phone do require electricity. In most cases this is a small but constant draw of electricity. It is advisable to avoid using these auxiliary telephone gadgets if possible, since they require a constant draw of electricity. The ones that are used should be set up so that one can turn them off and on only when needed, instead of allowing them to constantly use precious electricity. The telephone itself should not be dependent upon electricity,

Intercom systems should be separate from the telephone and have an on/off power switch to conserve power usage.

For totally remote sites with no phone lines, cellular phones similar to the type used in automobiles are required. These require electricity but should be installed with switches for turning power on only when in use. See Appendix this chapter.

#### Central Vacuum Systems

A central vacuum system is convenient, but it requires a much more powerful motor to create suction over long distances. A small vacuum cleaner that can be carried from room to room uses less electricity for its smaller motor and is preferable. In a large home, a "central vacuum" system should be divided into two or three smaller-motored, sub-central vacuum systems placed in strategic positions throughout the Earthship. These will require less energy for their smaller motors.

#### Alarm and Security Systems

Many people live where security systems are a must. If this is the case, choose and analyze the system you use, relative to how much and how often it requires electricity. If possible, have it controlled by DC power. When you reduce the amount of equipment dependent on your AC

inverter, the smaller and less expensive it will be. Inverters will be defined and discussed on the following pages.

#### Automatic Watering Systems

Automatic watering systems require control boxes that use electricity. Many electronic control devices have difficulty with AC (110 volt) power converted from DC (12 volt) batteries. Converted AC electricity is not exactly the same as line-grid electricity. The result is that the miniscule circuitry of the control and timing devices do not perform the same way as they would on grid AC power, i.e. devices do not always work how and when they are supposed to. Consequently, DC control boxes are necessary for timed devices such as watering system controls. There are solar powered DC watering systems\* on the market that are *independent of the domestic power system*. They have their own solar panels, batteries and DC control boxes. This facilitates keeping the main domestic power system simple, small, inexpensive, and is the recommended way to go. Another important factor of watering systems is the controlled use of "grey water" which allows you to water a planter while brushing your teeth. Grey water systems (discussed in Chapter Three) help reduce the need for automatic watering systems and the resulting electrical demand.



### Appliances

All appliances used in solar powered dwellings should be analyzed with regard to constant draws of electricity. For example, many gas ranges require electricity for timers, clocks, burner ignitions, etc. Microwave ovens can come with elaborate timers which draw electricity *all* the time. They also come with simple timers which only use electricity when the unit is being used. The owner of a solar powered home should carefully select which appliances he/she really needs, and then purchase the ones that are OFF when they are not being used. Over 50% of the appliances today still use electricity even when they are not in use.

Do not use electric clocks in a solar home. They are not likely to work well anyway, since the inverted AC power is not "clean" enough for their needs. They are also a constant draw of electricity. There are many other types of clocks available, quartz for example. When there is a choice, always choose the device which does not need electricity. This will keep your solar electric system simple and economical.

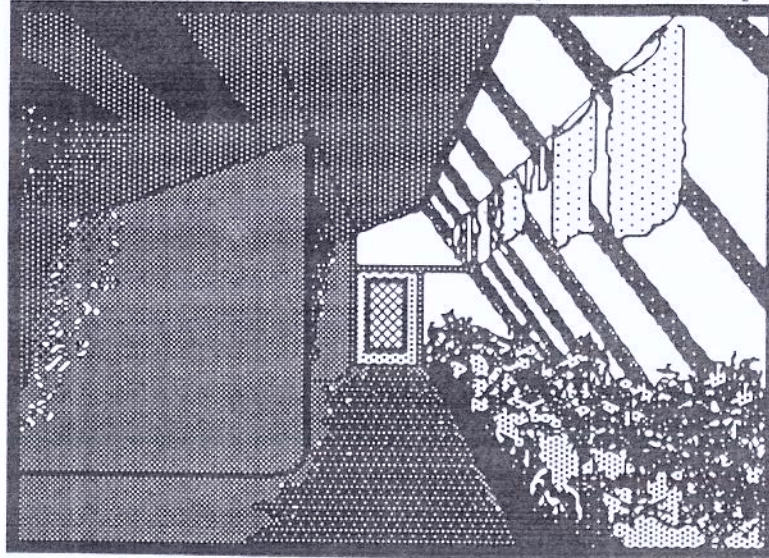
Conventional electric refrigerators are too inefficient to use in a solar powered home. There are now two DC refrigerators on the market.\* They are better insulated, more simple and use

\*2 see Appendix, Chapter 1.

much less solar power than conventional models.

Gas refrigerators are also an option, though not as "free" to operate as the DC solar electric models. The Real Goods Catalog (see Appendix Chapter 1) has many energy efficient appliances listed, priced, and reviewed. Solar Survival is currently working on a thermal mass refrigerator that will use even less electricity than the DC refrigerators.

Gas clothes dryers must be used. There is, of course, the timeless and always reliable solar clothes dryer... a clothes line which will work amazingly well year-round inside your Earthship!



Conventional clothes washing machines will work but choose a simple model. The elaborate, deluxe

appliances with more gadgets & accessories use more electricity and have more of a problem functioning on the inverted AC power. Dishwashers work also, but, again, a simple model must be chosen. Radios, VCR's, compact disc players and stereos all work on solar power, however, much of this equipment draws power constantly. Your entertainment center should have its own off/on power supply switch which allows you to shut the system off completely when not in use. In many cases a good automobile cassette or compact disc player has been used on a DC circuit just like in your car. This keeps one more appliance from going through your inverter.

**OVERALL, THERE ARE SEVERAL THINGS TO REMEMBER WHEN USING APPLIANCES:**

- 1) Think carefully about whether or not an appliance is really needed.
- 2) Choose non-electric appliances when ever possible.
- 3) Choose DC appliances when available.
- 4) Choose an appliance that is really OFF when it says it is "OFF".
- 5) Do not choose appliances that have many electricity consuming gadgets and accessories - especially timers, brains, etc. which won't work well on inverted power.
- 6) If an appliance does have a constant draw of power, provide an off/on power supply

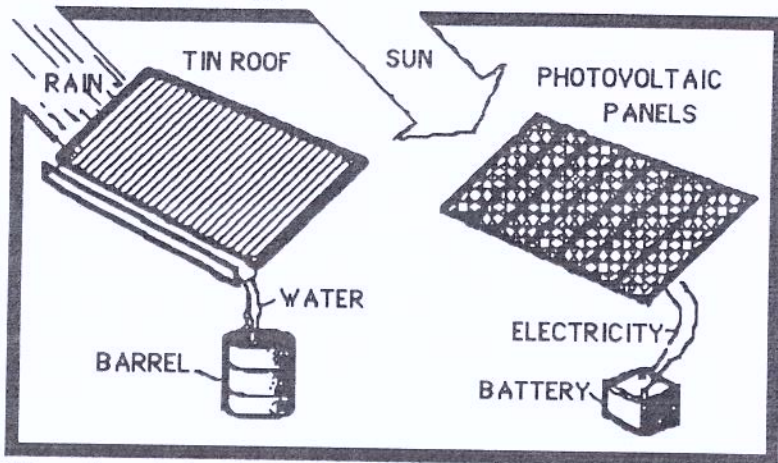
switch to that appliance.

Our overall objective is to **eliminate, reduce or control** all constant consumption of electricity. The bottom line with the analysis of each of the above systems has been to reduce or eliminate the electrical demands of that system. This involves redesigning the system, re-evaluating owner needs, and in most cases incorporating design features relative to the system into the Earthship itself. **Do not think of the dwelling as separate from its systems.** Think of our bodies. They are a *product* of their various systems - so should the Earthship be a product of its various systems. **The systems are an inherent part of an Earthship.** Regular housing, no matter how elaborate, is usually a box with a variety of energy consuming systems attached to it. The Earthship concept dictates that these systems BE the conceptual building blocks of the dwelling itself. Every system will be discussed in-depth in the following chapters. The purpose here is to establish the fact that analysis of the systems, relative to energy-conscious design and living, and the integration of the systems INTO the Earthship design, results in a **minimal electrical requirement**. This requirement can be economically satisfied by solar power. This is called **DESIGNING DOWN** your energy requirement. Now that we have the solar

electrical system itself minimized, we must understand the basics of it and integrate IT into the Earthship design.

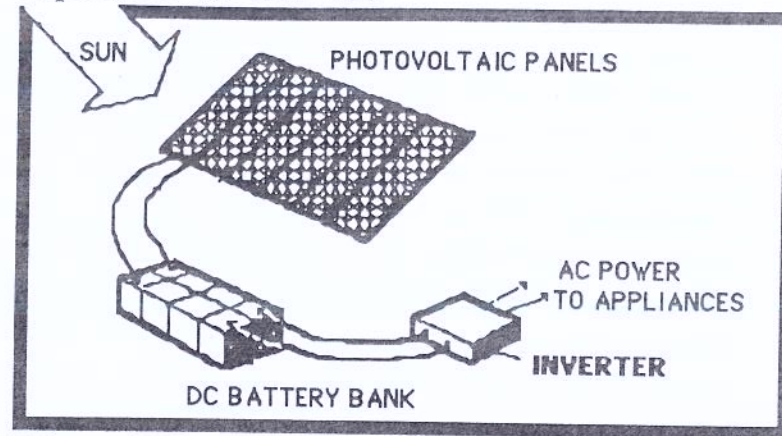
### THE BASICS OF PHOTOVOLTAIC ELECTRICITY

Energy is gathered via **photovoltaic** panels which convert sunlight into small charges of electricity. This electricity is then delivered to and stored in **batteries**. This is much the same as a tin roof that gathers rain and delivers it to be stored in a barrel.



The electricity is gathered and stored as 12 or 24 volt DC current. Most of our appliances are 110 volt AC current, so the electricity that we have captured from the sun must pass through an **inverter**, which changes it from DC to AC power. **The less current that has to go through this inverter, the smaller and less**

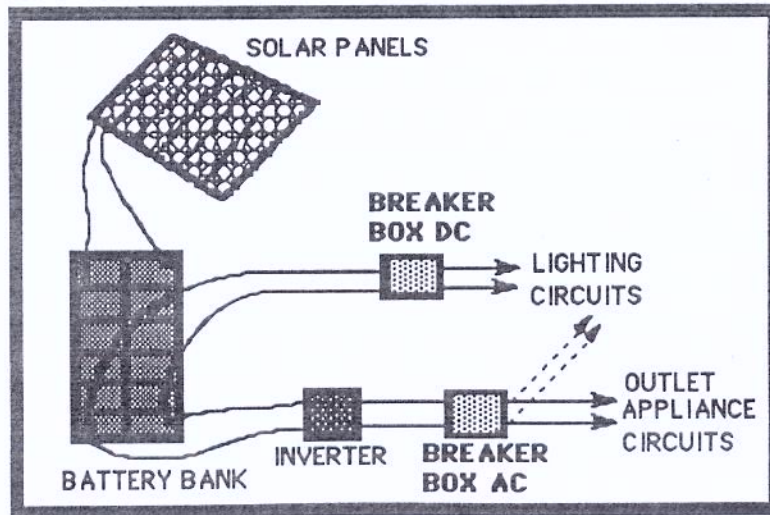
**expensive it will be.**



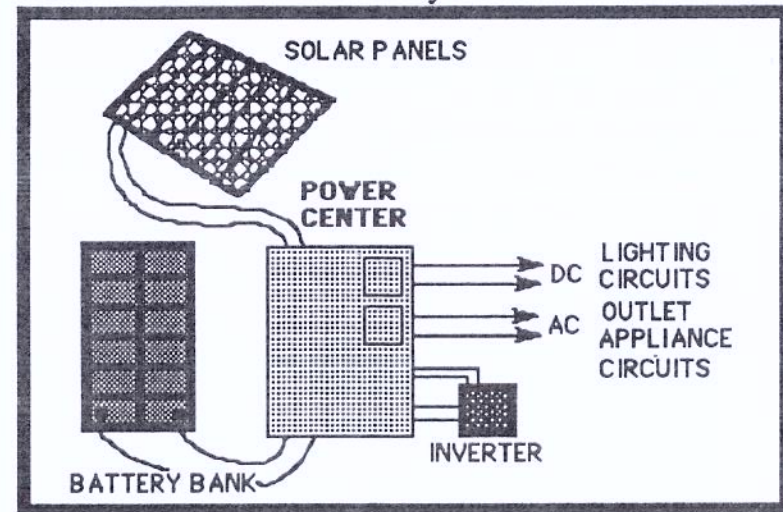
When ALL the power to be used must pass through the inverter, the system becomes *totally dependent* upon the inverter. If the inverter malfunctions, you are without power of any kind. This process of changing DC electricity to AC electricity also results in a loss of about 10% of the energy that has been captured from the sun. Furthermore, the AC inverter can get expensive if it has to handle too much power. These facts have caused many solar energy users to try to use only the DC power. This works well with lighting because there are many DC lights available on the market today. However, currently there are not enough household appliances on the market that work on DC power to satisfy the average person. As a result, sole use of DC power may be too limiting for some people. A combination of the two (DC for lighting and AC for appliances) is a good method of dealing with this situation. With this

combination system, if the inverter malfunctions, one still has lights which function directly from the batteries. Also, the lighting system is not subjected to the 10% energy loss caused by converting from DC to AC. The inverter doesn't have to be as large in this set up because lights are not running through it. The DC/AC combination is more efficient, more economical, and somewhat more reliable than a total AC system.

Regular circuit breaker boxes are used in a solar electric system. They occur after the inverter for the AC side of the system and after the batteries in the DC side of the system. From the circuit breaker boxes on, everything else in the system is quite normal. There will be a breaker box for the lights on the DC branch and a breaker box for the appliances on the AC branch, after the inverter.



This diagram schematically represents the major factors and flow of a solar electric system. This schematic is over-simplified and is only for understanding the collection, storage and distribution of electricity. Realistically, there are also charge controllers, in-line gauges, main-disconnect switches, and other devices required in a functional schematic. These are available as a **power center** which can include both AC and DC breaker panels.\* This unit is designed to provide you with all of the necessary equipment put together in a way that meets electrical codes. In many cases a power center is easier and more economical than installing gauges, breaker panels, disconnects etc. individually.



When a power center is used, everything goes into it for total control of the system at one spot.

\*3 see Appendix, Chapter 1

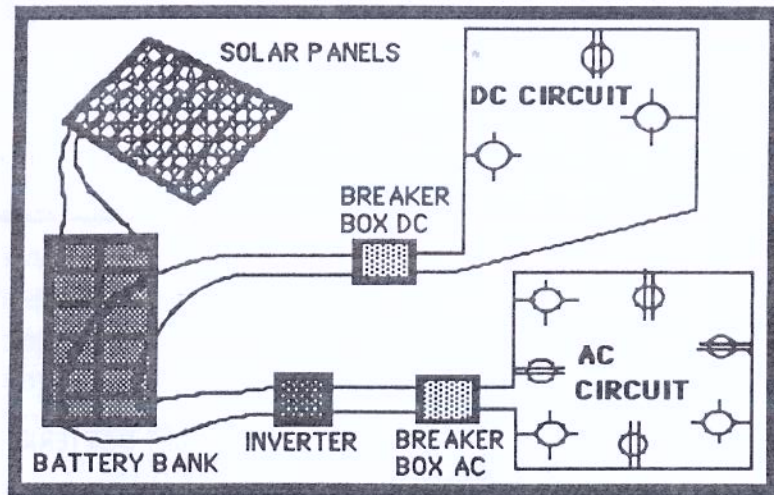
One major disconnect for the entire system can be located here. This disconnect shuts off (disconnects) everything.

The gauges in a solar electric system are similar to those on the dashboard of your car. They tell you the condition of your batteries, how much power you are using from your lights and appliances, how much you are getting from the sun, etc. Gauges can be part of the power unit or installed individually. They can be as involved and elaborate as you have money for, or they can be as simple as two or three gauges that, in a flash, can tell you if everything is ok. They should be located in as prominent a place in your Earthship as your fuel gauge is in your car. Gauges are available as remote units and can be placed anywhere in your home, i.e. remote from the room where your power center is.

