

# INNOVATIVE TECHNOLOGIES

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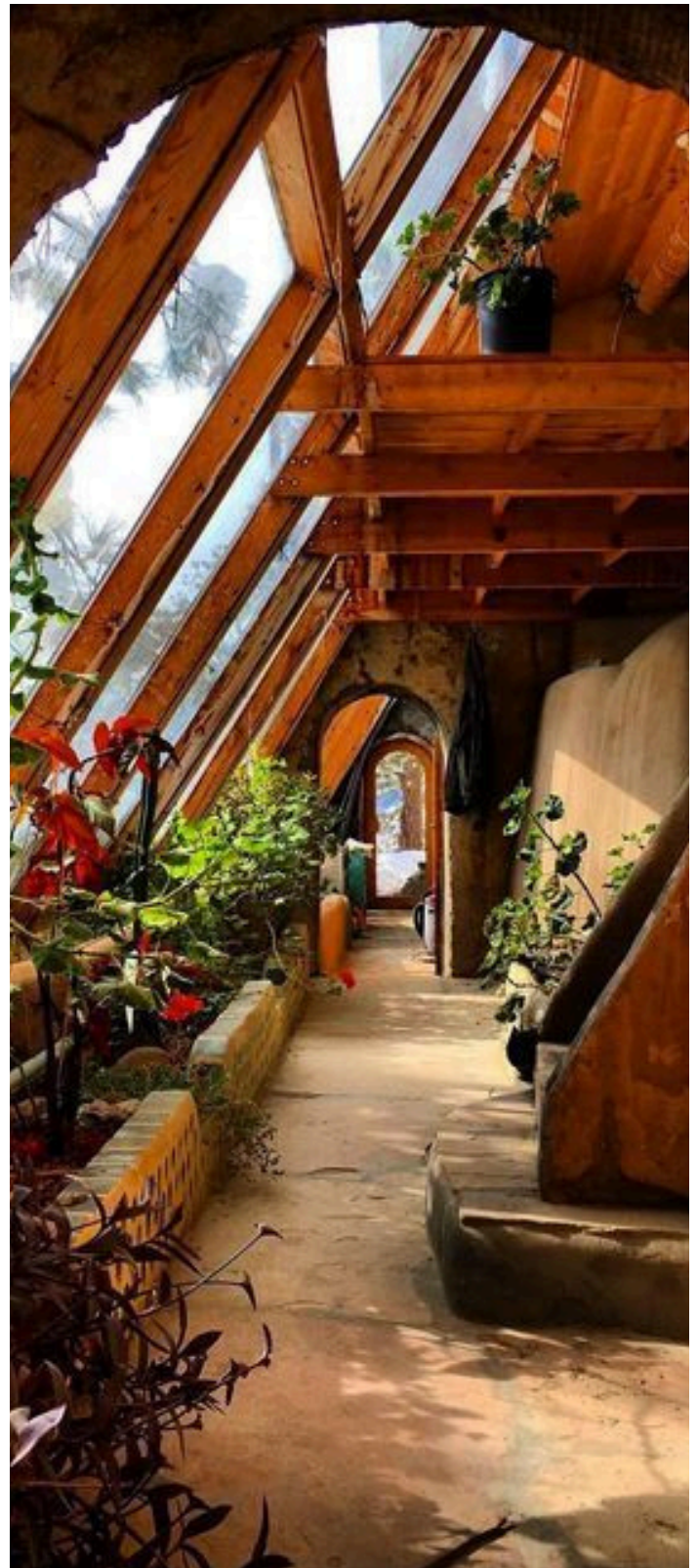
# Earthship

Research Project



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# What is an “Earthship” ?



Earthships are typically long skinny bungalows enveloped in the rear and the sides mostly with earth berm retaining walls while the front consists of a greenhouse.

This off-grid home produces its own energy, captures its own water, treats its own wastewater, grows its own food, and is passively heated from the sun and thermal mass. It is built using tires reinforced with dirt for the exterior walls main support as well as aluminum cans, mortar, and glass bottles for the interior walls.



<https://ideas-be.ca/data/six-nations-earthship/>



## Six core sustainability principles

1. Allows for on-site electricity production.
2. Allows for passive heating and cooling.
3. Allows for on-site wastewater treatment.
4. Turns rainwater into drinking water.
5. Allows for food production.
6. Uses readily available (recyclable) materials.

## Promote Sustainability

The goal of the “earthships” is to create structures that look as if they grew naturally within their environments. It is a home that sustains its inhabitants through its various self-sustaining functions, with no need for hydro, gas, or water connections, instead of the other way around. Earthships are built with raw materials that can potentially affect the environment negatively, but instead are used as a means to provide shelter as well as neutralize and reduce their risk to the environment.



[https://earthshipstore.com/products/global-model-construction-drawings?srsltid=AfmBOopfq8MMH67Hj3s\\_Rp-Ejl2XL4x3PDs1j6U2Qgj5m8q4cqW8lRjg](https://earthshipstore.com/products/global-model-construction-drawings?srsltid=AfmBOopfq8MMH67Hj3s_Rp-Ejl2XL4x3PDs1j6U2Qgj5m8q4cqW8lRjg)

Earthships also require very little use of wood as material due to its timber required only for roof beams. Thus, its earth-cemented tires containing no oxygen allow for a higher ignition temperature, which makes spontaneous combustion or fire from natural causes close to impossible.

