

earthed

Michael Reynolds



Building Earthships

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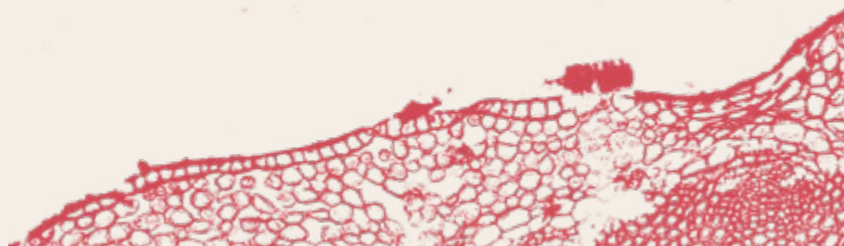
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“The things that we think must be addressed by ourselves, not government and corporations. And these are comfortable shelters that don’t use fossil fuel, electricity, water, sewage treatment, food and garbage. These six things have to be addressed to have a life here. And we figure at this point on this planet that the only way to really address these right is to show people how to do it themselves.”

– Michael Reynolds

01

The Teacher

The Teacher

Michael Reynolds ←

Michael Reynolds, founder and creator of the Earthship concept, came to Taos, after graduating from Architecture School in 1969.

Inspired by television news stories about the problem of trash and the lack of affordable housing, Michael created the “can brick” out of discarded steel and tin cans. Ten empty cans, four flat and six unflattened, were wired together to make a building block.

The early buildings used discarded steel or tin beer cans (this was before recycling existed). These cans were empty and simply used as free units of space with which to form light, strong concrete walls. These homes made from “garbage” immediately started getting press coverage though they were not nearly as sophisticated as the Earthships of today. Garbage is now all around the globe, especially tires, highly available and highly damaging to the environment when left in nature. In 1973 he obtained a patent for building blocks of cans.

Over the next decade, designs constantly evolved to incorporate thermal mass, passive solar and natural ventilation. The houses we now build with earth rammed tires are so strong that no foundation is required, giving load bearing walls and thermal mass storage. Solar glazing along the whole front of the structure allows the sun to heat the floors and the walls providing comfortable, stable temperatures inside without using fossil fuels or wood. Operable windows and skylights provided natural ventilation to cool the buildings.

“I basically wasn’t trying to invent Earthships back then, I was just trying to invent my life and by responding to what I saw around me in the news, the media.”