The DC current is somewhat sluggish compared to the AC current much the same way oil is sluggish when compared to water. Just as the oil requires a much larger pipe to deliver it at a comparable pressure to water, so does DC current require larger wires to deliver at a comparable voltage to AC current. For this reason, in normal applications 10 gauge (heavier) wire is used for DC current, and 12 gauge (lighter) wire is used for AC current. In this situation, the heavier DC circuit for lights can also be used at any time for

AC current as AC current works equally well in heavier wire. This allows the entire dwelling to be switched to AC if the owner should so desire and also allows solar dwellings to be wired absolutely conventionally up to the circuit boxes (the heavier wire in the lighting circuits still qualifies as conventional). This is a good idea, since many electricians and code inspectors are not yet familiar with photovoltaics. A conventional house wiring system saves the owner many headaches relative to the inspector's and the electrician's job. The entire photovoltaic system is then considered to be just the POWER SUPPLY to the circuit boxes for a CONVENTIONALLY WIRED DWELLING.

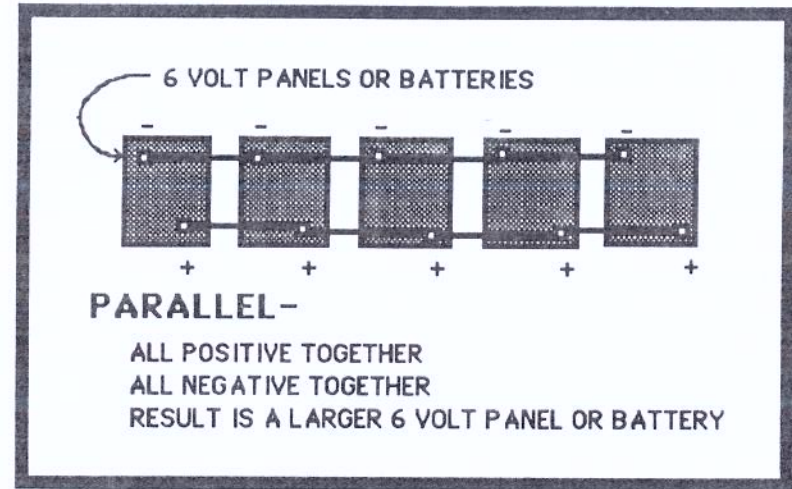
Due to the sluggish DC current, fewer outlets or lights can be put on one circuit in a DC system, than in an AC system. The sluggish DC current will drop in voltage after about three lights or outlets whereas an AC circuit can handle about eight lights or outlets. This is speaking generally, and it ultimately depends upon the actual use the circuit is designed for.



## THE COLLECTION PANELS

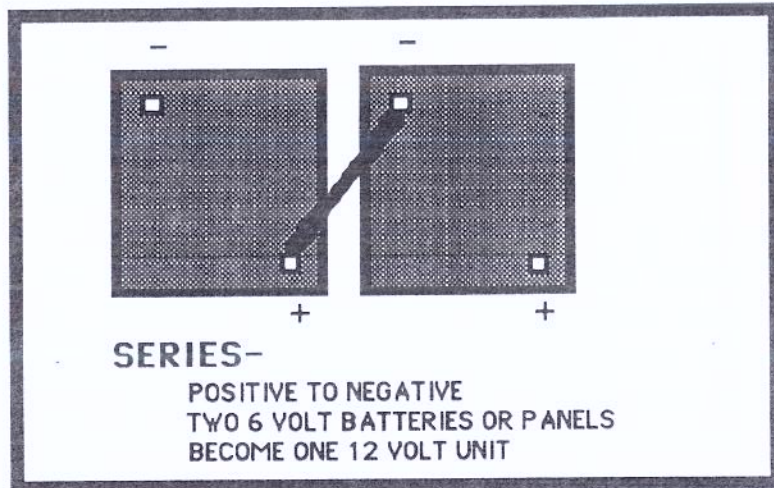
### PHOTOVOLTAIC - VOLTAGE FROM LIGHT

The collection panels come in various sizes, most commonly ranging from 12" x 48" to 18" x 36". The average panel puts out about 40 to 55 watts and costs between \$250 to \$350. If you shop around, you may find slightly better deals. Sometimes, used panels are available. Since there are no moving parts that wear out in a PV panel, used units are a fairly safe bet. Each panel has a positive and a negative post - just like a battery - and they can be wired in parallel or in series just like batteries. **Parallel** wiring is hooking all the positive posts of a battery or panel together and all of the negative posts together. The following diagram shows many six volt batteries or PV panels wired together with parallel wiring.

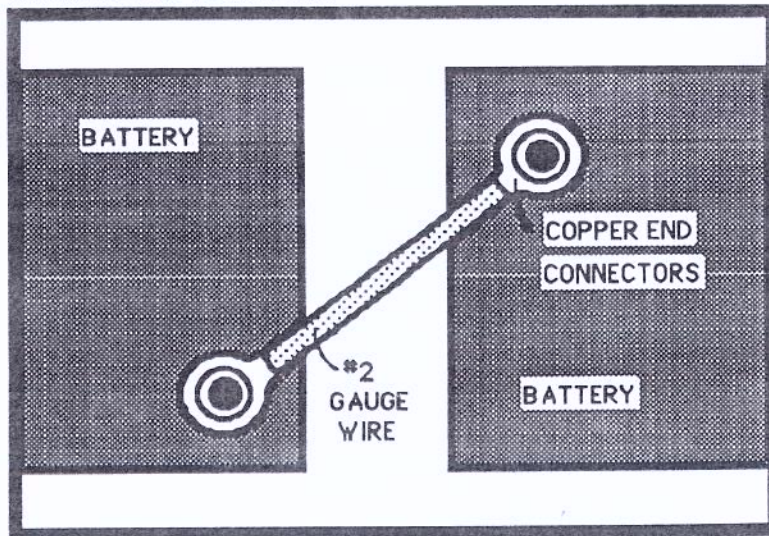


The result is a more powerful six volt battery.

**Series** wiring is a method of changing voltage. For instance - two six volt batteries wired in series results in the sum of the voltages of the two batteries. This is accomplished by wiring the negative post of one to the positive post of the other.

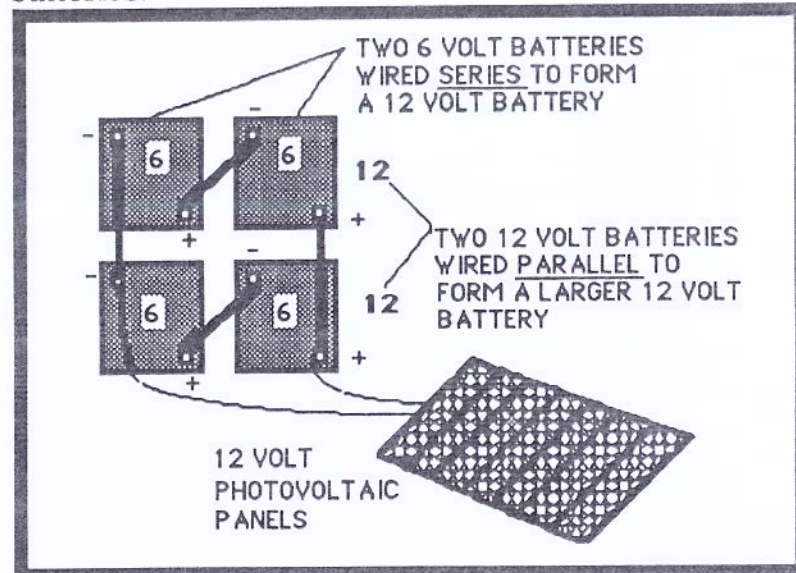


Heavy gauge wire (#2 or #4 gauge) is needed for both series and parallel wiring of batteries to prevent voltage losses between batteries. Copper end connectors are necessary to connect the heavy wires to the batteries.\*



Most available batteries are 6 volt and most panels

come in 12 volt. Therefore, batteries must be ganged in series to form 12 volts and parallel wired to increase the "size" of the 12 volt batteries.



Any two six volt batteries can be made into a 12 volt battery via series wiring. The 12 volt batteries can then be wired parallel to become just a larger 12 volt battery.

The panels usually come in 12 volt units. If you "gang" them or wire them in a series, the voltage can be changed from 12 to 24 or 36, etc. This is sometimes necessary, since AC inverters come in 12, 24, and 36 volt units. 12 volt and 24 volt are most common. **The array of panels and the battery bank both have to conform to the**

\*4 see Appendix, Chapter 1

**voltage of the inverter being used.** You could, therefore, have a 12 volt system, 24 volt system, etc. The choice between 12 volts and 24 volts would relate to whether you use all AC power or a combination of AC for outlets and DC for lighting. If you use a combination, a 12 volt system should be used because 12 volt lights are easier to get than 24 volt lights. Further, 24 volt appliances are not as easily available as 12 volt appliances. If you plan to run some lights and a few appliances on DC power, you should go to a 12 volt system, as it is easier to acquire 12 volt appliances and lights. The choice of voltage for your system will also relate to size. Small systems (for a two bedroom home) can easily be 12 volt. Larger homes require larger systems (higher voltage) which get more complicated. For this reason we recommend 2 or 3 small systems (see diagrams page 23) for a larger home. This allows you to stay 12 volt and stay simple. Many engineers and dealers do not yet agree with this. It is easy for an engineer to live with and understand a complex system but the average person would prefer a simple system repeated two or three times in different "wings" of the home.

The panels must face the sun, and so, must have the potential to be adjusted easily (four times a year) in order to be as perpendicular to the sun as possible throughout the seasons of the year - low

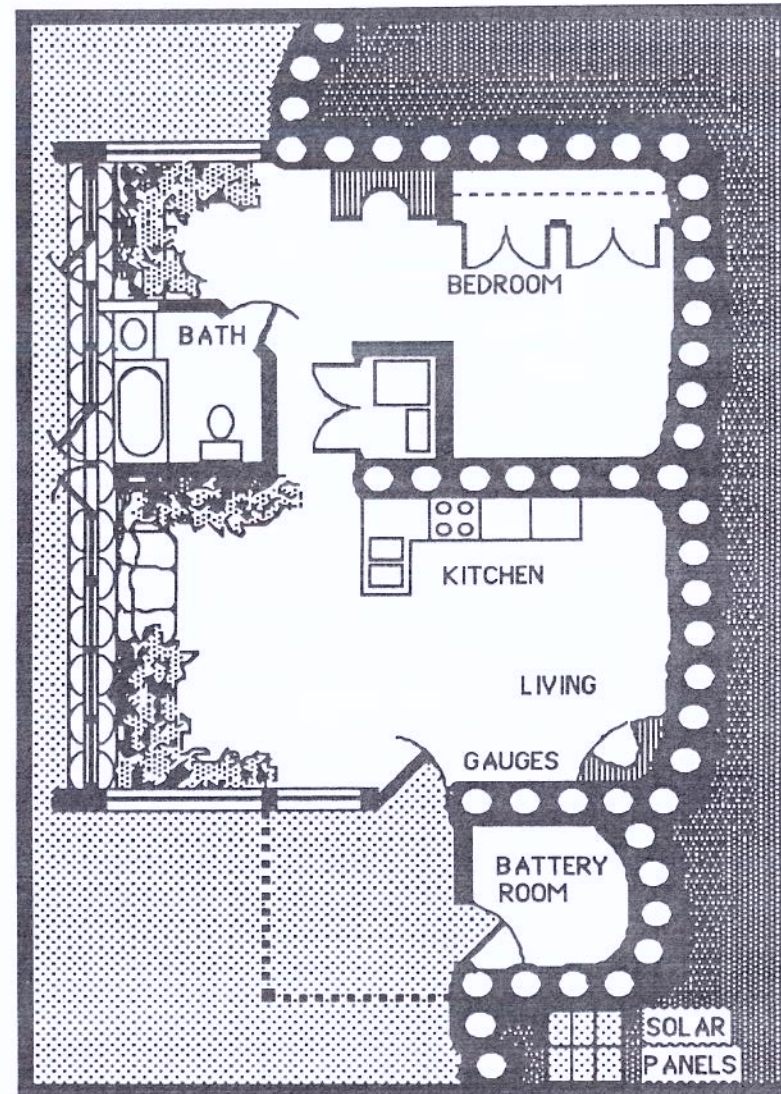
sun in winter and high sun in the summer (see Earthship Vol. I, Chap. 2). There are many adjustable mounting devices for panels on the market.\* It often makes sense to mount the devices directly on the Earthship itself for better proximity to the batteries. Some mounting devices have trackers to follow the sun. This makes it possible to get by with fewer panels, but the cost of the tracker usually offsets any savings for homes in the sun belt. An important issue in mounting is that the panels should not be flat against anything. Panels need air circulation around them to keep cool and sufficient space for wiring behind the panels. The panels must also be kept accessible. There should be no shadows from trees, buildings, chimneys, vents, etc. cast onto the panels at any time of the day, or of the year. One little shadow can "turn off" one whole panel. The panels must be as close as possible to the batteries which are storing the electricity. Due to the sluggishness of the DC electricity collected by the panels, the voltage drop can be significant if there are long distances between panels and batteries. Long distances require very heavy gauge copper wire and *copper is expensive.* For the same reason, batteries should also be centrally located in a large Earthship to avoid long, expensive runs of heavy gauge copper wiring for the dwelling itself. This central

\*5 see Appendix, Chapter 1.

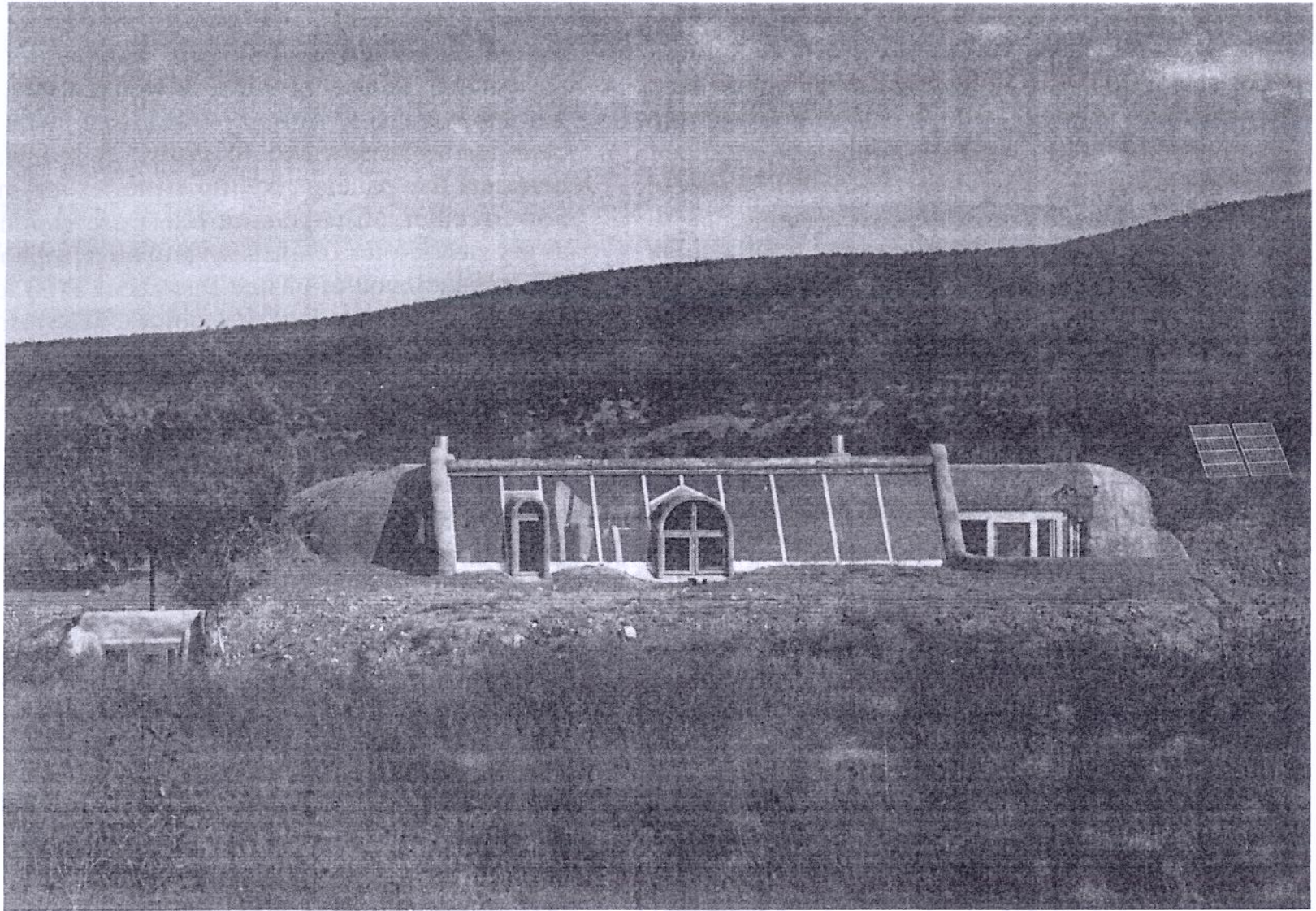


location of the batteries will also help to determine the most appropriate and economic location for the panels. The following diagram and photo illustrate a simple Earthship with battery room and adjustable array of photovoltaic panels positioned close to the battery room. This particular Earthship is small, so any location near the building is o.k. In a larger home, the battery room and panels should be more centrally located with respect to all spaces. However, if 2 or 3 small, simple systems are used in a large home, a simple 12 volt system would just be repeated with a nearby battery room for each system.