# How did “Earthship” emerge?



## Origin

In the early 1970s, Michael Reynolds, a New Mexican architect, started the movement of building sustainable houses due to his dissatisfaction with standard home designs.

Reynolds is a pioneer of low-impact living; his work revolves around creating self-sustaining houses mostly out of garbage, which drew attention to the excessive and irresponsible wastage of resources by people all around the world. He earned the title of “Garbage Warrior” over many years of perfecting the Earthship.

Reynolds, the father of the Earthship movement, founded his company, Earthship Biotecture, previously known as Solar Surviving Architecture, in order to form an organization dedicated to acquiring skills and knowledge that allow for the construction of homes integrating sustainable practices.



<https://ideas-be.ca/data/six-nations-earthship/>

## Organizations

The movement has garnered a community of people that lend their hand in building Earthships all over North America. Approximately 30-35 volunteers provide help throughout the construction process.

The majority of these volunteers come through the Earthship Academy, run by the Earthship Biotecture company, which provides training in earthship design principles, construction methods, and philosophy.

This construction activity allows people to learn how to build self-sustaining houses either for their own use, as a trade, or as a summer pastime.

<https://www.pembina.org/blog/earthship-sets-sail-southern-alberta-help-green-energy-futures-editor>



## Timeline



**Mid-1990s**

Reynolds built 3 earthships: Lemuria “Gravel Pit”, “Reach” and “Star”

20 contractors in North America and independent home builders were able to build Earthships for less than \$100,000 by studying with Reynolds

**1990s**

Earthship projects spread across Canada due to environmental activists, Pat and Chuck Potter, adapting Reynolds’s design for the long Canadian winters.

Cold adapted earthship homes have served as models for earthships in temperate countries: Belgium, Netherlands, United Kingdom, Southern Argentina

# Green Building Practices



## Solar orientation

In the northern hemisphere where the weather is typically colder, Earthship structures face south in order to absorb maximum heat. The walls are slanted and made of glass material that can be rarely found anywhere else in the structure.

The greenhouse covering the entire front of the structure serves as a primary heating system for the Earthship. This passive solar design has the ability to capture plenty of heat, especially during winter.

The thermal mass walls also allow heat to be absorbed during the day and it is retained for hours until the internal temperature drops, in which the heat is then released slowly, thus providing the necessary heating needed for the inhabitants.

## Energy saving system

Earthships can typically consist of photovoltaic solar panels and wind turbines as well as biodiesel generators to generate energy for heating and cooling.

Some earthships, typically in much colder climates, include small wood stoves to allow supplementary heating.

Earthships can also consist of composting toilets, solar hot water tanks, and insulated cold boxes that substitute as refrigerators.

## Greywater, Wastewater

Earthships allow for the reutilizing of greywater in ways that prolongs its use over many more times. The greywater is piped into the greenhouse to water plants and then undergoes a natural water treatment process before it is reused in the greenhouse or in the toilets.

Meanwhile, black water or wastewater is composted directly into a septic bed constructed in the Earthship, which is then treated before its usage in watering living plants inside and outside the building, thus contributing in the food production.

## Green roof

The integration of the green roof in the structure further provides sustainability practices that benefit the environment.

Earthships allow rainwater to be collected from the roof and stored in a plastic cisterns system buried behind the home, which is then filtered for residential use.



<https://ecobrooklyn.com/design/earthship-project-york/>

A propane system can also be used for cooking, drying clothes, and for back-up on demand hot water heating system. This sustainable fuel is a natural gas with many uses that continue to retain the main objective of earthships; sustainability.

# Earthship Designs



## Kinney Earthship

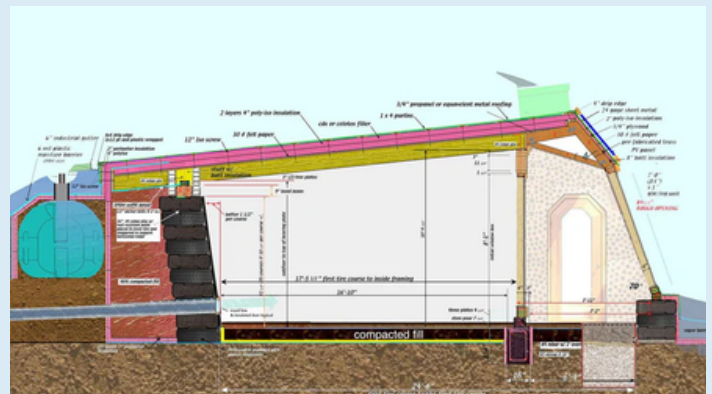
The Kinney Earthship “Kinship House” is an off-grid home located on the Southern Alberta prairie. This sustainable bungalow was built by Dawn, Glen and Duncan Kinney alongside Earthship Biotecture, run by Michael Reynolds. The home, built in only 5 weeks using recycled materials, features sustainable practices inherent in Earthship design: A greenhouse that provides necessary heating in the cold harsh climate, a water storage, and a sewage treatment system. the Kinney Earthship showed the possibility for Earthship designs to be adapted and sustained even in the harsh climates of the northern region.