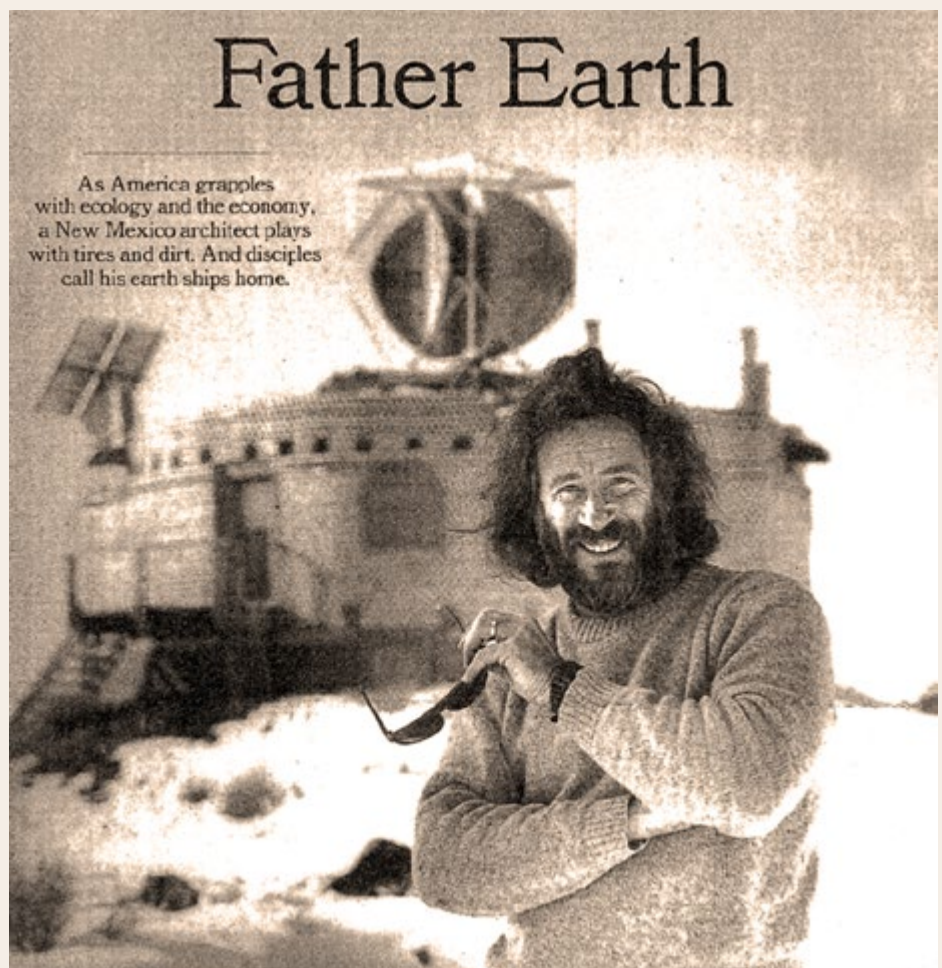


The Teacher

Michael Reynolds ←

The 2007 documentary, *The Garbage Warrior*, follows Michael Reynolds as he works to pass the "The Sustainable Development Testing Site Act." Legislation that allows land to be set aside for the testing and development of sustainable buildings. It gives innovators the freedom to dream up a solution, and go out and test their methods the next day. The building pictured to the right is the result of Reynolds' legislative battle, EVE, also known as Environmental Village Ecologies.

Michael Reynolds has appeared on a regular basis over the last 40 years on the radio, on television, film, and in print media around the world from Asia, Europe, Australia, to North and South America, and the world-wide interest in Reynolds' work is only growing. Reynolds has also been invited to lecture about his innovations around the world including; The Parliament of Sweden, KTH Royal Institute of Technology, National Technical Library in Prague, and The World Wellness Project Summit in Melbourne and more.



02

The Course

The Course

Building Earthships

Location

Taos, New Mexico, U.S.A.

Modules

7

Biome

Deserts and xeric shrublands

Duration

40 minutes

Travel to Taos, New Mexico to meet Michael as he shares the principles behind Earthships and how you can apply them to your own sustainable off-grid building. Learn how to meet the six points necessary for human sustenance by harnessing the abundant power of the earth's natural systems.

Waste is a huge challenge facing our modern world. Its constant production affects all corners of the planet. Earthships provide an alternative solution by creating buildings that repurpose, recycle and reuse to generate comfortable homes.

By working with simple physics and biology, Earthships are able to heat and cool themselves without relying on fossil fuels. They run on renewable electricity, harvest and treat water and sewage whilst growing food - a vessel that supports life to thrive. They provide a prime example of the ways humans can live in harmony with the environment.



The Course

Building Earthships

Through this course learn how these unique buildings can provide the basic needs in alignment with the earth's resources. How earthships have been built all over the planet and accommodate a variety of climates through different adaptations. As well as how off-grid living divests from expensive and problematic systems that continue to pollute our planet.

Modules

Module 1: Building the Earthship Idea
Module 2: Heat and cool
Module 3: Generate Power
Module 4: Source Water
Module 5: Manage Waste
Module 6: Grow Food Sovereignty
Module 7: Outro

Key Concepts

Sustainable design
Recycling
Off-grid living
Natural heating and cooling
Renewable Electricity
Water collection and treatment
Sewage treatment
Food production



The Course

Building Earthships

What You'll Need

This is a theoretical course and there are no tools required. Alongside this course booklet, you may find it helpful to have a notebook and pen to make notes.

Outcomes

- Understand the Earthship Concept
- Repurpose recycled materials
- Design a comfortable home
- Plan a natural heating and cooling system
- Understand basic solar electricity
- Source and recycle water
- Manage sewage and wastewater
- Grow and produce food



03 Modules

Module 1

Building the Earthship Idea

What can we do with the rubbish humans create? Earthships provide a solution. Dive into the history of Earthships, how repurposed materials create these buildings whilst also addressing the issue of waste.

Module Key Concepts

- Earthship History
- Repurposing and recycling materials
- Pitfalls of modern building materials
- Key points of human sustenance
- Issues of waste
- Independence from fossil fuels

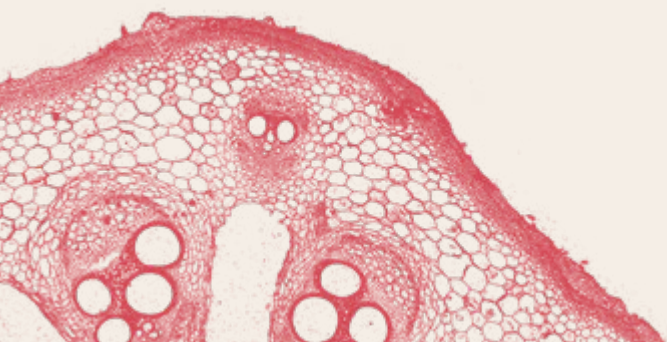
“We’re replacing materials that themselves are built to be garbage. In other words, most things that are made today and sold as building materials fall apart and end up in the landfill very quickly”