The PV panels are as integral a part of the Earthship as the headlights on a car. Therefore, they should be treated as such. Many people attempt to hide them. This is possible but always more expensive, inefficient, and inconvenient.



Floor plan of a typical Earthship



## THE BATTERIES

The batteries used for storing DC electricity collected from the sun are usually 6 volt deep cycle batteries ganged together with series and parallel wiring in order to create one big 12 or 24 volt battery. This is done in order to relate to whatever kind of AC inverter is being used. Deep cycle means something very similar to a deep barrel of water. Deep cycle batteries hold more charge. There are many types on the market. A six volt battery that lasts about five to seven years will cost about \$80. A twelve volt battery that lasts about twenty years will cost about \$200. How long a battery lasts depends upon how it is treated. A seven year battery will last seven years **ONLY IF IT IS NOT ABUSED**. This means that it cannot be overcharged or allowed to be drained too low. Batteries are happiest when they get hot and bubble occasionally. A six volt battery should read as high as 7 to 8 volts (no more) when charging and **SHOULD NEVER GET BELOW 6 VOLTS**. A twelve volt battery should read from 13 to 15 volts when charging and never dip below 12 volts. If you are constantly draining your batteries they will not last very long. Every system should have an automatic disconnect device to cut the load when the batteries get too low. This same device can cut the solar panel charge of incoming electricity when the batteries are too hot. This device is called a charge

controller. For example, in a 12 volt system the charge controller would divert the charge when the voltage reached 15 volts. It would also cut off the load demand from the dwelling when the batteries went down to 11 volts. It is installed between the panels and the batteries or in the power center. Charge controllers are continuing to get smaller, less expensive and more reliable as the industry evolves. They cost about \$100 for an average sized house, at this point\*. They are an integral part of the power center described on page 11. They can also be purchased and installed individually.

All batteries must have their water checked about once every month. This is similar to checking the water in your car battery. There are electronic devices that will alert you when your batteries are low on water. If you do not have this device, then checking the battery water is your trade off for not having an electric bill. Batteries should be filled only with distilled water.

Batteries must be kept in a room temperature environment in order to function at optimum efficiency. **A battery room becomes an important, centrally located factor in any "off the grid" Earthship design.** This room must be kept well-vented and separate from any other electrical or plumbing equipment such as

\*6 see Appendix, Chapter 1

the inverter or the hot water heaters. The batteries actually need a space of their own. It can be a separated, vented section (or box) in a mechanical room but there should be enough space to easily check and top off battery the water.

### THE INVERTER

There are many inverters on the market. Size is a big issue with any inverter. If the power requirement is *DESIGNED DOWN* through the analysis discussed earlier, the inverter can be kept smaller and, obviously, less expensive. Some inverters can be "ganged" like batteries and solar panels. This is an important factor to consider when purchasing an inverter as it allows your system to grow. Expect to spend \$1,100 for an inverter large enough to handle a small home with a *DESIGNED DOWN* power load. The inverter must be kept very close to the batteries due to the voltage drop in the "sluggish" DC current. However, it must be in a separate space from the batteries as a spark from the inverter could cause an explosion in the batteries. Usually battery rooms have a special compartment for batteries and all the other breaker panels, inverter, etc are in the battery room but **OUTSIDE** the vented battery compartment.

The panels, the batteries, the inverter and the gauges (or the power center including circuit

panel gauges and controller) are the main components of a photovoltaic power system. This is very simple for an average two or three bedroom electrically *DESIGNED DOWN* home. Larger homes get more complicated but still use these basic components. S.S.A. or Photocomm Inc. (see Appendix Chapter 1) should be consulted for systems larger than eight panels and ten batteries. S.S.A. currently recommends a series of small eight panel, 10 battery systems for a larger home. We recommend this because we know the cost and performance of the small system. It is therefore very easy to project cost and performance for 2, 3 or 4 of these. Larger systems can get out of control on unforeseen costs, design fees, electricians' dilemmas, maintenance and service, and questionable performance.

### BACKUP

Learning to sail a boat takes practice. Likewise, living in a solar home takes practice. An experienced solar fanatic could take a small photovoltaic system and never have a problem or a care. However, an inexperienced believer who has spent all of his or her life with an abundance of power could get into trouble quite often during the first year or so of solar living. Good advice to the novice is to have a backup source of power if possible. This is to avoid inconvenience and to save and prolong the life of the batteries in case

of an unusual number of cloudy days. There is also the possibility of leaving something on and running down your system. Wind becomes second nature to the sailor but all of us are not sailors yet. A backup system can make learning to "sail with the sun" a more pleasant experience.

Gasoline or propane generators are one method of backing up a system. Another method is simply having an electric hookup that you switch on only for emergency use. Both methods of backup should be set up to charge the batteries only, just as the sun charges the batteries. This way you will always be using the same system. There are "brains" that cost about \$700 to control this automatically.\* If you are using a series of small systems, just have the backup go to one strategic system to provide backup in one main area.

Photovoltaic systems for a two bedroom home can be as small as eight panels, ten batteries, an eleven-hundred dollar inverter and a few simple gauges , i.e. \$5000 or \$6000 with a power center. The same home if not properly analyzed or "*Designed Down*", with an owner *unable to evolve from "gadget dependence"* could need a \$20,000 system. The issues here are **analysis, energy-conscious design and personal evolution**. These three ingredients can work

\*7 and 8 see Appendix, Chapter 1

together to make independence the way sand, cement and water work together to make concrete.

Larger homes need not be more complicated. They can be broken up into "wings", each with its own simple eight panel power system or in some cases ganging two together. This keeps the systems simple and easy to understand. Coordinating and integrating the systems of the various wings may still need guidance by S.S.A.\*

### LIVING WITH A SOLAR ELECTRIC SYSTEM

The bulk of this chapter has provided a basic understanding of photovoltaic electrical systems. This understanding must be established in order to attempt living with a PV system. Now that we understand what we are trying to live with, *let's live with it*.

You get up in the morning. It's cloudy. O.K., you're not going to do a wash today. You don't turn up the heat because your Earthship inherently provides it. You don't need any lights during the daylight hours for the same reason. As a matter of fact, you don't need *any* power today except for a few small things. You're going to get a few FAX messages, so you turn on your FAX machine as needed. Your solar refrigerator is running, but it is so well insulated and

efficiently designed that it can run off and on for several days without really depleting your power system. If there are many cloudy days, a solar refrigerator can be turned off at night and then back on in the morning without spoiling the food. This is possible only because it is so well insulated. The new "mass solar" refrigerators by Solar Survival will allow this as a normal procedure. You need your computer, but it doesn't use that much power and your battery bank is sized to handle this small load for several days. You watch the weather report to see if it's going to be cloudy or sunny for the next few days. (The weather man is getting more and more reliable as the years pass by). If it's going to be cloudy, you don't use many lights tonight and you keep T.V. viewing to a minimum. If it's going to be sunny tomorrow, you plan to do a wash tomorrow, and maybe you'll watch a video movie.

The point is that you stay in tune with the weather and you plan your daily activities accordingly. This is not too much of a problem given the fact that all of your power and household energy is absolutely free for the rest of your life. Your only obligation is that you stay in tune with the daily weather forecast to plan your day, as opposed to doing whatever you want, whenever you want, as often as you want, and having to pay for it through the nose with both money and

destruction of the environment. *Who cares if your kids still have a planet to live on as long as you can do a wash whenever you want and can run the dishwasher so you don't risk getting dish-pan hands?* The idea here is to know that **you will still live through your children after your body is dead and gone.** It's like you have a sandwich and your two kids are with you. Would you eat it all and tell them to find their own, or would you divide it into three pieces and give them each some of it? Well, it's the same with this earth. Do we want to leave some for our children or do we want to *eat the whole thing ourselves?*

When the sun is out, you use as much electricity as you want. When it is cloudy you watch what you do - **or else you fight wars over oil and live with nuclear waste.** That is all there is to it. You watch the weather and your gauges and decide what you want to do and when you want to do it. The sun is your friend, a dependable friend. You know its nature - it is sometimes behind a cloud. You can depend on this also. It's almost like a relationship with another person. This person has moods. The sun has "moods" but unlike another person, it has no ego. We accept the seasons ("moods") for what they are. We ski in the winter and sunbathe in the summer. This is the same attitude we must adopt on a *daily basis* for solar living. Our lives must *gravitate* around

the sun, much the same as the planets *gravitate* around the sun. We allow our lives to gravitate around much shallower things like TV shows, religions, social clubs, football games, politics etc. Why not let something as true, unbiased, reliable and giving as the sun call a few of the shots? This is all it takes to live free of utility bills and with the promise of having a planet for our children to inherit.

Solar living is much the same as sailing in a sailboat. The boat is designed to relate to the wind. The boat is operated relative to what the wind is doing. The good sailor still goes wherever he wants without noise, without pollution, without fear, but with the peace of mind in knowing there will always be wind.

#### Solar Survival Recommendations

Our recommendations are based on twenty years of trial and error in solar living. The technology is constantly evolving and we are constantly learning. These recommendations may be subject to change every six months as we continue to put ourselves in "guinea pig" situations to learn more through further testing of current equipment, as well as testing our concepts (of how to use that equipment) and ourselves.

For an average 2 to 3 bedroom *DESIGNED DOWN* home:

#### **Panels**

8 Kyocera 51 watt panels with pole mount rack

#### **Batteries**

10 to 12 Exide or Trojan 6 volt deep cycle batteries. We do not currently recommend twenty year expensive batteries as technology will be radically improved in seven years. Why be stuck with a 20 year battery?

#### **Inverter**

Photocomm PCUL 12/17 2500 watt inverter. UL continuous output 1700 watts

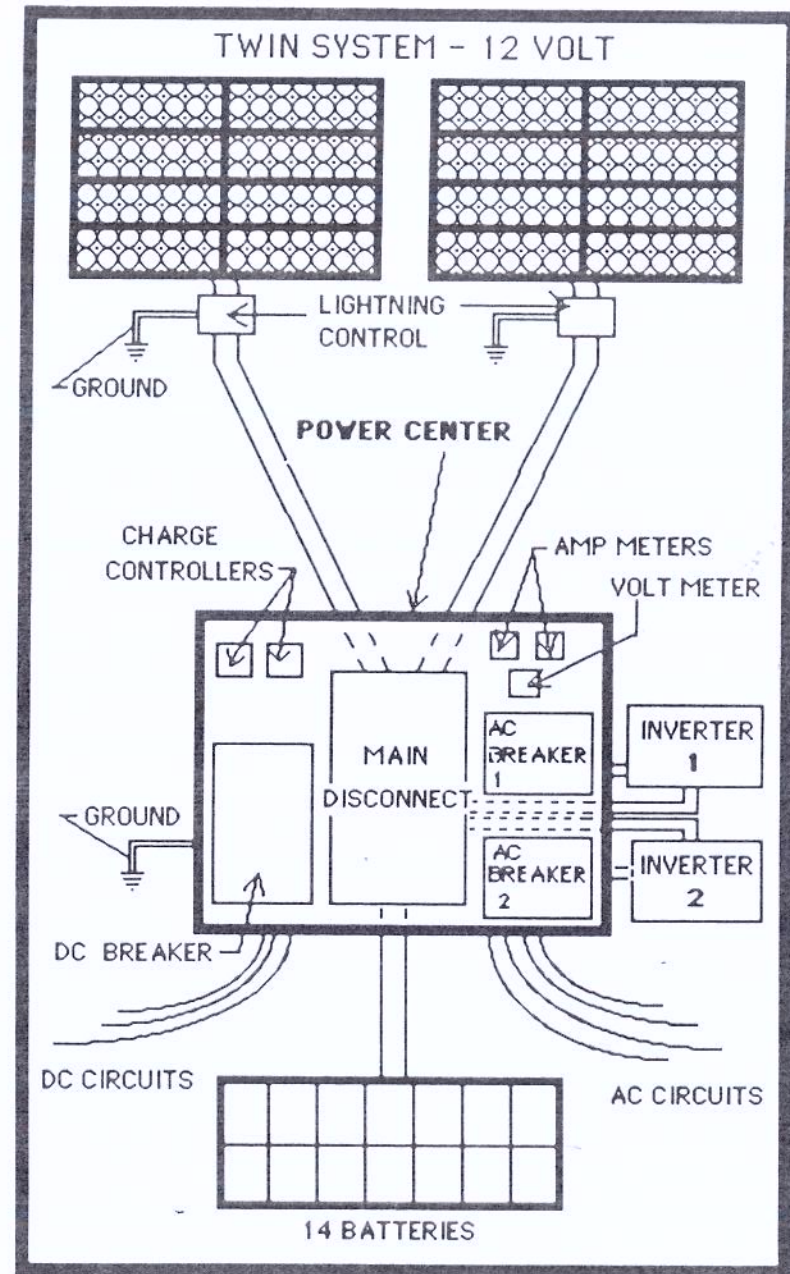
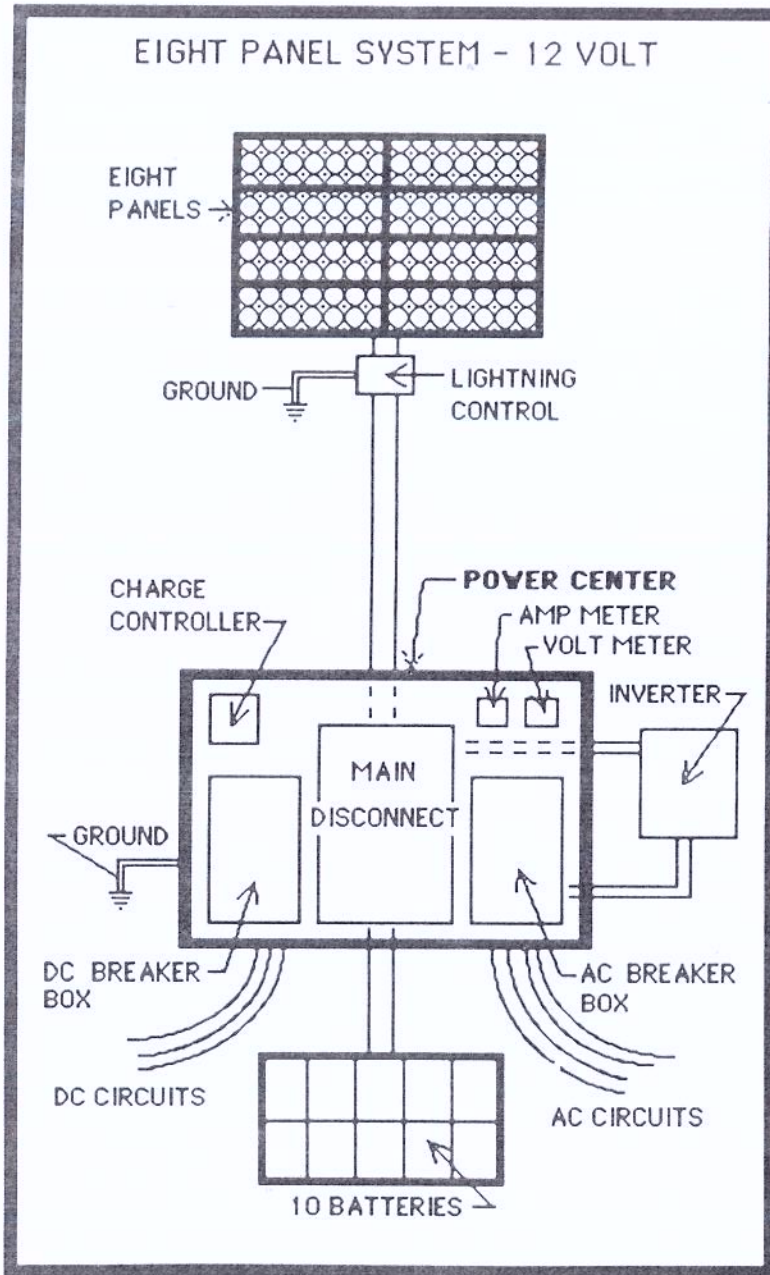
#### **Charge controller**

Photocomm NDR 30 12 volt with manual override usually built in to power center.