<https://calgaryherald.com/gallery/take-a-tour-of-albertas-first-official-earthship>

## Global model

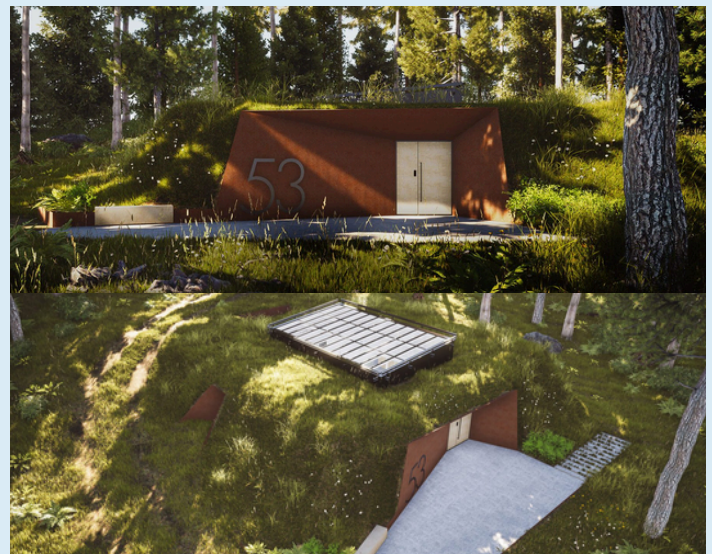
The Global Model Earthship is a self-sustaining home, designed by Reynolds, that performs in almost any climate around the world. This model has been used as the blueprint for Earthship constructions in countries like France, Germany, Mexico, Canada and United States of America. The design features a double greenhouse located between the inner living spaces and the outside, as well as underground cooling tubes and convection skylights that allows proper ventilation and air conditioning for the comfort of the inhabitants of the building.



[https://earthshipstore.com/products/global-model-construction-drawings?srsltid=AfmBOoptfg8MMH67Hj3s\\_Rp-Ejt2XL4x3PDs1j6U2Oqj5m8q4cqW8lRjg](https://earthshipstore.com/products/global-model-construction-drawings?srsltid=AfmBOoptfg8MMH67Hj3s_Rp-Ejt2XL4x3PDs1j6U2Oqj5m8q4cqW8lRjg)

## Earthship 2.0

Earthship 2.0 is an economical innovative architecture in British Columbia designed by Rafael Santa Ana. This sustainable design retains most of the original features from Reynolds’s earthships while combining middle-eastern interior courtyard concepts. The reverse temperature control method of an inward-facing design, featuring a central garden allows the optimization of the building envelope’s thermal performance. The design is burrowed into the terrain to lessen its impact on the surrounding ecosystem while allowing natural light inside with a sloped centered skylight. The structure opens the doors to sustainable, economical, and eco-friendly modernized building designs in Canada.



<https://loopdesignawards.com/project/earthship-2-0/>

The design of Earthships continues to be adapted throughout many countries, but the main idea of self-sustaining homes that consider environmental impacts still remains.



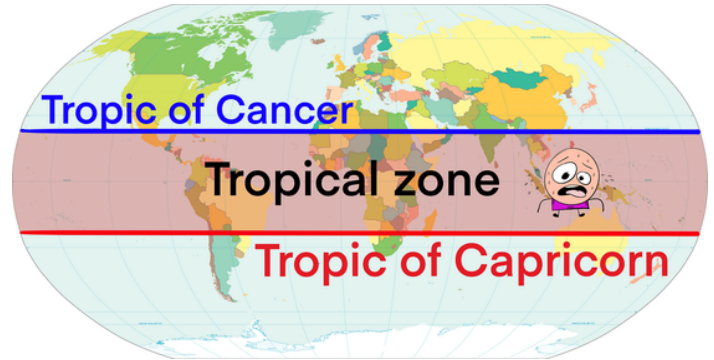
# COST OF CONSTRUCTION

How much money do you realistically need in order to build your own earthship and be fully independent? This section of the report will provide a cost analysis of an earthship in Quebec, Canada. Multiple factors determine the cost of this type of project with the primary ones being: location, project scope, project time, material quality, labour expenses, legal requirements and financing options.

## Factor 1: Location

Before building an earthship you need to know where you're going to put it. According to Earthship Bioteecture, the optimal location for building an earthship is in the Tropics. However, the province of Quebec is located in the Tropic of Cancer and a portion of it is also in the Arctic Circle. Starting a project in a less favorable environment automatically increases costs, but by selecting a site in a less challenging area will help reduce cost.

Some favourable locations for building Earthships in Quebec include: Montérégie, Outaouais, Bas Saint Laurent.