Teachers Tips

You can use a variety of recycled materials to make Earthships

Summary

- First created 50 years ago by Michael Reynolds, the Earthship concept emerged as a response to multiple intersecting crises and can serve as a way to live comfortably without relying on the fossil fuel industry.
- There are many different materials you can use for Earthships including glass and plastic bottles, aluminium cans, car tyres, cardboard and other materials that might otherwise go into landfill.
- The recycled materials used to build Earthships often out-last many building materials that are used within modern construction.
- Earthships aim to use no fossil fuel whilst responding to the six points necessary for human sustenance: temperature, power, water, waste, food and comfort.



Module 2

Heat and Cool

Explore the first of six aspects necessary for human sustenance that Earthships address. Understand how these buildings work with the power of the sun to heat and cool the temperature of a room, without using fossil fuels.

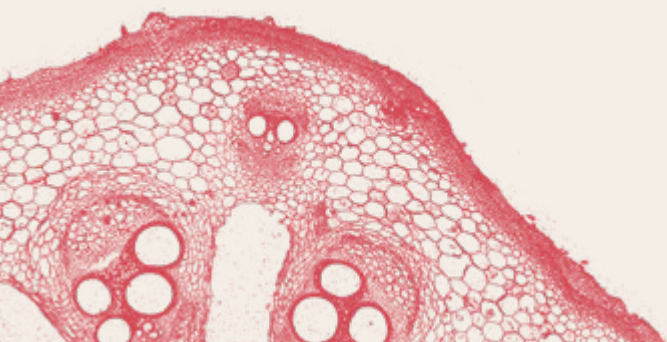
Module Key Concepts

- Natural convection & solar thermal dynamics
- Insulation techniques
- Adaptation to different climates
- Independence from energy companies

“It’s almost like turning on a heater. It’s not like huddling around a stove and on the other side of the room, it’s freezing. This whole building is at an ambient temperature and stays that way.”

Summary

- Earthships work by harnessing natural convection and solar thermal dynamics rather than pumping heat or energy into the space to change the temperature.
- These buildings are created with high levels of insulation which means they hold the temperature.
- The three foot thick walls act to absorb the temperature of the room. In the day the heat transfers into the walls and the room stays cool. Then at night when the temperature drops the heat from the walls is released. This is how the buildings stay at an ambient temperature.
- There are ways to adapt and fine tune Earthships such as using drapes to help keep the temperature cooler from the greenhouse area.
- Earthships are designed in harmony with the planet to provide sustenance to humans. Part of their benefit is they do not require external companies to provide electricity, water and manage waste, therefore they do not require people to pay bills.



Module 3

Generate Power

Electricity is part of our way of life. Michael outlines the benefit of creating renewable energy on site rather than transported through expensive energy grids.

Module Skills

- The shortfalls of the electrical grid
- Solar panels
- Renewable energy

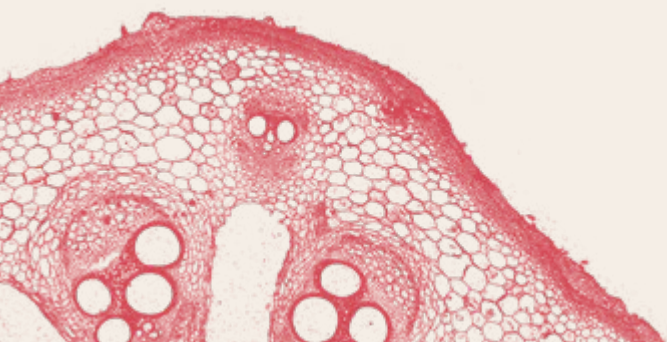
“We don’t need to put the electricity into panels and then deliver it on the grid. We need to put it in every house.”

Teacher’s Tips

The type of solar panels you choose may depend on the climate you live in and the light available.

Summary

- Electricity is a part of our modern way of life and we need it in order to use many modern appliances. This is why it is included within the Earthship concept.
- Electricity is often generated in one spot and transported through the grid via very long distances.
- To create an Earthship you want to consider how to generate your own electricity. This means you are not dependent on money to pay for the electricity that comes through the grid.
- Solar panel technology is rapidly evolving meaning that it is possible to generate electricity from ambient light, not just direct sunlight.
- Electrical grids are expensive to maintain and use. These buildings remove the need for the electrical grid by using solar power and other renewable energy sources on site.



Module 4

Source Water

Earthships harvest, filter and clean to increase the usability of water. Learn how in this module and the importance of recycling water.