#### **Power center**

Custom order from S.S.A. This unit will include the main disconnect required by code as well as amp and voltage meters, AC and DC circuit breaker boxes, charge control and panel disconnects.

The power center described above is a code approved unit that allows you (via diagrams) to hook up your own inverter, batteries and panels to this unit. All the technical electronics work that would require an electrician is done for you inside this unit. You simply custom order the power center with the number of AC and/or DC circuits you want.





### Larger Homes

Break the home up into "wings and use several modules of either or both of the systems diagrammed on the previous page integrated by SSA. Larger "designed" systems can get out of hand on cost and complications very easily. Furthermore, they are hard to understand and service for average home owners and electricians. This small system has proven itself as a reliable, simple and strong system and we know exactly what it costs. Simply duplicating it for a large dwelling (with some technical advice from SSA) is a safe and simple recommendation. Many solar engineers might not agree with this but our recommendation comes from living with and using solar energy for many years - we are currently building a community with modules of this system as the power supply for construction tools - jack hammers, concrete mixers, skillsaws, sanders, etc. When construction is complete, the same system that built the home powers it.

## APPENDIX

### Ventless Gas Heaters

MADE BY VALOR

Order from Solar Survival Architecture

505 758-9870

PO Box 1041 Taos, New Mexico 87571

1. Small - will serve as a backup heater for up to 600 square feet of Earthship space.  
184-N for natural gas  
184-P for LP gas
2. Large - will serve as a backup heater for up to 1000 square feet of Earthship space.  
185-N for natural gas  
185-P for LP gas

### Solar Watering Systems

1. Photocomm, Inc.  
Landscape/Irrigation Division  
1941 Don Lee Place, Suite B  
Escondido, CA 92025  
(619) 741-5690  
or  
Photocomm, Inc.  
Solar Electric Power Systems  
4419 E. Broadway  
Tucson, AZ 85711  
(602) 327-8558
2. Rain Bird Sales, Inc.  
145 North Grand Avenue  
Glendora, CA 91740  
(818) 963-9311
3. Sprinkler Irrigation Supply Company  
4610 McLead Road, N.E.  
Albuquerque, NM 87109 (505) 881-4050

### Solar refrigerators

MADE BY SUN FROST

Available from 4 cubic foot to 19 cubic foot  
Order from Solar Survival Architecture (SSA)  
Box 1041  
Taos, NM 87571  
(505) 758-9870

### Photovoltaic Panels, Mounting Racks, Charge Controllers, Inverters, Control Brains, Power Centers and Batteries.

Order from Solar Survival Architecture (SSA)  
Box 1041  
Taos, NM 87571  
(505) 758-9870

### Wiring Manuals for Solar Electric Systems

1. New Solar Electric Home  
by Joel Davidson
2. Living on 12 Volts and Wiring 12 Volts  
for Ample Power  
by David Smead and Ruth Ishihara
3. Wiring Simplified  
by H.P. Richter
4. Home Power Magazine  
P.O. Box 130  
Hornbrook, CA 96044 - 0130

### Solar pumps

MADE BY SURE FLOW

Order from Solar Survival Architecture (SSA)  
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Taos, NM 87571  
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2. Photocomm, Inc.  
Solar Electric Power Systems  
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Tucson, AZ 85711  
(602) 327-8558
3. Flowlight Solar Power Workshop  
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1-800-DC-SOLAR

### Cellular Phones

Decker Communications Systems  
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201 Cruz Alta Rd.  
Taos, NM 87571

### Consultation for all Systems

By appointment, phone or in person @ \$60/hr  
Solar Survival Architecture (SSA)  
Box 1041  
Taos, NM 87571  
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## 2. DOMESTIC WATER

### S Y S T E M S

IN THESE TIMES IT IS BEST TO HAVE AND TO BE IN CONTROL OF YOUR OWN WATER SUPPLY. MOST CITY, TOWN AND COMMUNITY WATER SYSTEMS (IN ADDITION TO PROVIDING "QUESTIONABLE" WATER) ARE DEPENDENT ON ELECTRICITY FOR OBTAINING AND DELIVERING WATER. THIS MAKES THE WATER DEPENDENT ON COMMERCIAL ELECTRICITY. COMMERCIAL ELECTRICITY LOOKS UNRELIABLE FOR THE FUTURE EVEN IF YOU CAN OVERLOOK THE DEVASTATION THAT PRODUCING CENTRALIZED COMMERCIAL ELECTRICITY BRINGS. *THEREFORE AN EARTHSHIP MUST HAVE ITS OWN WATER SYSTEM.*

THIS CHAPTER WILL COVER WAYS OF ACQUIRING AND DELIVERING WATER THAT USE MINIMAL OR NO ELECTRICITY. AS IN THE PREVIOUS CHAPTER THE FOCUS WILL BE ON THE METHODOLOGY AND CONCEPT IN AN ATTEMPT TO ESTABLISH A CLEAR UNDERSTANDING OF *HOW TO GET GOOD WATER* FOR DOMESTIC USE. THE EQUIPMENT NEEDED WILL BE DISCUSSED BUT ACTUAL INSTALLATION OF THE EQUIPMENT, WHICH INVOLVES CONVENTIONAL PLUMBING AND MECHANICAL SKILLS, WILL BE ASSUMED TO BE WITHIN THE GRASP OF LOCAL MECHANICAL CONTRACTORS AND OTHER CONSULTANTS.

*Water was a major factor in bringing life to the earth. Water rises, falls, runs and travels all over the earth in many different forms - vapor, rivers, rain etc. Water joins and embraces the earth and the result is a beauty and a life force that far surpasses what the earth would be without water. Maybe humans should learn something from water. Does our interaction with the earth result in something that far surpasses what the earth would be like without us or would the earth be better off without us?*

*Water is much like electricity and money. If you need a tremendous amount of it, it becomes difficult to acquire and you find yourself devastating something or someone else to get it. However if your requirements are minimal your quest for water will be an easy one with little effect on the other inhabitants of the planet.*

With this thought in mind let's look at the water requirements for a typical house.

### PRELIMINARY WATER ANALYSIS

A conventional house is set up as if water supplies were endless. Many areas (California) are beginning to see that this is not true. Water tables that took thousands of years to develop are being lowered not to return in the foreseeable future. Water tables and bodies of surface water are being contaminated by everything from sewage,

pesticides and garbage dumps to power plants and industry. Much of the water in the future will have to be purified which will be a time consuming and expensive process, if adequate water is available at all. Due to potential water shortage and existing contamination of water, individual dwellings must capture, purify and reuse their own water. **The Earthship must have features inherent to the initial design to achieve this.** Looking at the various water uses in an existing house is the place to start assimilating information for designing a water system into the Earthship.

### **TOILETS**

Toilets take 4 to 5 gallons of water every time they are flushed. Not only is this an excessive waste of water, it also presents a problem of what to do with this 5 gallons of water that is now raw sewage. If we didn't mix our shit with so much water it would be a whole lot easier to deal with as it would be a much smaller quantity of matter. Toilet or "black water" systems will be dealt with in the next chapter. The issue here is to point out that the use of large quantities of water for dealing with our shit is ridiculous and ultimately makes the problem worse, aside from using too much water. We simply do not have the water to waste anymore considering the contamination, the shortage and the energy and effort it takes to obtain water and, in the future, purify it.

Consequently, it is advisable to use composting type toilets which (believe it or not) *are* developed to the point that they work well and do not smell. They also give you something to put back into the soil. **The use of compost toilets immediately makes a significant reduction in your water requirement.**

There are various types of compost toilets, some of which even flush requiring a small amount (1 quart) of water. There are also low flush type toilets which use a fraction (1 gal.) of the water that a conventional toilet uses. These are all steps in the right direction. However the best advice considering all factors is to **not use water for a toilet at all** (sources for composting toilets are presented in the appendix for this chapter).

### SHOWERS AND BATHS

There is no doubt that the grime and dirty air of city living gets both clothes and people dirtier much faster than the cleaner air and cleaner life, in general, of rural living. *Less pollution would therefore enable us to use less water to stay clean.* As we continue to create a dirtier world, we continue to increase our demand for water. This, coupled with our water-related luxuries has resulted in a tremendous water per capita figure for the average American. A normal modern household is equipped to facilitate long steamy showers and/or deep sudsy baths for every

individual once or twice a day. This is not to mention the more luxurious homes with hot tubs, jacuzzis and swimming pools. There is a question here. Is there enough water on the planet (and sewage facilities) for every one on the planet to be this luxurious with water? This is not a moral issue. It is a *fact* of humanity. Whether we like it or not humanity is a *unit*. Just as water seeks a common level and will not rest until it does - so does humanity seek a common level and will not rest until it does. **There will not be peace on earth until all of humanity has reached a common level.** No more "haves" and "have-nots", upper class and lower class, privileged and not privileged. We must therefore use this earth and everything on it with all the rest of our "human unit" in mind. If everyone can not do what you are doing then the the very fact that you are doing it is not in keeping with ecology, peace, or common sense.

Even if you do not see yourself connected to all of humanity, the excessive use of water simply makes it harder for you to obtain and deliver your own water and thus makes you and your lifestyle more dependent on a very shaky if not outright disintegrating way of life. The bottom line here is fewer and shorter showers with water saving shower heads, fewer baths in smaller bathtubs, and *communal* swimming and jacuzzi facilities. The idea of communal anything is totally distasteful to some people, but just how

many of your amenities do you think you can individually own? After all, we are *communally* sharing this planet. The Romans had "The Baths" and they were quite beautiful. Do we all need our own swimming pools, jacuzzis, and hot tubs? **The use of water, like the use of electricity, has gotten out of hand when "American standards" are translated to a global level. Reduce your requirement and reduce everyone's stress.**

One doesn't have to agree with the thoughts put forth above to at least understand that the amount of water used for bathing could be cut in half thereby making it much easier to obtain and deliver your own water.

### **SINKS**

The way we use sinks is their only problem. Most all of the operations that we do at kitchen and bathroom sinks waste water. Water is left running while we shave or while we wash dishes. It simply goes down the drain increasing our sewage problem and decreasing our water supply. Getting into the frame of mind that **water is like energy, gold/money, or time** will help us use our sinks in such a way that we will significantly reduce our water consumption.

### **PLANTS, GARDENS AND LANDSCAPING**

Most interior planting and gardening can and should be watered with re-used grey water. This will be discussed in the following chapter. Landscaping and tree planting should seriously relate to indigenous life that thrives on existing climatic conditions, i.e. rainfall. Mulch should be used both inside and out to conserve and hold the water used for plants. Obviously it takes a certain amount of water to start and transplant things, but once they are established **landscaping should not require constant watering.** For example, if you build an Earthship in the desert and try to grow a huge lawn you are creating stress for yourself and the planet. Lawns are *out* if you are trying to provide your own water in a climate where grass doesn't grow naturally. **Water-conscious landscaping must prevail** (and can be very original and beautiful) if you want to survive on your own water system. It may not even be a question of whether you want to or not anyway - you may *have* to survive on your own water system. *Then its you or the grass.*

### **OTHER USES OF WATER**

Everything else from washing the car to washing the dog to hosing the driveway will want to be thought about before you do it. There are many ways we use water and take it for granted. If we were supplying our own water (at no expense to

ourselves or the planet) most of these ways we use water would probably be dropped from our schedule without remorse.

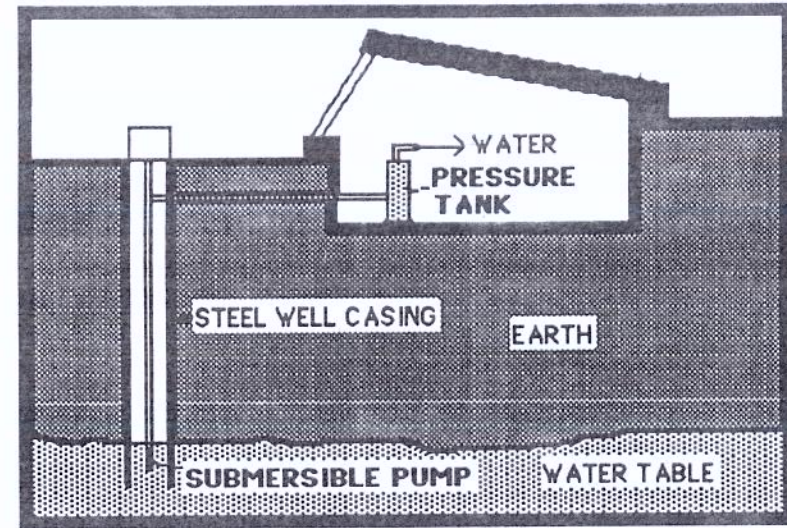
It is quite clear that less pollution, trimming and/or organizing our luxuries, and simply assuming a *water-conscious way of life* could cut our consumption of water by 75%. If we can make this mental shift\*, we can reduce our water requirement to the point that it will be within our grasp to acquire and deliver it to ourselves.

Now that we have reduced/designed down our water requirement to something within our grasp, let's look at how to go about getting it.

### THE BASICS OF ACQUIRING AND DISTRIBUTING WATER CONVENTIONAL WELLS

Conventional wells are pumped with a submersible electric pump to a pressure tank which pressurizes the water lines for household use.

\*1 see A Coming of Wizards, p.106.