## Factor 2: Project Scope

One of the main factors that impact the total cost of an earthship is the project scope. Earth ships can come in multiple models and sizes. Some can be bigger, some smaller, some are built on different types of soil, somewhere built in different environments and all of these elements constitute the project scope. Obviously making a more difficult build will increase the total cost. The main elements that will increase the cost of an earthship based on the project scope are: the heating methods, the water supply method, the electricity method, the plumbing and sewage system, and the food production system.

In addition, the project scope is also influenced by the choice between a custom-designed Earthship and a pre-designed model. Pre-made Earthship plans can be purchased from established providers such as Earthship Bioteecture (earthship.com), which offers standardized designs at varying price points. Their plans range from \$2,082 CAD to \$17,214.00 CAD depending on the size and complexity of the project (number of rooms, storeys, features, etc.)

## COST BREAKDOWN

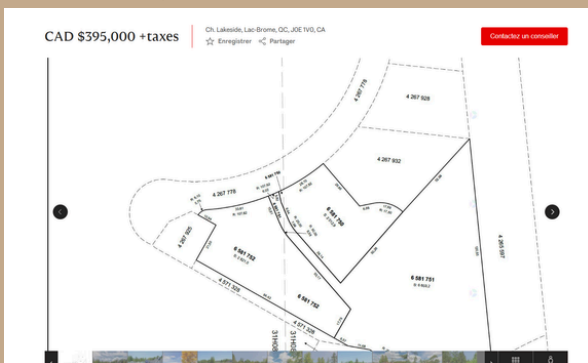
### Size:

"A useful rule of thumb is about AUD\$3500 [\$3352.96 CAD] per square metre of "gross floor area" (this is the "footprint" of the house - you can think of it as the size of the floor slab). If you are a very energetic and resourceful owner builder you might achieve \$2000/m2 [\$1915.98 CAD]. If you want a more complex design with lots of "bells and whistles" then the price might go up to \$4500 [\$4310.95. CAD] per square metre. Hence a two bedroom home with a footprint of 150m2 will cost \$525K [\$503K CAD]. Maybe you could do it for \$300K [\$290K CAD] as an owner builder." ("FAQ." Earthship Eco Homes, www.earthshipcohomes.com.au/faq.html.)

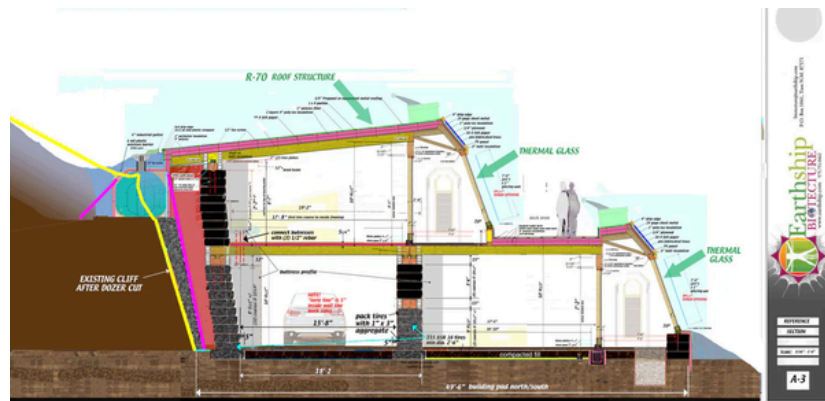
**Estimated cost: \$200K CAD-\$300K**

### Site:

Typical Earthship designs require 1 to 2 acres minimum of land. For example, a 1.6-acre lot in Lac-Brome Quebec is listed for \$395,000.



CH. LAKESIDE, LAC-BROME, QC, J0E 1V0, CA | LAND FOR SALE.  
MONTREAL.EVREALSTATE.COM/FR-CA/PROPERTIES/OUR-LISTINGS/CH.%20LAKESIDE-LAC%BROME-QC-J0E%201V0-CENTRIS-9974120.. 2026.



"5 BED 3 BATH SPLIT LEVEL GLOBAL MODEL EARTHSHIP CONSTRUCTION DRAWINGS" EARTHSHIP BIOTEECTURE, EARTHSHIPSTORE.COM/PRODUCTS/GLOBAL-MODEL-CONSTRUCTION-DRAWINGS?VARIANT=44187701805315.

However, with pre-made plans, modifications are often required to adapt the design to Quebec's cold climate, local building codes, and site-specific conditions, which can increase the overall project cost

It is important to note that even if pre-made plans are created by licensed architects, the plans may still require approval from a local, provincially licensed architect to be valid, as architectural credentials do not automatically transfer between regions.



### Factor 3: Project time

The total duration of the project has a significant impact on the overall cost of building an Earthship. Earthships typically take between 12 and 24 months to construct. During this period, the owner must continue to cover personal living expenses such as rent, utilities, and daily costs, while simultaneously funding a construction project that can last one to two years, unless they choose to live or camp on the construction site. In 2025, the a person living alone comfortably in Montreal needed to spend around \$4,000 per month for basic living expenses (EcoFlow), which totals up to \$48,000 for one year and \$96,000 for two years.