Module Skills

- Harvesting water
- Removing Silt
- Filtering for drinking water
- Processing greywater via plants
- Legal implications of harvesting your own water

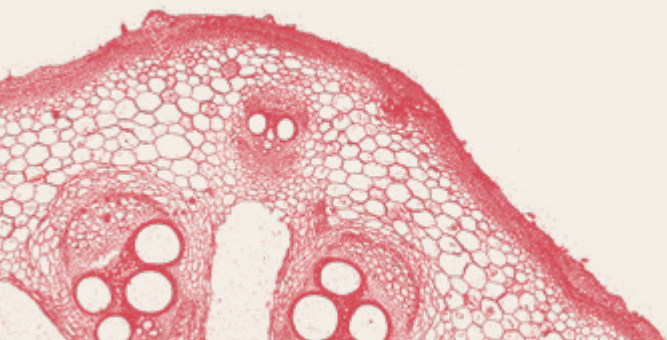
“So you can take five gallons of water and turn it into 20 by using that five gallons four times. Water becomes not something that you depend on the government and the corporations to provide for you, and an infrastructure, you are your own infrastructure.”

Teachers Tips

In some places it's important to meet government and legal regulations in order to enable the creation of an Earthship.

Summary

- Water is one of the six aspects of human needs that Earthship buildings address.
- The rise in adverse weather events due to climate change means that water security is increasingly important to deal with.
- Due to fracking and the use of pesticides it is important to research whether the groundwater will be contaminated in certain areas.
- Earthships are designed to harvest water from rainfall through metal roofs.
- The water that is harvested from the roof is channelled into a cistern through a number of silt catching devices. The cistern is made of tyres and plaster.
- In drought climates such as New Mexico Earthships are important as they have created ways to reuse water multiple times.
- Depending on where you live it's important to understand the legality of harvesting your own water.



Module 5

Manage Waste

In order to create an off-grid home you need to address the sewage you create. Learn how to harness the nutrients available in blackwater and recycle grey water through the power of plants.

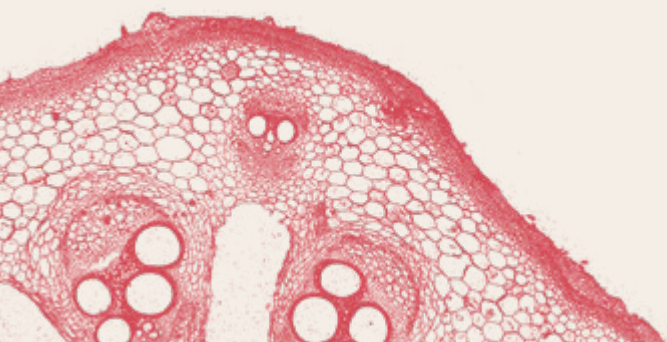
Module Skills

- Black and grey water treatment
- Septic Tanks
- How plants clean water
- The pitfalls of sewage treatment plants

“You don’t want to throw your sewage away, then go to the health food store and buy oranges. You want to use your sewage to grow your own oranges.”

Summary

- Earthships harness sewage as it is high in nutrients that can help to grow plants and food.
- Grey water is from a washing machine or shower. Black water is from your toilet and kitchen sink.
- Grey water runs through botanical cells which have gravel in the bottom. The roots of the plants oxygenate the water helping to clean it.
- That water circles through these planters becoming clean enough until it is pumped up to the toilet to be flushed with, rather than fresh clean water.
- Kitchen and toilet water enters a blackwater tank that processes the water anaerobically.
- The anaerobic process puts out effluent in the form of water that then enters outdoor rubber lined botanical cells.
- By treating your own sewage you can become independent from sewage treatment plants that regularly break, leak and pollute the planet.



Module 6

Grow Food Sovereignty

Learn how to work with developers and landowners to defend public access and ensure nature has a place in future plans.

Module Key Concepts

- Health impacts of industrial agriculture
- Reusing water and nutrients to grow food
- Testing food for E-coli

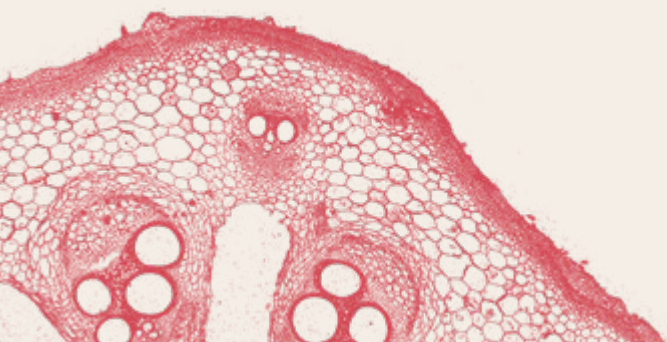
“Food is a product of daily living in an Earthship. You take a shower, you reharvest the shower water for growing plants, and plants produce food. And this food is freeing you from an industry that is poisoning people and taking all their money.”