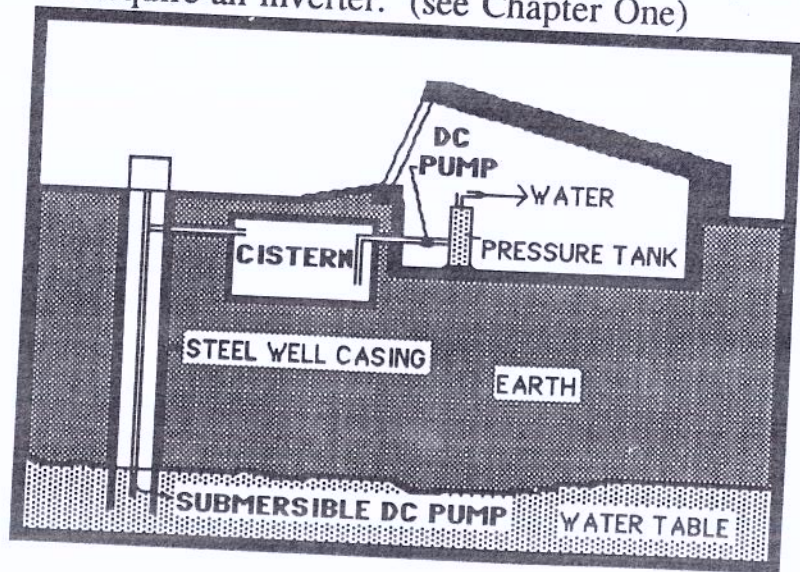
This requires electricity to pump from the well and pressurize the tank every time a significant amount of water is used. Well pumps use a lot of electricity because they are pumping from deep in the well. They use even more when they first start up. This is called a surge. Therefore, serious electricity is needed every time water is needed. When you are making your own electricity, it is precious. *You can reduce and in some cases avoid the use of electricity every time you use water.*

### SOLAR WELL AND CISTERN

A conventional well can be pumped into a storage cistern continuously and slowly all day long (while the sun is out) by a small solar powered DC pump. The surge is avoided because the pump is not turned off and on all day. It only



comes on once and goes off once a day. Storage of electricity in batteries is avoided because the small pump only has to run while the sun is out. The pump can be very small because it doesn't have to produce waterline pressure from deep in the well. It simply has to trickle water into the cistern all day long. The water is then pumped from the cistern into a conventional pressure tank which pressurizes the water lines for domestic use. This pump is DC and also is much smaller and uses much less electricity than the conventional AC pump deep in the well. Therefore, this method reduces the amount of electricity used every time water is needed as the two small pumps use much less electricity than the one large pump (see Appendix, Chapter 2 for solar pumps). DC pumps are advisable as they do not require an inverter. (see Chapter One)

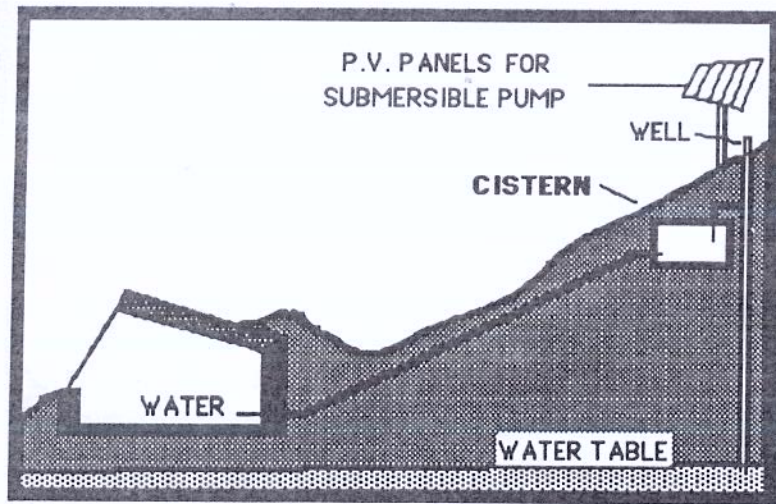


With this system you are getting water pumped for free whenever the sun is out without depleting your battery storage of electricity for domestic use. You can then use this water anytime of the day or night with a *small* amount of your solar electricity from your battery bank. This has become a standard method of obtaining water for "off the grid" dwellings. This is a better way but it still requires electricity (even though a much smaller amount) every time you use water.

### SOLAR WELL - GRAVITY CISTERN

With a little help from one of our friends - **gravity** - we can eliminate one of the electric pumps and the pressure tank. If you have chosen a sloped building sight (and this is a good reason to do so) you can solar pump the water from the well into a storage cistern placed up the hill from the Earthship and let gravity provide pressure and delivery of the water to the dwelling.

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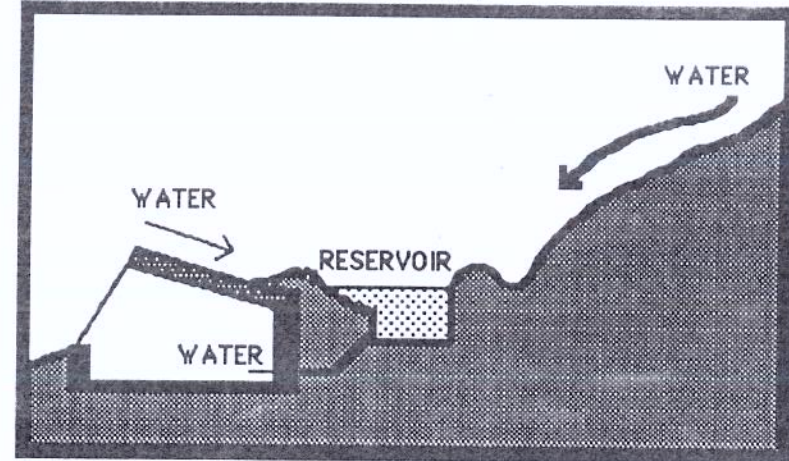


This concept can also be applied exactly the same way using a common windmill instead of solar panels and a pump. Just as our friend the sun "lives" in the sky, gravity "lives" on a sloped site. Choosing a sloped site is choosing a site with *built in energy* for domestic water distribution and waste water distribution as we will see in the following chapter. This built in energy can also aid in the collection of water which can eliminate the well and/or pumping process altogether.

### WATER CATCHES

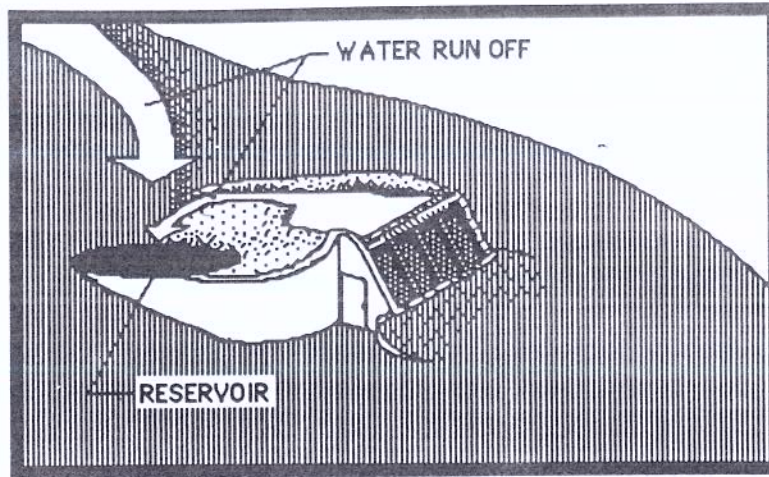
With a little forethought in site selection and Earthship-landscape design, you can avoid the well *and* the pump by catching roof run-off and/or hillside run-off in a reservoir or cistern. Locate your reservoir or cistern as high as possible and your plumbing as low as possible and

*let gravity collect and deliver.*



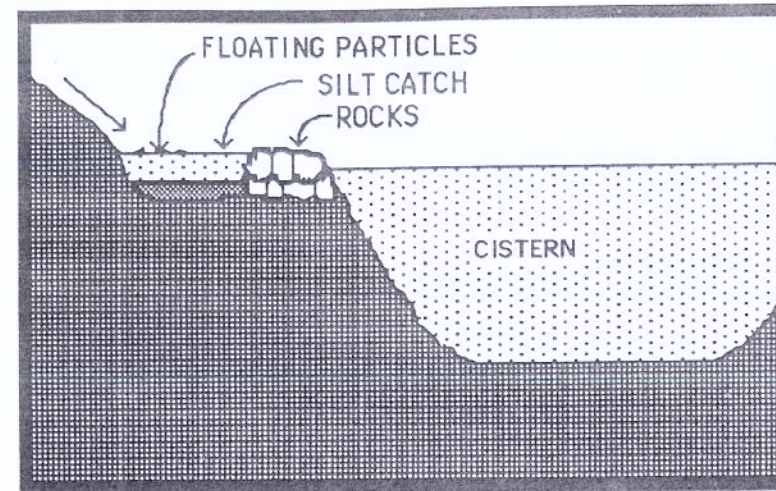
The price (after initial installation) is free forever. Gravity is a phenomenon like the sun. It continuously gives. We simply have to "position ourselves" appropriately to receive. This is the nature of this vessel we call Earthship. It will sail without stress forever. We will never run out of sun or gravity and we will never have to pay for them in any fashion.

In this case rain and gravity completely eliminate the need for electricity in the water system. Again we see that **the initial design of your Earthship is interwoven with the various systems themselves.**

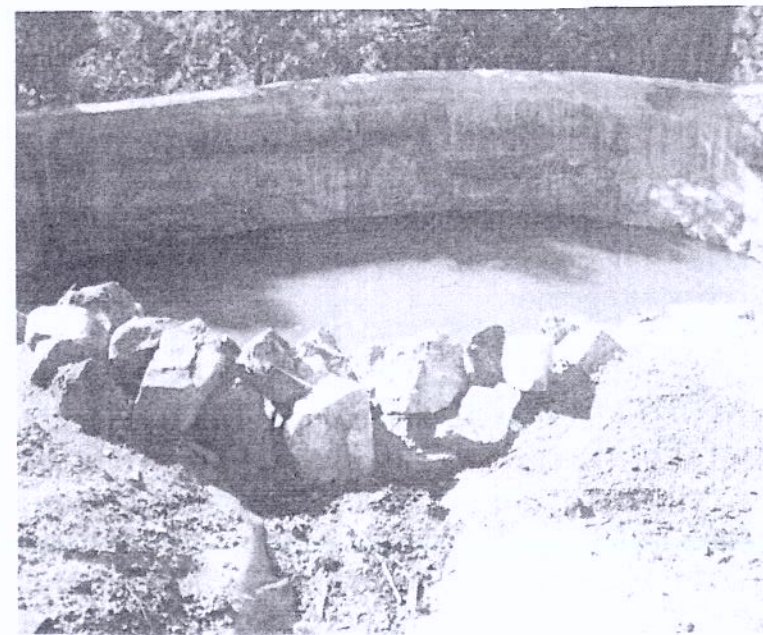


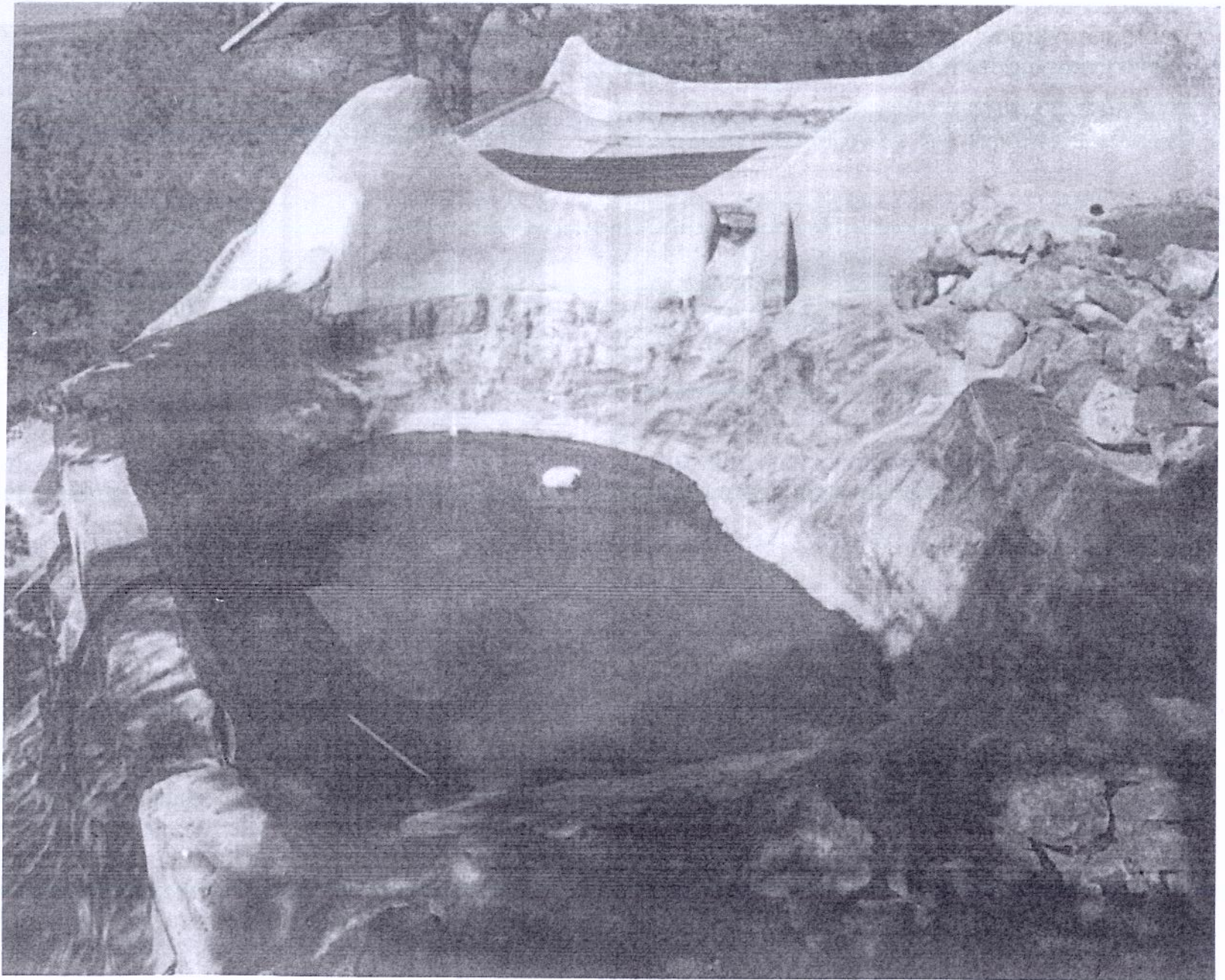
With conservative use of water the above system can fully provide for the water needs of a dwelling even in areas with only occasional rainfall. If you are catching surface run-off from the entire mountain or hill behind you, a tremendous amount of water can be caught from each rainfall.

Reservoirs that catch ground surface run-off need silt catches to trap dirt and gravel from the water. One way to do this is to build a small dam in front of the cistern with a small pool behind it. This blocks the runoff and lets the water overflow into the cistern after particles etc. have settled to the bottom of the silt catch. This simply lets settlement to take place before the water reaches the cistern.

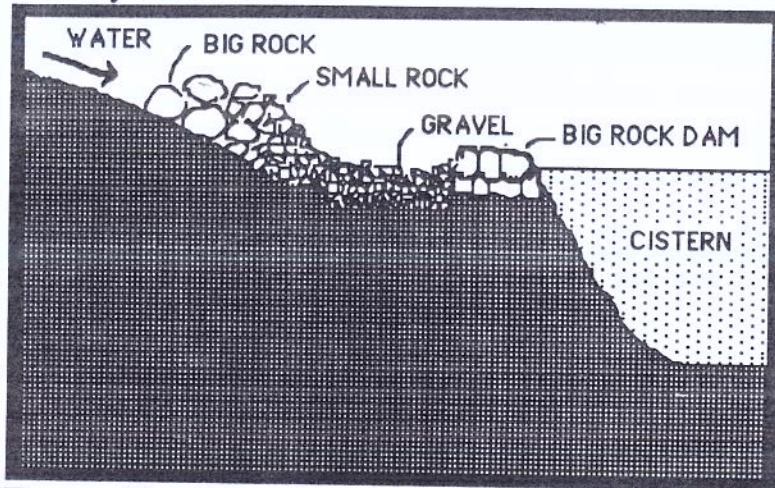


The dam should have rocks on top at the point of overflow. The water can flow through the rock to filter out particles floating on top.

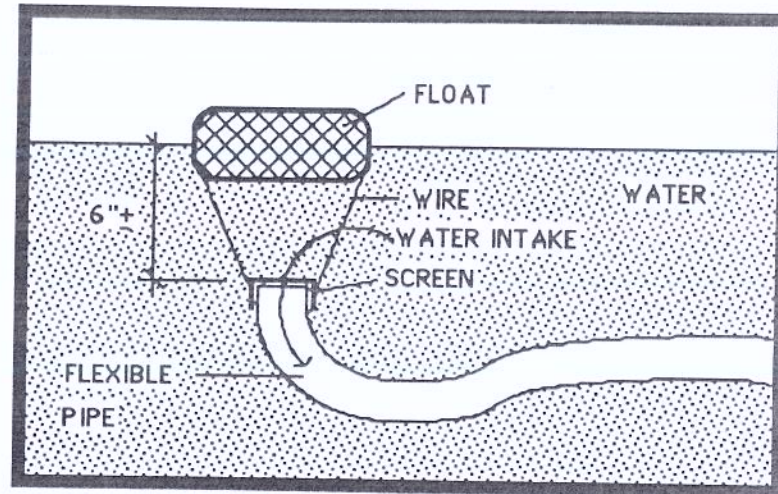




Another method filters the water through rock barriers ranging from large boulders to gravel on the way to the cistern.