### Factor 4: Material Quality

Earthships are mostly built with natural and reclaimed high-performing and long lasting materials. For an average size build, an estimate for the cost of materials is \$700-\$4,100 CAD for recycled materials and ranges between \$0-\$2,800 CAD for tires depending on availability and sourcing. (Castellanos, Chad.)

Some common materials include:

- Recycled tires with rammed earth
- Earth and soil
- Aluminum cans and glass bottles
- Adobe, clay or mud
- Reclaimed wood and metal

In colder climates there also needs to be a particular attention on insulation materials such as:

- Rigid foam insulation
- Mineral wool
- Straw bale insulation
- Sheep's wool insulation
- Reclaimed insulation panels.

## COST BREAKDOWN

### Heating:

The traditional heating methods used in earthships are thermal mass and passive solar design, which are essentially “free” since they are part of the building's structure. Unfortunately these methods alone are insufficient to maintain an ambient indoor temperature in Quebec due to the very low temperatures during winter.

### Other heating options include:

- Electric baseboard : Simple, reliable and easily available. **Estimated cost: \$50-\$400 per unit**
- Radiant floor heating: Provides consistent, efficient heat by warming the floors, which then radiates warmth throughout the living space. **Estimated cost: \$1,000 per 100 sqft**
- Heat pumps (air source or geothermal source): Energy-efficient systems that can provide both heating and cooling. Geothermal source pumps are more expensive upfront but highly efficient long-term. **Estimated cost: \$6,000 to \$40,000 per unit.**
- Hybrid solar-thermal systems: Relies primarily on thermal mass and passive solar design, while supplementing heat through other alternative heating options when additional warmth is needed. **Estimated cost: \$50 to \$40,000**
- Propane or Natural Gas Heaters: Provides reliable heat during extremely cold periods. This system should be installed in well-ventilated spaces and used in combination with a carbon monoxide detector to ensure safety. **Estimated cost: \$100 to \$2,500 per unit**
- Wood Stoves or Pellet Stoves: Provide fast and efficient heating that works well in combination with thermal mass walls. A consistent supply of dry wood or pellets is required for reliable operation. **Estimated cost: \$700 to \$4,000 per unit**

### Electricity:

Earthships typically use Solar panels and wind turbines to generate DC electricity.

- **Geothermal Energy (Ground-Source):** Uses the stable temperature of the ground to generate electricity. **Estimated cost: \$15,000 to \$30,000**
- **Hybrid Systems:** Combining solar, wind, and/or geothermal allows for more consistent energy supply year-round. **Estimated cost: \$20,000 to \$40,000**
- **Solar Panels:** Convert sunlight into electricity, typically paired with battery storage for off-grid use. **Estimated cost: \$10,000 to \$25,000**
- **Wind Turbines:** Generate electricity from wind energy. Requires a suitable site with consistent wind. **Estimated cost: \$5,000 to \$15,000 for a small residential turbine**

## COST BREAKDOWN

### Food:

Producing food on a self-sufficient property in Quebec involves both crop cultivation and potentially livestock management. Typical crops that grow well in this region include potatoes, carrots, onions, cabbage, leafy greens, tomatoes, cucumbers, raspberries, strawberries, and apples.



For livestock like cattle, food costs are significant. On a small cow-calf operation, average feed and maintenance costs per cow can range from approximately \$540 in feed and roughly \$1,300 per year in total operating costs.



Raising chickens is a relatively low-cost method of food production for a small self-sufficient property in Quebec. A basic chicken coop suitable for 4 to 6 laying hens would cost between \$500 and \$2,000 for the setup and maintenance



Overall, a small mixed food system (garden plus a few livestock) may require an investment of several thousand dollars annually in feed, seeds, and infrastructure but can significantly reduce external food costs compared with buying all produce and meat from external sources.

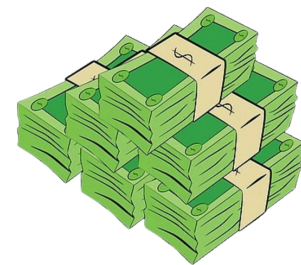
### Factor 5: Labour Expenses

Earthships can be constructed by a professional team at an estimated cost of approximately CAD \$200 per square foot. (Castellanos, Chad.) Alternatively, construction can be supported by volunteer labour, which can significantly reduce overall labour costs. In this case, the labour is free however, the owner is typically responsible for providing food and accommodation for volunteers throughout the construction period.



### Factor 6: Legal Requirements

Building an Earthship in Quebec requires compliance with local zoning bylaws, municipal regulations, and the Quebec Construction Code. Due to the unconventional nature of Earthships, additional approvals may be required. These requirements typically involve costs related to building permits, inspections, and professional reviews, which can range from \$1,000 to \$10,000. In some cases, engineering reports or approval from a locally licensed architect may be necessary to ensure the project meets safety, structural, and environmental standards.



### Factor 7: Financing

In Quebec, financing an Earthship is often more complex than financing a conventional residential property. Paying for the property in cash is often the simplest option, as lenders may not consider non-traditional, off-grid constructions eligible for standard mortgage financing. Many financial institutions might consider an Earthship as a risky investment which can limit borrowing options. As a result, Earthship projects frequently rely on personal savings, personal loans, or lines of credit, increasing the need for higher upfront capital.