Teachers Tips

- Make sure to include herbs in the food you are growing.
- Learn how to test your food and water for E. Coli.

Summary

- The design and biology of an Earthship means that you can grow a variety of different foods.
- The industrial agriculture industry uses high amounts of antibiotics in animal feed that can affect human health.
- Growing your own food in an Earthship enables independence from the industrial agricultural system.
- Earthships are circular in that they recycle and reuse the water to grow food.
- The food grown within Earthships may need to be tested and checked for things like E. Coli.



Module 7

Outro/Building the Earthship Movement ←

Earthships cover everything needed for human survival whilst providing comfort and autonomy.

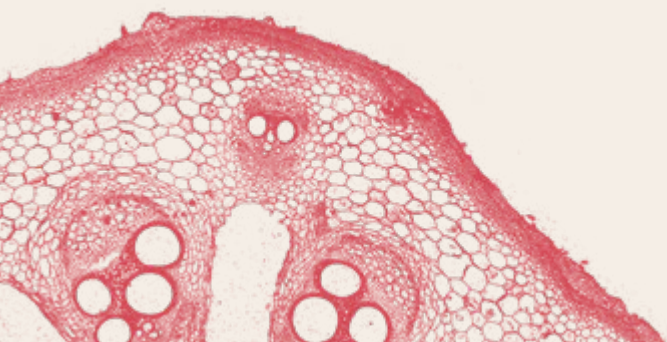
Module Key Concepts

- Human Survival
- Comfort
- Autonomy

“I’m trying to put a billion people in sustainable, autonomous housing. That’s the goal. You can imagine the effect that that would have. Yes, we’d have an economy, but it would be insignificant.”

Summary

- The Earthship concept is about providing everything needed for human survival and taking money out of the equation.
- Earthships provide a level of comfort and autonomy that has the potential to benefit many people in the years to come.
- This course has touched on the six aspects needed for human sustenance. There is more extensive information and the opportunity to dive deeper through the Earthship Academy.



04 Glossary

Glossary

Altitude

The height of an object or point in relation to sea level or ground level.

Anaerobic Process

A part of a process that occurs in the absence of free oxygen. An anaerobic treatment cycle involves wastewater entering a bioreactor receptacle containing a thick semi-solid substance called sludge, full of anaerobic bacteria and other microorganisms which break down the organic contaminants present in the wastewater.

Antibiotics

A medicine (such as penicillin or its derivatives) that inhibits the growth of or destroys microorganisms.

Back Burial

Burying the building on three sides with dirt, to capture the thermal mass and to ensure the thermal wrap is covered.

Biosphere

A structure enclosing a self-contained ecosystem or ecosystems.

Black Water

The wastewater from bathrooms and toilets that contains faecal matter and urine. Water from kitchens and dishwashers are also considered blackwater due to the contamination by pathogens and grease. It is also referred to as sewage or brown water and can carry disease and bacteria, both of which could be harmful.

Botanical Cells

This is a rubber lined container that plants grow in and that grey water moves through. The bottom is filled with gravel that water can flow through, then there is a layer of sand or straw and then soil and plants. ([PeakD Earthship Biotecture](#))

Building materials

These are materials used for construction. Many modern day building materials are man-made and synthetic but building materials also



Glossary

include naturally occurring substances such as clay, rocks, sand and wood. Many synthetic building materials rely on mining, petroleum and logging which create environmental damage.

Carcinogenic

A carcinogen is a substance that is capable of causing cancer. Carcinogens may occur naturally in the environment or may be generated by humans. Exposure to some chemicals and hazardous substances can increase the risk of cancer. A few well-known carcinogens are asbestos, nickel, cadmium, radon, vinyl chloride, benzidine, and benzene. These carcinogens may act alone or with another carcinogen to increase your risk.

Chlorine

A halogen element that is isolated as a heavy greenish yellow gas of pungent odour and is used especially as a bleach, oxidising agent, and disinfectant in water purification

Cisterns

A cistern is a reservoir water system featuring a large tank made from either concrete, steel, wood, or fibreglass. It's stored underground where it collects rainwater for household use and, in some cases, consumption. Cisterns range in capacity from 100 gallons to several thousand gallons.

Clearcut

An area of forestland where most of the standing trees are logged at the same time and a few trees remain post-harvest. Forested buffers are left around streams and lakes, and the area is replanted within two years of harvest.