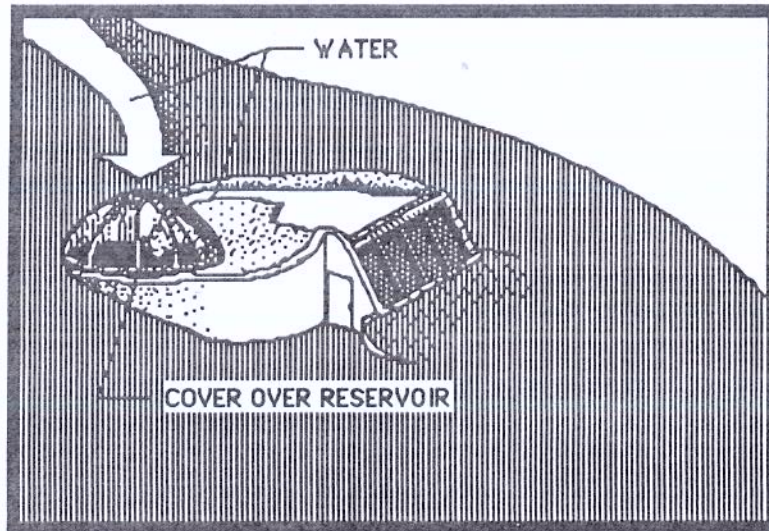
Even with silt catchers, outdoor cisterns still get some debris on top and silt on the bottom. This, in addition to a potential layer of ice on the surface, requires a "floating intake" from the cistern to keep the intake pipe away from debris on top and silt on the bottom.



Here the flexible intake pipe is suspended to the desired distance below the surface and above the bottom.

Water catch cisterns should be placed on south facing slopes in cold climates to catch snow melt. On north slopes the ice and snow evaporate before melting thus losing most of the water to the sky.

Insulated floating spa covers would be required to cover your water reservoir during the freezing winter months. Another option is to build a structure/room over the reservoir and use it for a humid growing space while protecting your water from freezing.

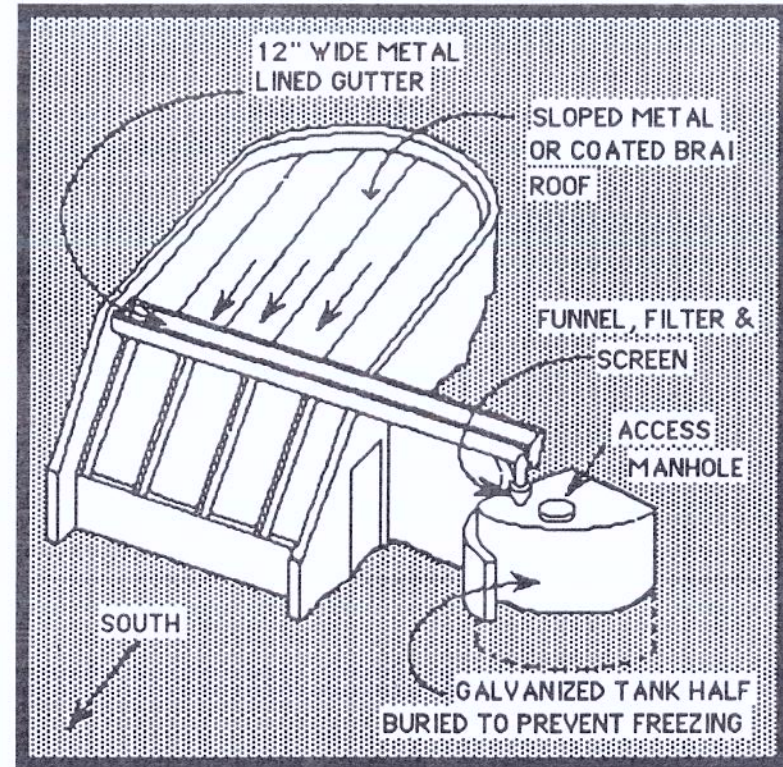


In line filters are required to filter water from an open cistern. These filters require some pressure to suck the water through. A small DC solar booster pump can be used here (see Appendix, Chapter 2 for DC pumps and filters).

### ROOF CATCHES

In areas with reasonable rainfall, enough water for domestic use can be caught from the roof alone. If you have at least 10" of precipitation per year, your roof is all the collection you would need. (see appendix for annual rainfall-National Weather Service) Collecting roof runoff is much easier and more economical than collecting ground surface runoff. It requires a metal roof for drinking water. The rubber (Brai) roofs presented in Earthship, Volume I can be painted with one coat of epoxy or acrylic paint and then

one coat of Livos paint\* to make the collected water potable. The following diagram illustrates a water catch system that will work in most of the U.S.A.

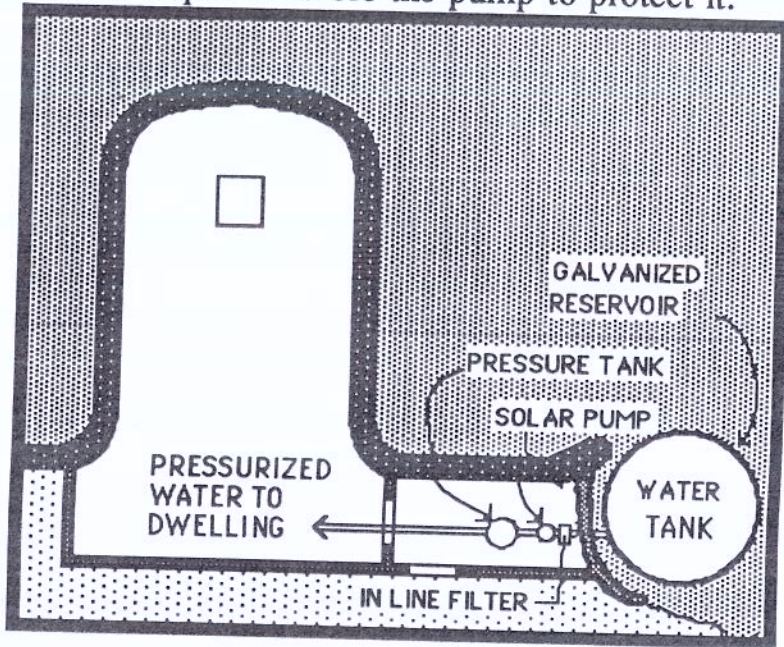


The water is caught by the south pitched (metal or coated) roof. It is then collected in the south facing gutter and runs to the storage tank. The storage tank\* is partially submerged to create enough thermal mass to prevent hard freezing of the water.

\*2 An organic paint, see Appendix, Chapter 2

\*3 see Appendix, Chapter 2

The water is then pumped into the dwelling by way of an underground line (below frost level) with a small D.C., solar powered pump. The solar pump pressurizes a conventional pressure tank, and the result is typical household water from the tap. Use conservatively. An in-line filter is required before the pump to protect it.

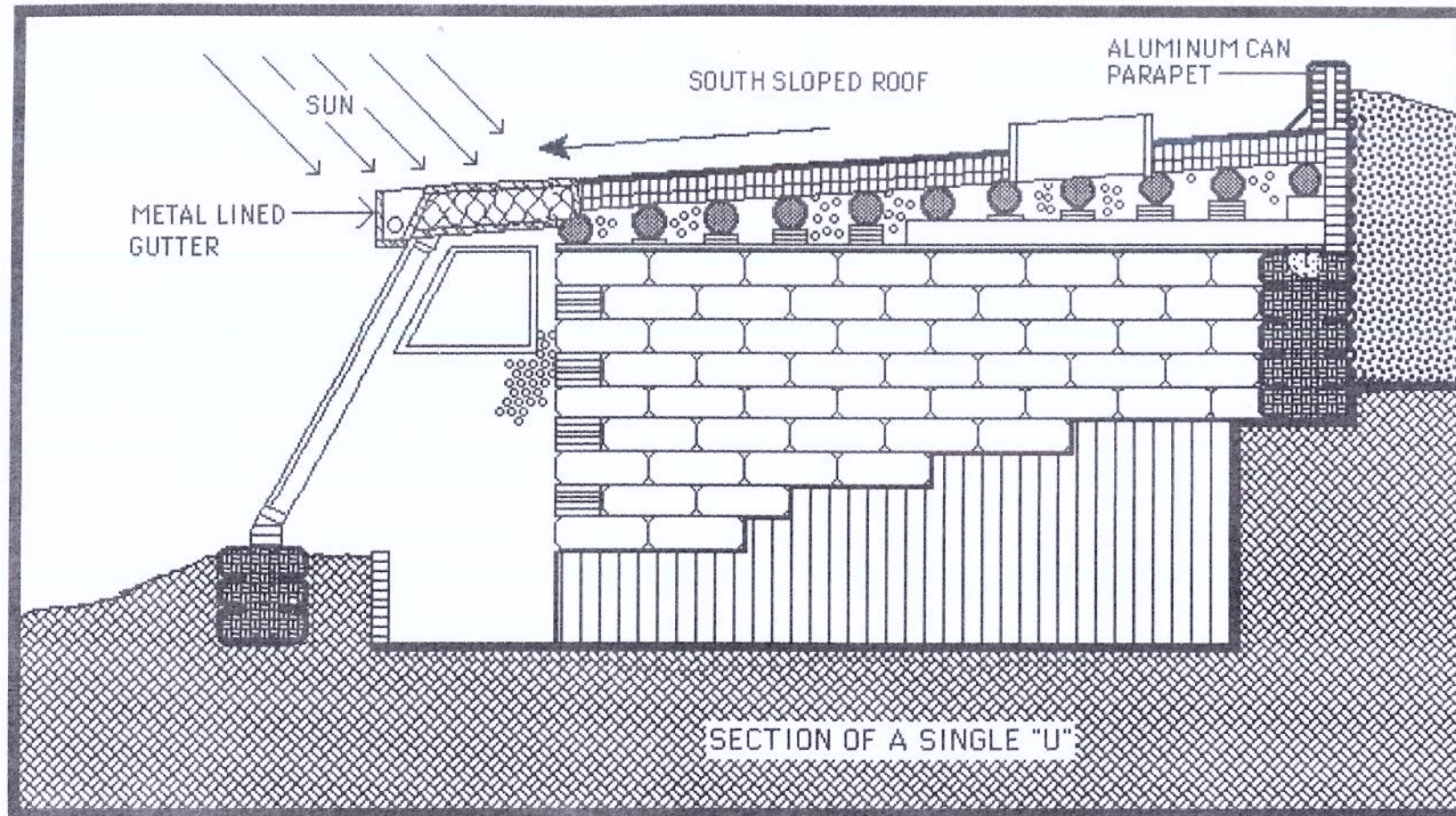


### CATCHING WATER FROM SNOW

The standard design of the Earthship, presented in Volume 1, must be slightly modified in order to catch snow melt. **The roof must slope to the south.** This causes the snow to melt faster than it evaporates. A roof that slopes north will lose two-thirds of your snow to evaporation before it melts.

Two people use about 800 gallons of water per month when compost toilets and grey water systems are employed. Therefore a 3,000 gallon reservoir would take you through almost four months without precipitation (see Appendix, Chapter 2 for galvanized tanks). A galvanized tank should be painted with tar on the outside part that is buried. This helps prevent rust and corrosion. The partial burial of the tank captures enough thermal mass to prevent freezing of the water. If you get less than 10" of precipitation per year in your area, install two or three 3000 gallon tanks to catch more from each rain. A tank larger than 3000 gallons gets difficult to handle.

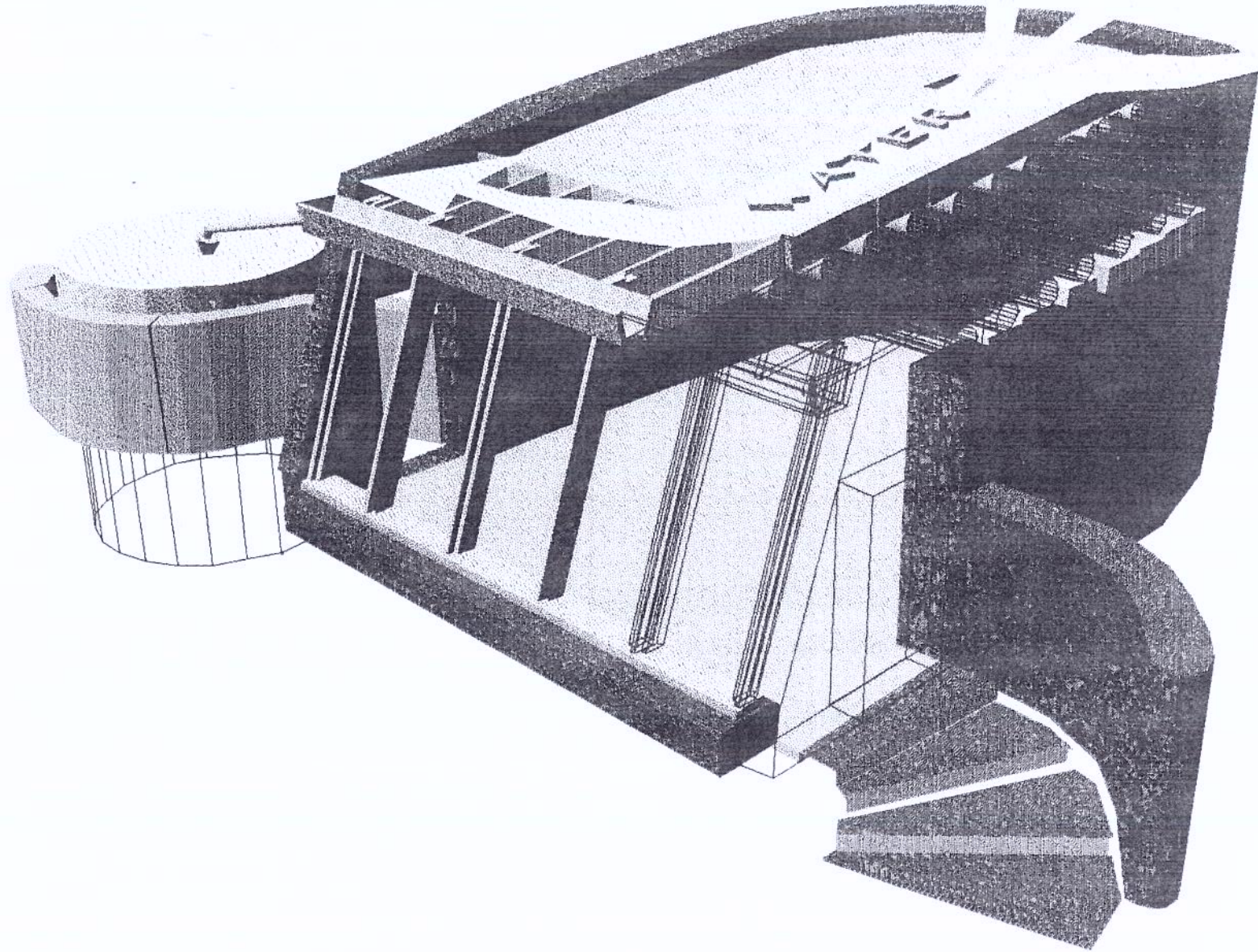
\*4 see Appendix, Chapter 2.