# CONSTRUCTION STYLE & SIZE



## Styles of construction (aesthetics)

- Earthship designs Incorporates many natural and reclaimed materials when constructing. Tires can be used to replace rammed earth bricks because they have the perfect form. This method works well to create airtight walls, provide structural stability, store thermal energy, improve and secure insulation, it helps reduce heat loss during colder climates and helps maintain a stable temperature indoors throughout the year.
- Structural, bearing and retaining walls are often made with rammed earth encased in recycled steel-belted tires. This gives earthships a solid and earthy appearance. Building walls this way creates a thick, sculpted look that visually expresses the overall mass of the structure.
- Other materials are used as well such as cans and bottles. Bottle brick walls are an iconic decorative feature that allows natural light to pass through. The walls are typically plastered with adobe mud and most interior finishes include mud floors along with reclaimed wood and metal.



## Size of Construction (Limitation)

Earthships can be built in many different sizes depending on the type of home chosen, from small studios to larger family homes. Every room includes thermal mass, which helps store heat and keep indoor temperatures stable and comfortable all year. Earthships can also be built in sections, allowing parts of the home to be constructed individually and expanded over time. This makes the construction process more flexible and allows homeowners to start small and build more later if they want.

- Studio (800 sq. ft.)
- One bed (1000 sf. ft.)
- Two beds (1200 sf. ft.)
- Three beds (1500 sf. ft)



# CONSTRUCTION PHASE & PERMITS

## Permits, property and utilities

### Permits:

- These are difficult to obtain and usually not recognized by the codes, earthships are unconventional construction methods that are not directly stated in the Canadian building codes. This makes approval for a project hard to obtain. Builders often need approval from a professional stamped drawing obtained by an architect/engineer. This proves structural safety and code compliances.

### Property:

- Earthships are easier to build in rural areas (outside cities and large towns) where regulations are less strict, while urban areas have more rules that limit alternative construction.

### Utilities:

- Solar electricity system, this captures power from the sun and stores it in batteries. (Solar panels capture sunlight and convert it into electricity, which is stored in batteries for later use.)
- Wastewater treatment process, Greywater from sinks and showers is filtered through indoor plant beds and reused for toilet flushing, while toilet water is treated by passing through the soil, where dirt and plants clean it, and then it safely goes back into the ground.
- Catch water = water is caught from the sky (rain and snow melt) and is stored into cisterns. This water goes through basic filtering to remove dirt and debris, the stored water is then filtered to be safe to drink. Cisterns can be placed above ground, buried or integrated in the building which can connect to the municipal water when water level gets low.



## Construction phases (time)

Every earthship turns out different depending on the recycled and local material you used, making every build very unique.

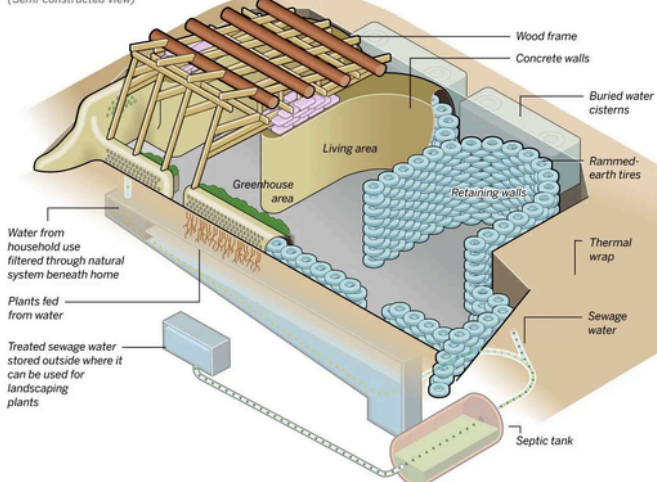
1. Pack tires with compacted earth to form structural walls. (700-1500 tires used)
2. 15-20 min to compact each tire which can add up to 400+ hours of labor.
3. Plastering the walls
4. Building the roof and green house
5. Adding interior walls and floors

- A typical 1 bedroom/2 bedroom earthship takes about 4 months to build when it's done by an experienced team.
- Owner-built earthships take about 6 months, sometimes even more to complete. This depends on the skills you have and how much time you can dedicate to the project. If construction is done on a part time basis, the project can take 2 years or more to finish.

### BETTER LIVING THROUGH GARBAGE

Earthships are self-sustaining homes constructed from as much locally-sourced, reclaimed material as possible.

#### INTERIOR (Semi-constructed view)





# KNOWLEDGE & SKILLS

## PRECEDENTS IN CANADA

The Earthship design was intentionally designed to excel in desert and prairie climates. The sustainability-conscious design that can operate independently from the grid is an attractive style of project for many Canadians. In practice, however, there are immediate factors such as humidity and the colder climate that negate a lot of the features that make an Earthship classified as an "Earthship".