Convection

The movement caused within a fluid or gas by the tendency of hotter and therefore less dense material to rise, and colder, denser material to sink under the influence of gravity, which consequently results in transfer of heat.

Diabetes

Diabetes is a disease that occurs when your blood glucose, also called blood sugar, is too high. Glucose is your body's main source of energy.



Glossary

Your body can make glucose, but glucose also comes from the food you eat. Insulin is a hormone made by the pancreas that helps glucose get into your cells to be used for energy. If you have diabetes, your body doesn't make enough—or any—insulin, or doesn't use insulin properly. Glucose then stays in your blood and doesn't reach your cells. Diabetes raises the risk for damage to the eyes, kidneys, nerves, and heart. Diabetes is also linked to some types of cancer.

Drought Climates

Drought is a normal climate pattern that has occurred in varying degrees of length, severity, and size throughout history in various locations. A drought climate may be subjected to abnormally dry weather over an extended period of time resulting in a water shortage in the affected area. Areas that might experience this include the Mediterranean, West Africa, East Asia, South West and South Australia. (Drought.Gov)

E.Coli

A bacterium commonly found in the intestines of humans and other animals, some strains of which can cause severe food poisoning.

Effluent

Effluent is sewage or other waste that's dumped into water. Effluent traces back to a Latin word meaning "flowing out," and as an adjective the word can still be used in that sense.

Fahrenheit

A scale of temperature on which water freezes at 32° and boils at 212° under standard conditions. It is mostly used in the USA.

Filter

A porous device for removing impurities or solid particles from a liquid or gas passed through it.

Fluoride

A mineral that is naturally occurring and released from rocks into the soil, water and air. Fluoride has both beneficial and negative effects depending on how much has entered the body.

Glossary

Formica

A hard durable plastic laminate used for worktops, cupboard doors, and other surfaces.

Fossil fuel

A material formed from the decomposition of carbon-based lifeforms such as plants and animals that died millions of years ago. They create carbon-rich deposits that can be found in crude oil, coal and natural gas that are extracted and burned for energy.

Fracking

Short for “hydraulic fracturing”, which is the process of creating fractures in rocks and rock formations by injecting specialised fluid into cracks to force them to open further. The larger fissures allow more oil and gas to flow out of the formations and into the wellbore.

Gallon

A unit of liquid or dry capacity equal to eight pints or 4.55 litres.

Glued laminates

A type of structural engineered wood product constituted by layers of dimensional lumber bonded together with durable, moisture-resistant structural adhesives.

Greenhouse

A glass building in which plants that need protection from cold weather are grown.

Grey Water

The relatively clean waste water from baths, sinks, washing machines, and other kitchen appliances.

Heart Disease

Cardiovascular disease (CVD) is a general term for conditions affecting the heart or blood vessels. It's usually associated with a build-up of fatty deposits inside the arteries and an increased risk of blood clots.



Glossary

Landscaping

The process of making a garden or other piece of land more attractive by altering the existing design, adding ornamental features, and planting trees and shrubs.

Line resistance

This is caused by the collision between electrons and atoms present in the conductor. In this case, if the conductor is longer, there will be more collisions leading to higher resistance.

Monsoon

Is a seasonal prevailing wind in the region of South and SE Asia, blowing from the south-west between May and September and bringing rain (the wet monsoon), or from the north-east between October and April (the dry monsoon).

Off-gassing

The airborne release of a chemical, a chemical in vapour form. Whenever you smell a product, it's off-gassing. It happens the most when a product is new. Furniture, mattresses, carpeting, paint, electronic devices, clothing, aerosol sprays, and building materials are just a few of many, many examples. The health effects of off-gassing include headaches, skin irritation, and damage to the liver, kidney, and the central nervous system.

Oxygenation

A measurement of dissolved oxygen concentration in soil or water.

Pharmaceutical

Any kind of drug used for medicinal purposes, like cough syrup or sleeping pills. Pharmaceutical consumption has been increasing for decades, driven by a growing need for drugs to treat age-related and chronic diseases,

Physicist

A scientist who specialises in the field of physics, which encompasses the interactions of matter and energy at all length and time scales in the physical universe.



Glossary

Plaster

A building material used for the protective or decorative coating of walls and ceilings and for moulding and casting decorative elements.

Plumbing

The system of pipes, tanks, fittings, and other apparatus required for the water supply, heating, and sanitation in a building.

Pressure tank

Vessels that are used to store or convey gases, vapours, and fluids at pressures greater than atmospheric pressure, also known as high pressures. They come from pressure vessels which are sealed containers that store the same contents.

Septic Tank

An underground chamber made of concrete, fibreglass, or plastic through which domestic wastewater flows for basic sewage treatment. Settling and anaerobic digestion processes reduce solids and organics.