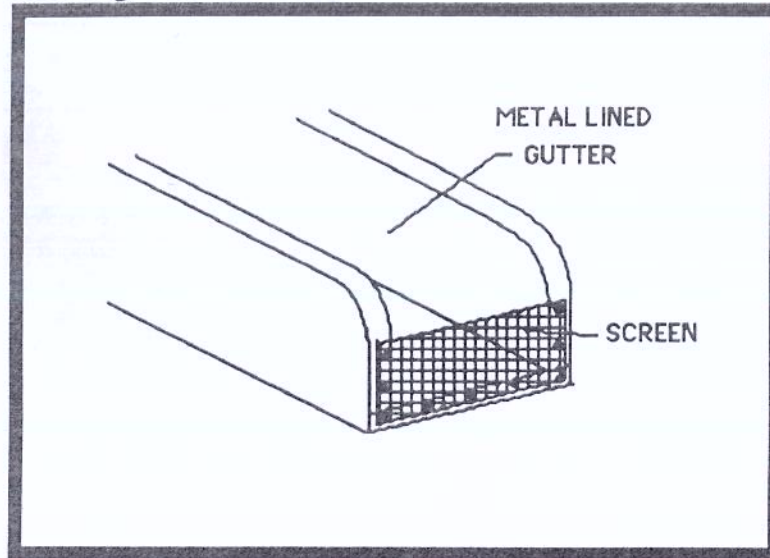
The slight north pitch of the roof presented in Volume 1 will allow snow to evaporate before it melts, thus losing most of your water to the sky. The south pitch described here, facilitates melting and reduces the possibility of ice dams.

This south pitch is structured similar to the north pitch, as the above diagram illustrates. The aluminum can parapet is recommended to keep bermed-up dirt off the roof.

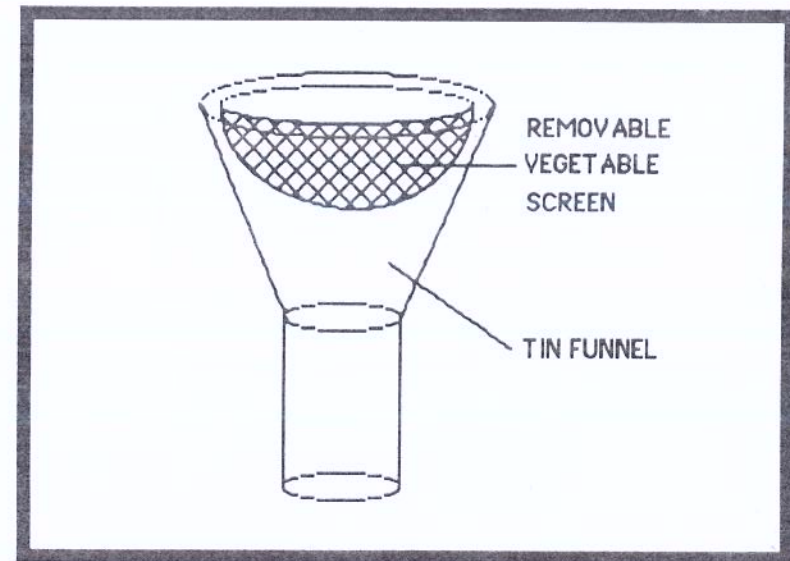




Screens should be used where the gutter drains into the pipe that goes to the storage tank to begin filtering out debris.

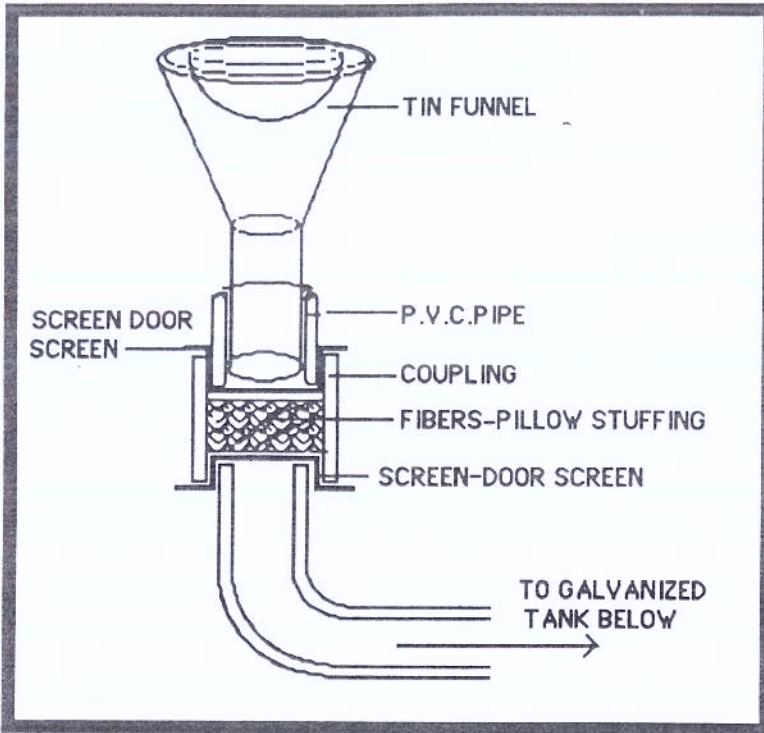


As the pipe drains into the tank, a metal funnel (as large as possible) with a vegetable screen basket (or some homemade facsimile) can further collect any debris.



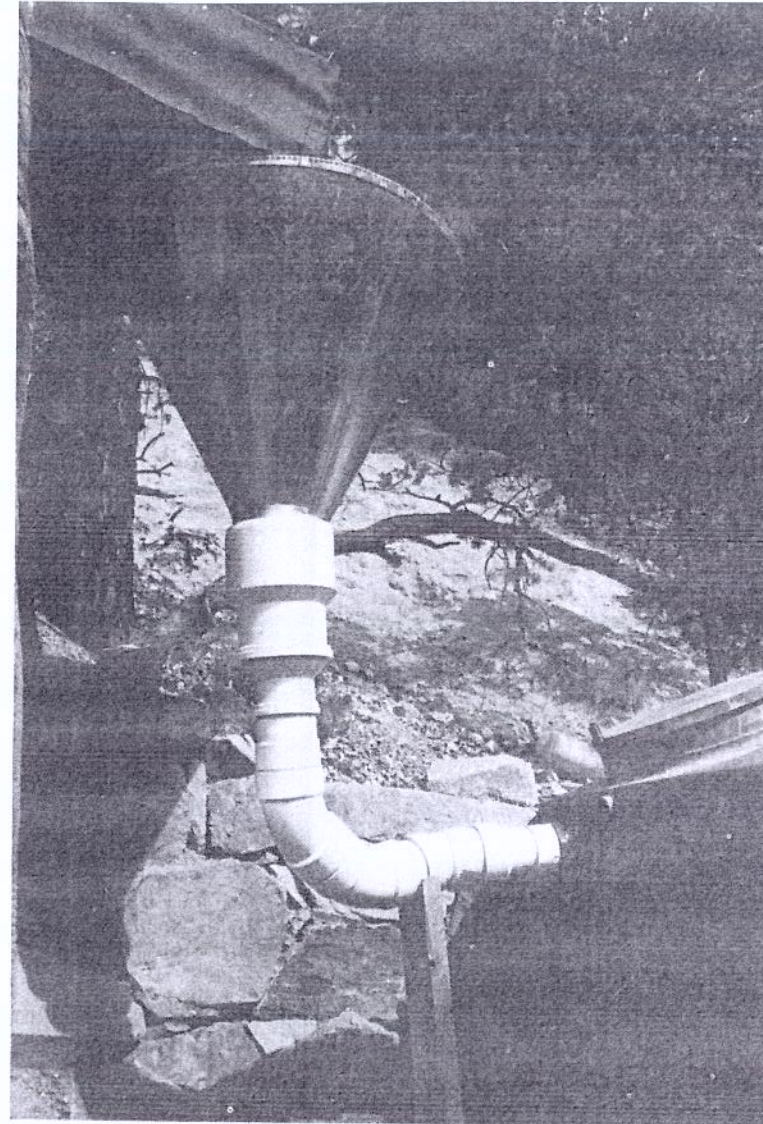
The size of this funnel and screen is relative to the roof collection surface. A larger roof area requires a larger funnel and tank inlet. In some cases this will get so large that the vegetable screen basket will have to be fabricated to a large custom size. The larger you make your funnel and inlet pipe the less chance there is of having a torrential rain overflow your funnel and waste some water. We recommend at least a 3" inlet into the tank.

Any fiber or filtering material such as common pillow stuffing can be used to further filter the water as it falls into the tank. The diagram on the next page shows a good preliminary filtering set-up.



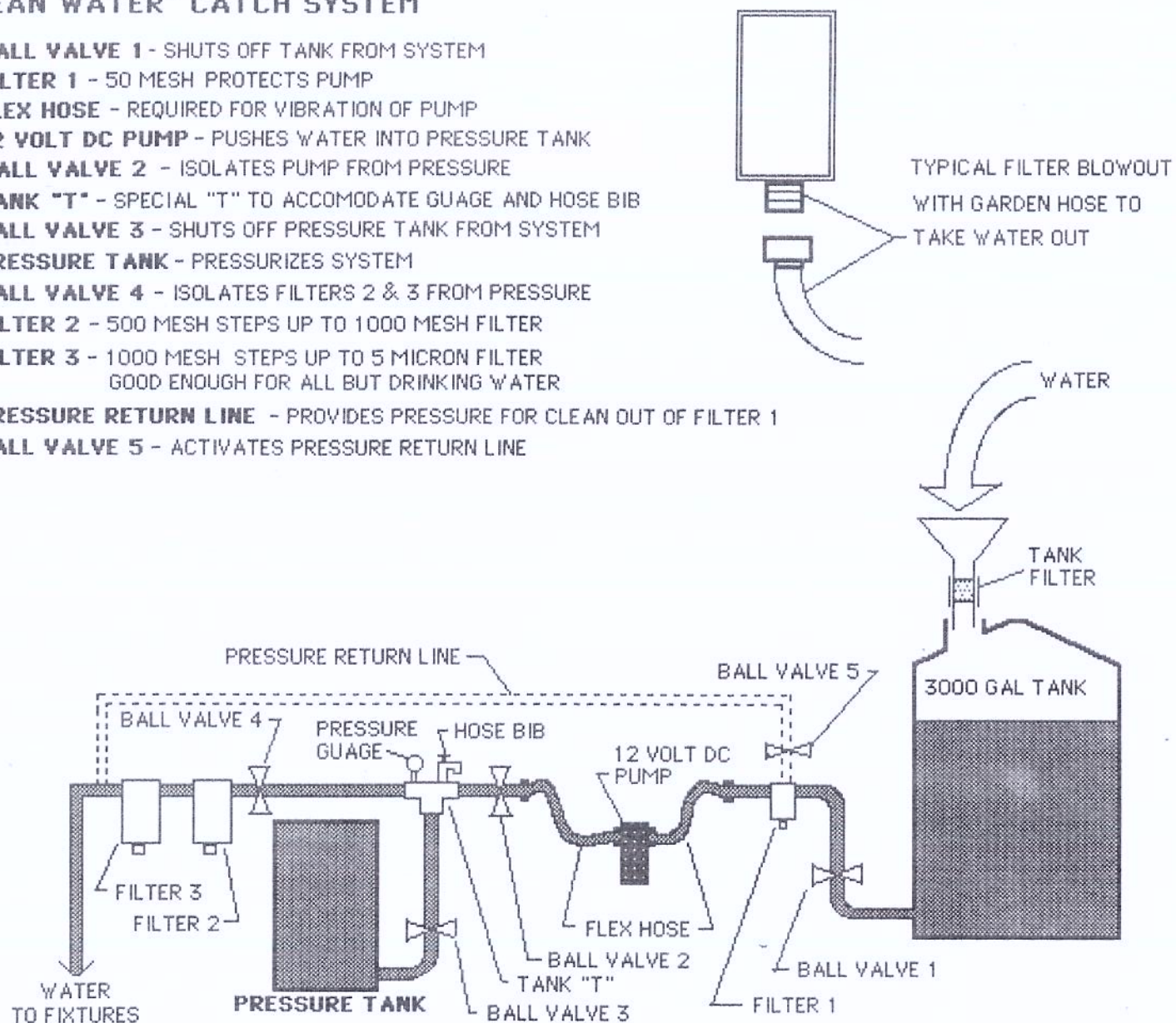
A regular in-line filter\* should be installed between the storage tank and any pumps. Most pumps have specifications for protective filters required. Catching run-off from the mountain or hill itself in addition to the roof requires more filters after the pump. A special drinking water filter that filters out bacteria may be necessary. Have your water tested to determine this. The following two diagrams illustrate the plumbing schematic for a "clean catch" requiring less filters and a "dirty catch" requiring more filters.

\*5 See Appendix, Chapter 2



## "CLEAN WATER" CATCH SYSTEM

- BALL VALVE 1** - SHUTS OFF TANK FROM SYSTEM
- FILTER 1** - 50 MESH PROTECTS PUMP
- FLEX HOSE** - REQUIRED FOR VIBRATION OF PUMP
- 12 VOLT DC PUMP** - PUSHES WATER INTO PRESSURE TANK
- BALL VALVE 2** - ISOLATES PUMP FROM PRESSURE
- TANK "T"** - SPECIAL "T" TO ACCOMODATE GUAGE AND HOSE BIB
- BALL VALVE 3** - SHUTS OFF PRESSURE TANK FROM SYSTEM
- PRESSURE TANK** - PRESSURIZES SYSTEM
- BALL VALVE 4** - ISOLATES FILTERS 2 & 3 FROM PRESSURE
- FILTER 2** - 500 MESH STEPS UP TO 1000 MESH FILTER
- FILTER 3** - 1000 MESH STEPS UP TO 5 MICRON FILTER  
GOOD ENOUGH FOR ALL BUT DRINKING WATER
- PRESSURE RETURN LINE** - PROVIDES PRESSURE FOR CLEAN OUT OF FILTER 1
- BALL VALVE 5** - ACTIVATES PRESSURE RETURN LINE