There are an estimated 30-50 Earthships that have been built in Canada since around the 2010s. A majority of which have been built in the province of Ontario, with a few notable projects found in British Columbia, Alberta, Quebec, Prince Edward Island, and Nova Scotia.



MAP OF KNOWN CANADIAN EARTHSHIPS - DARFIELD EARTHSHIPS BLOG

What can be observed from these projects is that a lot have had to step away from the traditional Earthship design. This begs the question if these structures can be truly classified as Earthships.

## Alternative Power Source - Heating

The Earthship design utilizes solar panels and wind turbines; in Canada, such methods of sustainable energy production are insufficient or impractical. Many Canadian Earthship designs inevitably end up burning biomass and fossil fuels for supplementary heat and power. Wood stoves and propane tanks become the default for many Canadians as they can be a more reliable source of energy than solar panels and wind turbines, which are intermittent sources of energy that heavily depend on geography, and have a higher up-front cost for installation. These sustainable power sources are increasing in popularity across Canada as the technology becomes more affordable and accessible to the public.

Hydroelectricity is already a sustainable power source, which makes hooking a Canadian Earthship to the Hydro grid a reasonable solution if the property is located in proximity to the grid. The only caveat being that your "off-the-grid" homestead might not be so independent and "off-the-grid" after all.

## Passive Solar Design and Thermal Mass

The original design of an Earthship was built to comfortably withstand the New Mexico winters. Temperatures at their coldest average between 6°C and -7°C, with hot summers that could reach 27°C to 36°C. They utilize thermal massing strategies to retain comfortable interior temperatures. Walls will absorb solar heat during the winter days and re-radiate at night, when it is cooler, to warm the inside of the structure. The inverse functions just as effectively during warmer temperatures in the summer. Taking the hot air indoors and redirecting it through the wall to the exterior. In Canada, the effectiveness of a thermal mass structure is lost for nearly all climate zones throughout the provinces. There is a mark of lost efficiency when exposed to prolonged cold spells, limited temperature swings between day-night cycles, and several design and operational challenges due to insufficient exterior insulation or poor thermal coupling.

Ecohome Engineer, Denis Boyer, states that *"Except for water and other materials with very high conductivity, due to the relatively subtle variations in temperature that any passively-heated house could expect to see over a 24-hour cycle, only the first 6 or 7 inches of the wall would show any noticeable temperature change through absorbing and releasing heat"*.

To summarize, Earthships only utilize the first third of the wall thickness as a thermal mass. The thermal wrap and insulation in the design become a flawed feature as it is too far back into the wall to be properly effective in insulating the walls. Floor slabs also need to factor in a sufficient R-value to ensure there is no significant heat loss. The Montreal-Ottawa corridor requires at least a depth of 10ft to maintain temperatures between 6.3°C in January and 3.4°C in April.

## Insulation and Mould - Humidity

In the north, the provinces and territories that make up Canada have a drastically higher humidity level than that of New Mexico, being one of the driest states in the U.S.A. The Average Annual Relative Humidity in Canada sits around ~74%, while the desert of New Mexico has ~45.9%. While an Earthship built in a more arid environment can get away with minimal to no use of insulation, the same can't be done in the north.

The greenhouse is designed to cultivate food production within the living space of the structure and is a very attractive feature for the limited growth and harvest seasons many Canadians face. However, the planting space can create a humid critical zone that runs the length of the building and inevitably results in a serious mould problem later down the line. The condensation created from the south-facing greenhouse and the lack of proper insulation in the Earthship could have serious health concerns. To heat these higher-humidity areas requires more energy than simply afforded through passive solar design.

According to Health Canada, “the optimum range of relative humidity for a healthy indoor environment would be between 30 and 55 RH, above or below those levels increases the risk of respiratory issues.”

When insulation is used on an Earthship, the de facto type is XPS foam boards, which are non-biodegradable and are made with blowing agents (otherwise known as HICs - potent greenhouse gases). There are far more sustainable and efficient types of insulation in the market that can be used to achieve the same goal. EPS foam, Rigid mineral wool, and Hemp insulation panels are some of the leading products on the current market.

## GROW CALGARY - EARTHSHIP FARM

In Calgary, Paul Hughes uses the Earthship design solely for food production, early plant germination, on his farm during the winter seasons. The structure was built in 2013 after facing challenges with



PAUL HUGHES OF GROW CALGARY - OCTOBER 24, 2016.  
PHOTO BY MIKE DREW /POSTMEDIA

the local municipality building code. The building was almost demolished due to its unique building techniques which are unprecedented in the Canadian Building code. This farm works with several nonprofits and food programs to donate fresh produce and educate through community volunteer workshops. This example avoids the complications created when trying to adapt a northern Earthship into a comfortable living space.



While there could be difficulty acquiring the proper permits to build an Earthship Plant nursery in other provinces, it shows how these structures can be used primarily for agriculture in more remote zones of Canada. The pictures taken at the Grow Calgary Farm show the final stages of construction before any finishing, cladding, or landscaping are completed.



GROW CALGARY EARTHSHIP FARM - PHOTO BY MIKE DREW /POSTMEDIA

### Volunteer Labour and Skills

The labour and skill knowledge used to build this project and many similar Earthships across Canada were accomplished through volunteer work.