Sewage treatment

A type of wastewater treatment which aims to remove contaminants from sewage to produce an effluent that is suitable to discharge to the surrounding environment or an intended reuse application, thereby preventing water pollution from raw sewage discharges.

Shelter

The fact of having a place to live or stay, considered as a basic human need.

Silt

A solid, dust-like sediment somewhere between sand and clay in size that is carried by water, ice and wind, building up in the area it is deposited.

Solar Panels

A panel designed to absorb the sun's rays as a source of energy for generating electricity or heating.



Glossary

Solar Thermal Energy

A form of energy and a technology for harnessing solar energy to generate thermal energy.

Sustainable Autonomous Housing

Housing that is designed to be operated independently from infrastructural support services such as the electric power grid, gas grid, municipal water systems, sewage treatment systems, storm drains, communication services, and in some cases, public roads.

Sustenance

Sustenance is food or drink which a person, animal, or plant needs to remain alive and healthy.

Thermometer

An instrument for measuring and indicating temperature, typically one consisting of a narrow, hermetically sealed glass tube marked with graduations and having at one end a bulb containing mercury or alcohol which extends along the tube as it expands.

Utilities

Basic services for your home, apartment, or business needs to keep it comfortable and functioning properly. Common utilities include water, sewer, electric, gas, trash, and recycling.

Vacuum

The space in which there is no matter or in which the pressure is so low that any particles in the space do not affect any processes being carried on there.

Zero discharge system

Zero liquid discharge (ZLD) is an engineering approach to water treatment where all water is recovered and contaminants are reduced to solid waste.



05

Go Further / Credits

Teacher Info

If you want to know more about how to build these homes, we are confident that we can teach anybody to do it.

You can attend or more in depth educational programs either online or in person by visiting: www.earthshipglobal.com/academy-sessions

If you want to experience an Earthship then you can also head to: www.earthshipglobal.com/eco-nightly-rentals

Follow us on social media:

 [earthship](https://www.instagram.com/earthship)

 [@earthship](https://www.youtube.com/@earthship)

Further Resources

[Garbage Warrior movie](#)

[Earthship phone App](#)

"A digital archive of all things Earthship. For those interested in building their own or just curious about the concept, you will have access to a library of drawing sets for basic models, diagrams of general systems, scroll-able versions of one of our most popular books, "The Coming of Wizards", which encompasses much of the history and philosophy behind Earthship ideas, and much more."

Earthship books volume I and II by Michael Reynolds

What Next?

As an Earthed member you can watch this Earthed Course on demand at whichever time suits you best. Also, keep an eye out for future Earthed opportunities to get direct tips and answers from Paul. Whether you're organising a local litter collection or starting a river restoration community, make sure you head to the Earthed Community area to ask questions, help other members, share photos, and get inspired to keep on growing.

Starting your river restoration? You're an inspiration! Share your Earthed Work with us via the community forum and social media using the hashtag #weareearthed.