## "DIRTY WATER" CATCH SYSTEM

**BALL VALVE 1** - SHUTS OFF TANK FROM SYSTEM

**FILTER 1** - 50 MESH PROTECTS PUMP

**FLEX HOSE** - REQUIRED FOR VIBRATION OF PUMP

**12 VOLT DC PUMP** - PUSHES WATER INTO PRESSURE TANK

**BALL VALVE 2** - ISOLATES PUMP FROM PRESSURE

**TANK "T"** - SPECIAL "T" TO ACCOMMODATE GAUGE AND HOSE BIB

**BALL VALVE 3** - SHUTS OFF PRESSURE TANK FROM SYSTEM

**PRESSURE TANK** - PRESSURIZES SYSTEM

**BALL VALVE 4** - ISOLATES FILTERS 2 & 3 FROM PRESSURE

**FILTER 2** - 500 MESH STEPS UP TO 1000 MESH FILTER

**FILTER 3** - 1000 MESH STEPS UP TO 5 MICRON FILTER  
GOOD ENOUGH FOR ALL BUT DRINKING WATER

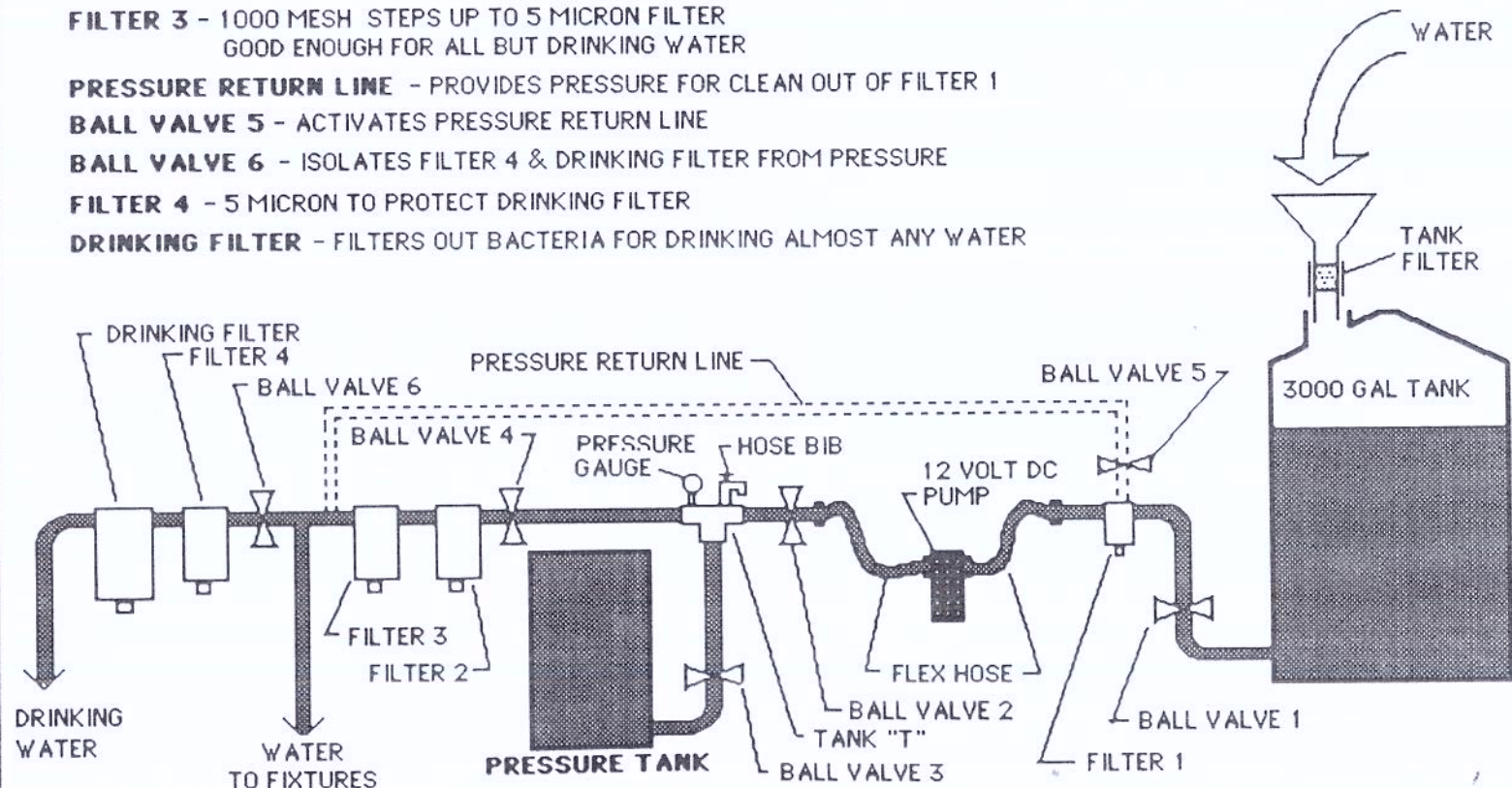
**PRESSURE RETURN LINE** - PROVIDES PRESSURE FOR CLEAN OUT OF FILTER 1

**BALL VALVE 5** - ACTIVATES PRESSURE RETURN LINE

**BALL VALVE 6** - ISOLATES FILTER 4 & DRINKING FILTER FROM PRESSURE

**FILTER 4** - 5 MICRON TO PROTECT DRINKING FILTER

**DRINKING FILTER** - FILTERS OUT BACTERIA FOR DRINKING ALMOST ANY WATER



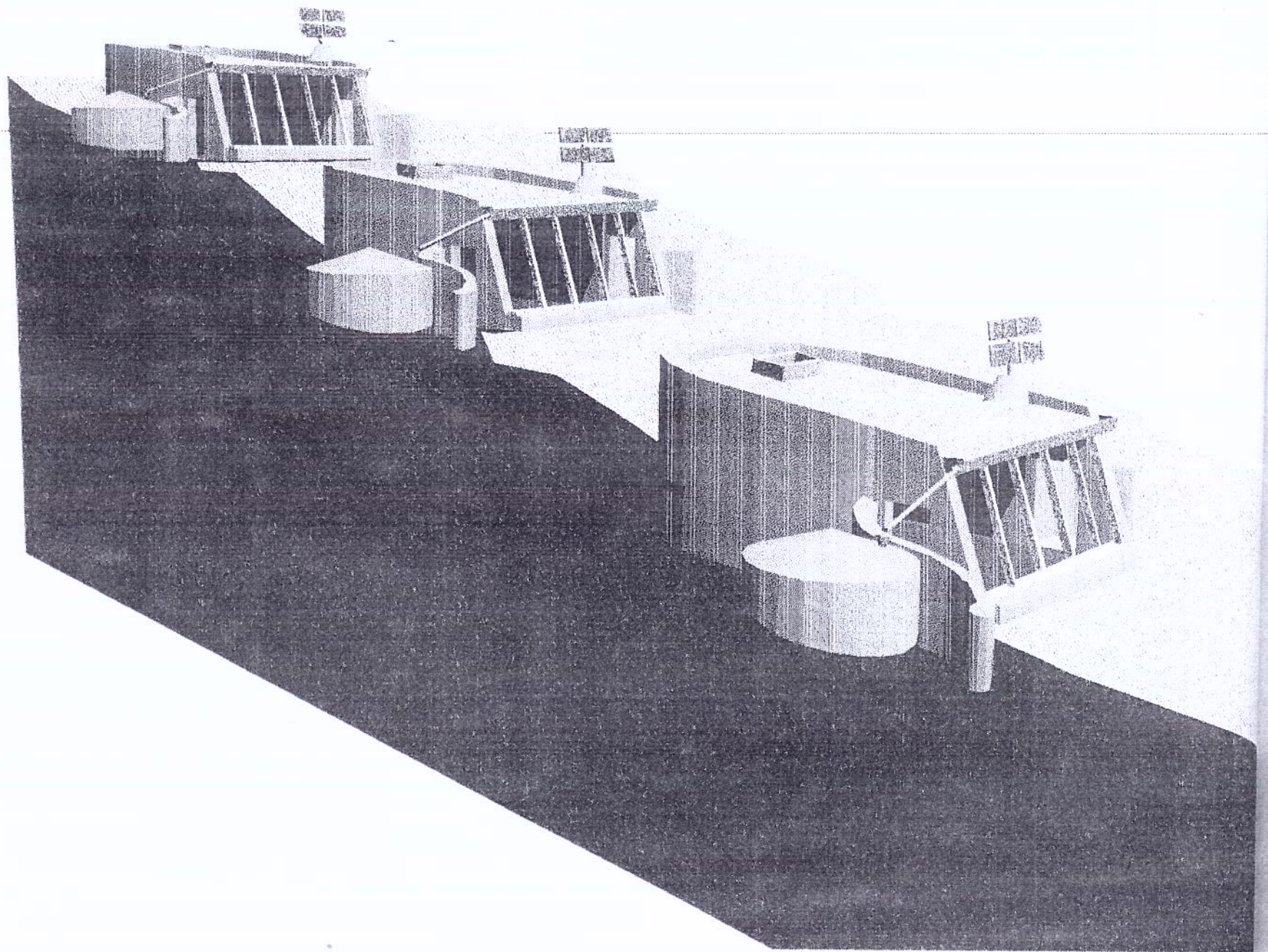
## SOLAR SURVIVAL RECOMMENDATIONS

This chapter has presented many options for the collection and distribution of domestic water. Various site conditions, climatic conditions, sizes of dwellings and budgets will further direct your choice. At this point, the best water supply for the least amount of money is achieved by collecting roof run-off only, from a slightly south pitched, (for cold climates) painted, Brai\* or metal roof into a metal holding tank. Make the tank as large as you can afford - 3000 gallons for a 2 bedroom home. Use 2 tanks or one larger tank for more bedrooms. A small Sure Flow D.C. pump\* with a filter installed before it is used to pump the water into a conventional pressure tank if the site doesn't allow gravity feed. The optimum use of the gravity concept would be for a large dwelling or community that steps up a hill. The upper roofs could collect water for a partially buried (to prevent freezing) holding tank that "gravity feeds" the rooms below. Filters and screens (as described on page 40-41) would still be required as water enters the tank. Decide if you have clear or dirty water and relate to the diagrams on pages 43 & 44. This will help you choose the number of filters you need. The special drinking water filter requires filters before it in the system to protect it.

Have your water tested to determine the need for a drinking water filter.

This would require no electricity or mechanical equipment for domestic water supply. The initial design and location of your Earthship relative to our "friends" gravity, rain and thermal mass would totally provide for domestic water needs.

\*6 and 7 see Appendix, Chapter 2



## APPENDIX

### Compost Toilets

MADE BY SUN-MAR

Order from SOLAR SURVIVAL ARCHITECTURE, P.O. Box 1041 Taos New Mexico, 87571 505 758-9870

See Chapter 3, p.63

### Pumps

MADE BY SUREflo

Order from SOLAR SURVIVAL ARCHITECTURE, P.O. Box 1041 Taos, New Mexico, 87571 505 758-9870

1. #2088-044-135 6 amp pump delivers 3.6 gallons per minute. This is the pump used to pressurize the pressure tank in the systems recommended. It must have a 60 mesh filter before it to protect it. Don't ask it to pump higher than 8 feet.

2. This is a small booster pump for small time systems when a pressure tank is not being used. We have used it to service one sink in a studio without a pressure tank. Don't ask it to pump any higher than five feet.

3. DC well pumps  
FLOWLIGHT SOLAR POWER WORKSHOP

Rte. 1 Box 216  
Española, NM 87532  
1-505-753-9699

### Pressure Tanks

Your local plumber or well driller can supply you with a conventional pressure tank. The larger you can afford, the better. We recommend 27 gallon draw down. This means you can take out 27 gallons before your pump is asked to work. If you have trouble, order one from SOLAR SURVIVAL ARCHITECTURE, P.O. Box 1041 Taos, New Mexico, 87571 505 758-9870

### Paint coating for Brai roofing

Vindo Enamel by  
LIVOS PAINT  
1365 Rufina Circle  
Sante Fe, New Mexico, 87501  
505 988-9111

### Low Flush Toilets

MADE BY SEALAND

Order from SOLAR SURVIVAL ARCHITECTURE, P.O. Box 1041 Taos, New Mexico, 87571 505 758-9870

### Filters

Made by RUSCO  
Clear, blow down filters



Order from your local plumber or  
SOLAR SURVIVAL ARCHITECTURE  
P.O. Box 1041, Taos, New Mexico 87571  
505 758-9870

Blow down means you blow the filters out with water to clean them rather than constantly buying and replacing cartridges. These filters come in assorted meshes and micron densities.

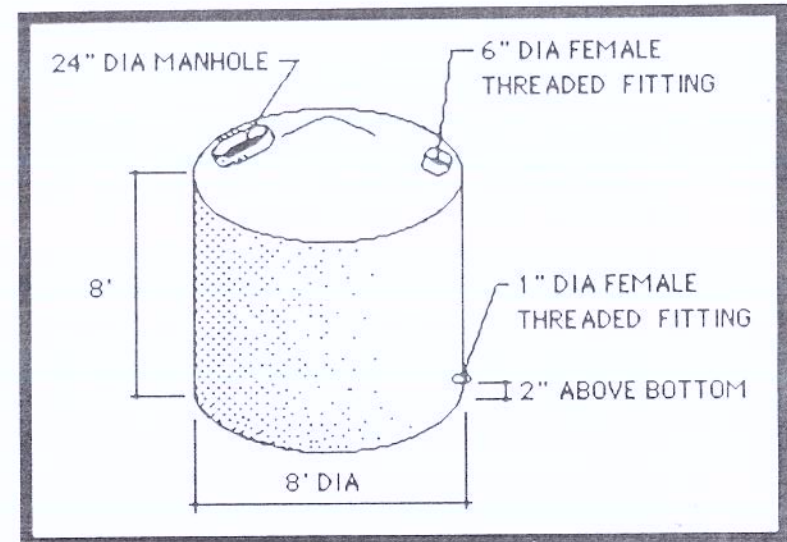
Made by KATADYN

A drinking water filter, #HFK with built in spigot and #HFSK an in line filter

### Tanks

Custom order a 3000 gallon galvanized steel tank with a 24" diameter manhole in the top with lid. Order a 6" diameter female threaded fitting at the top and a 1" diameter female threaded fitting at the bottom.

1. Local distributors of large galvanized tanks can be found in your area phone book. Freight is expensive on these. If you can find one close, it is better.
2. Tanks can be ordered from :  
SOLAR SURVIVAL ARCHITECTURE,  
P.O. Box 1041 Taos, New Mexico, 87571  
505 758-9870

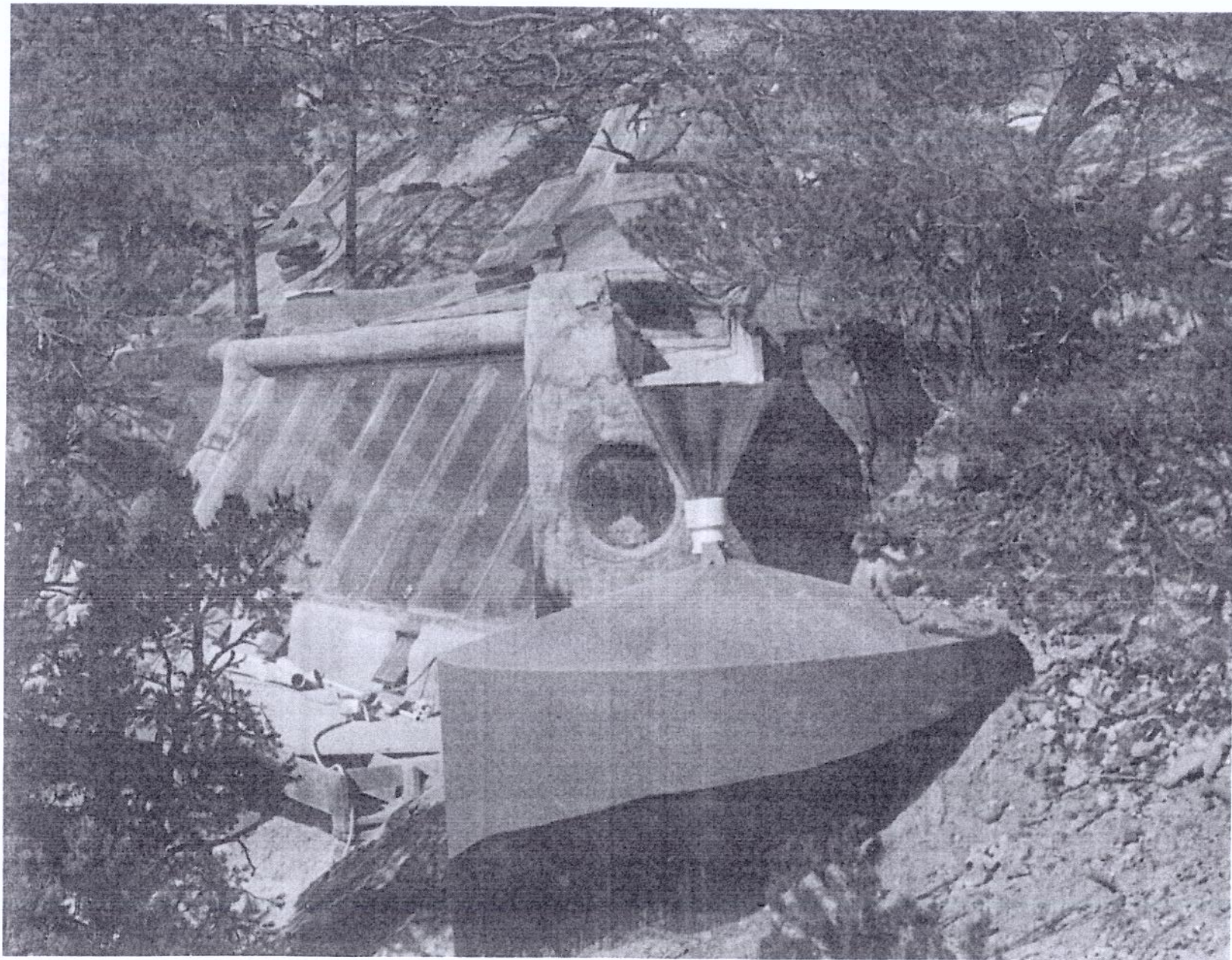


### Submersible Pumps

1. FLOWLIGHT SOLAR POWER WORKSHOP  
Rte. 1 Box 216  
Espanola, NM 87532  
1-800-DC-SOLAR
2. PHOTOCOMM INC.  
Solar Electric Power Systems  
4419 E. Broadway  
Tucson, Arizona 85711  
(602) 327-8558

### Annual Rainfall Information

1. National Weather Service-call for information in your state.





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