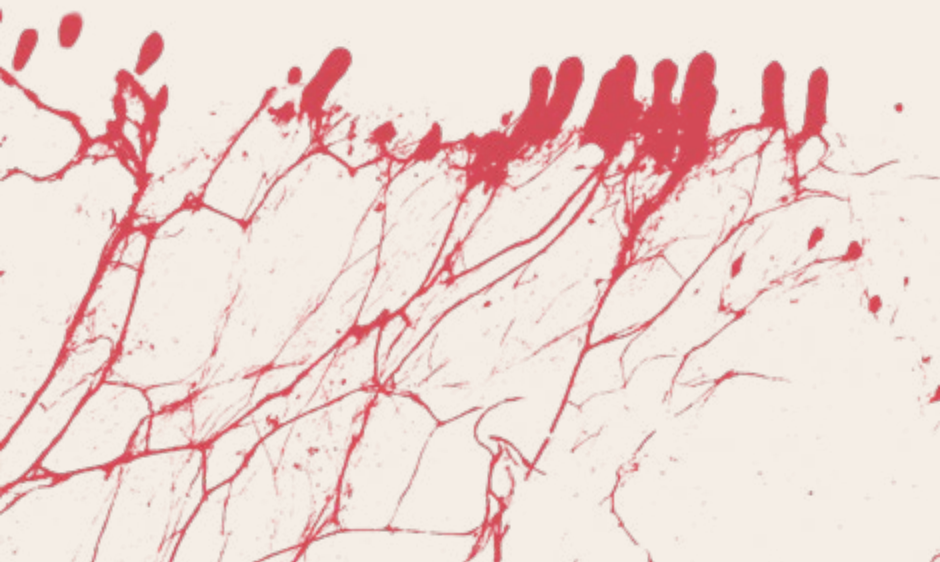
Credits

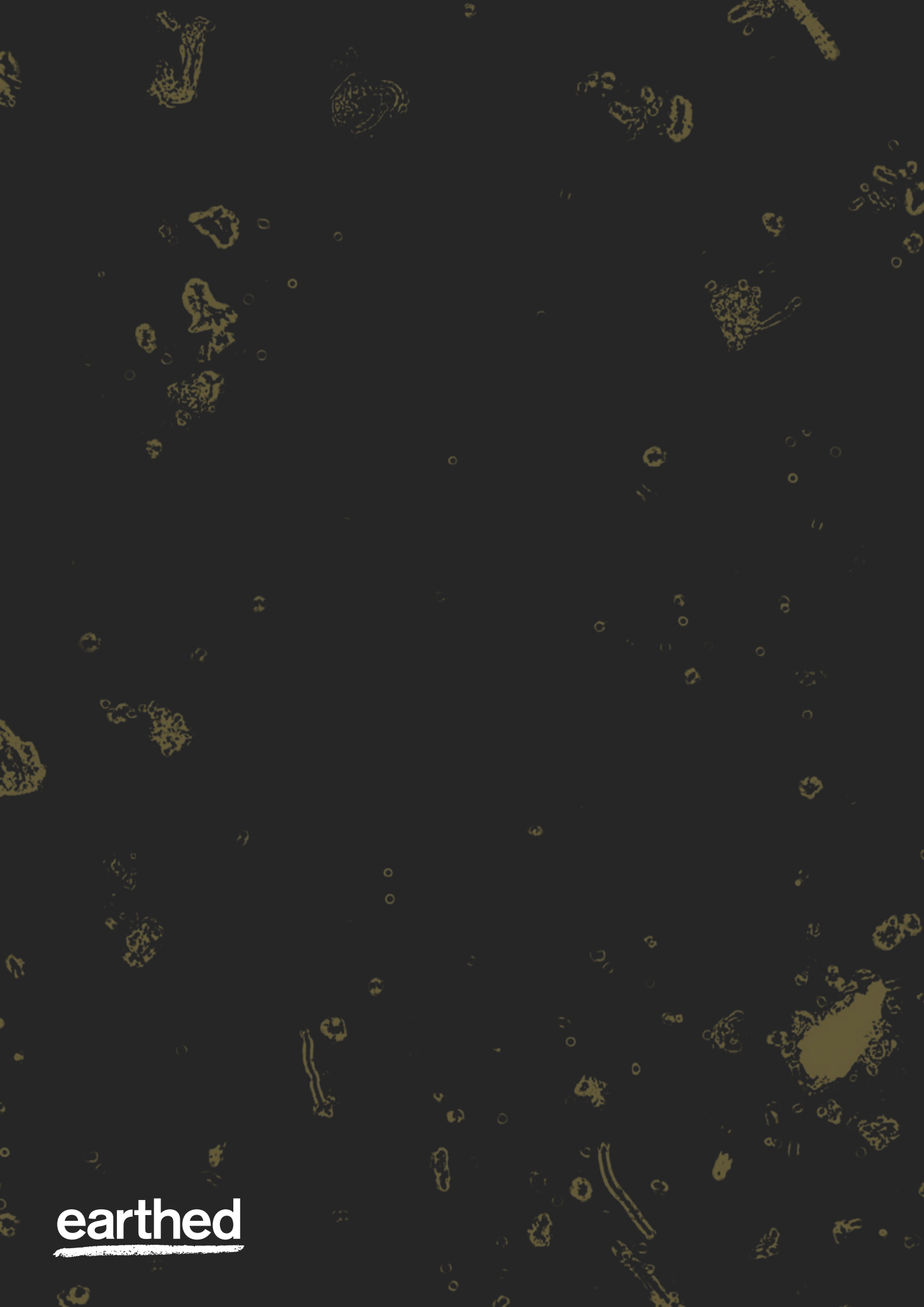
At Earthed, we look towards and celebrate our Nature Teachers and the skills, stories and knowledge they share with the world. Because their understanding is not only deep, beautiful, and full of generations and generations of learning; it is powerful. And it is key to addressing the threats we face today as well as paving our paths to thriving futures.

We would like to thank Michael Reynolds for inviting us to Taos New Mexico to see these Earthships and taking the time to share his 50 years of experience with us.

About Earthed

Earthed is the nature skills platform for a global community of people learning to grow. It's for everyone who wants to restore the air we breathe, the water we drink, the land we farm and the food we eat. Whether you're an expert or a beginner, come and join us.





earthed