For a fee, the New Mexico Earthship Biotechnology company takes on the most labour-intensive steps for property owners by hosting four-week workshops for students and volunteers.

Experienced Earthship builders and instructors teach the skills and knowledge acquired from previous projects while supervising students. The teams of eight builders and sixteen students often manage to get the structure enclosed within those four weeks. The “shell and systems” are then left to the owner to continue finalizing the remaining steps of construction. The Earthship Biotechnology company offers a second site visit or the possibility of being hired to complete the remaining structure. Local plumbers and electricians are required to install any plumbing or electrical systems the structure will use. The Earthship Biotechnology company also offers online academy lessons for those looking to learn more about Earthship philosophy and building practices.

In Canada, the volunteering and Earthship community is a lot smaller and heavily reliant on Facebook community groups, blogs, and local builders.

It is harder to find experienced builders, engineers and specialists who can ensure the structure is code-compliant. However, the small communities are growing slowly but steadily in each province as many new homeowners find ways to work around the housing crisis.

## COOK FAMILY - EARTHSHIP HOME

In Port Rowan, Ontario, a couple built their Earthship in 2014 and it is entirely off the grid, using a combination of sustainable energy sources. The home can maintain comfortable living temperatures in the summer and winter at 20°C due to a mix of air conditioning, furnace, airflow and thermal mass similar to most other Earthships.



CRAIG AND CONNIE COOK EARTHSHIP - PHOTO BY KATHERINE CHENG/THE WEATHER NETWORK

The retired couple had little help or knowledge of building an Earthship in the Ontario area, as it was one of the first pioneers of adapting Earthship design in Canada. The couple has since gone on to help others build their own in the Ontario area and continues to pass on their knowledge and experience in building and living in an Earthship.

Many Earthship owners have called the structure a “living machine” that requires a lot of research and commitment from those choosing to live in one. In Canada, there are already over 200,000 pre-existing homes in the northern communities that function off the grid. However, one important thing to consider is how living in a sustainably conscious structure, such as this design, is not the lifestyle for everyone.

### Maintenance and Lifestyle

The start of maintaining one of these structures begins with the first year of construction. Temperature regulation will eventually stabilize within several months to a year after construction. Adjustments and inspections will have to be done to ensure there is proper ventilation and sealing to manage moisture control and heat loss. The plaster walls will eventually crack and degrade over time due to UV sunlight exposure. The tires that are used to make up the walls can release toxic petrochemicals into the air of the inhabitants, should there be any change to the integrity of the plaster. These gases could pose a danger to the health of individuals who are exposed for long durations. Though there have been no research reports that test the long-term impact the tires pose on residents. Repairs and patches to the walls will be required throughout the lifespan of the building.

The sustainable systems in place to catch rainwater through the gutter system, or blackwater and greywater recycling, will have to be maintained. Water filters will have to be replaced as needed, and gutters and cisterns will need to be cleaned. If there is a septic tank system on site, the regular maintenance and cleaning of this system would be required. These integrated systems need careful maintenance.

Earthships will require a bit more of a green thumb than the average houseplant owner is familiar with. The greenhouse offers the possibility of producing your own fresh produce in-house, but you can not do so without any oversight. Depending on the size of the greenhouse and the types of plants grown in this space, the amount of time committed to maintenance will change.

The power cells used by solarpanels and wind turbines have a Power Organization Module that requires regular oversight. Performance checks and inspections of the type of battery conditions will be necessary to make sure the power systems are functioning at their optimal.

When it comes to long-term maintenance, expect long wait times in trying to procure specialized professionals who know how to inspect and repair an Earthship. It is for this reason that the Earthship Biotechure company strongly recommends owners to learn the necessary skills themselves through their academy.

All buildings, whether they are your standard construction home or the sustainably conscious Earthship, will require maintenance throughout their lifetime. The variety in design styles, construction techniques, and sustainable systems installed in Canada makes it harder to fix a price or a measure of complexity when compared to the average Canadian home. What can be established is that these Earthships will require the owner to be involved and conscious of the inner workings of their residence far more than many Canadian homeowners are familiar.



PORT ROWAN, ONTARIO - JUNE 5, 2023 PHOTO BY KATHERINE CHENG/THE WEATHER NETWORK





## PROS & CONS

### Pros:

- These structures are energy efficient. They rely on their thermal mass to heat and cool their internal space. Solar systems are used for electricity. These types of homes can also help harvest self-sufficient indoor gardens from greywater and rain.
- Sustainable: The indoor gardens use passive water recycling. The walls of earthship homes are made of reclaimed or natural materials which reduces its environmental impact.
- Easy to build: The construction requires a lot of manual labour but the process is not difficult.
- The use of reclaimed materials reduces the amount of waste that could have been found in landfills.
- The materials used for earthship housing can be easily shaped into different designs or unusual forms. It allows for personal artistic touches and unique homes to be built.
- Potters promoted Earthships as being nearly fireproof because the dirt-filled tires used in the internal walls contain little to no oxygen.



### Cons:

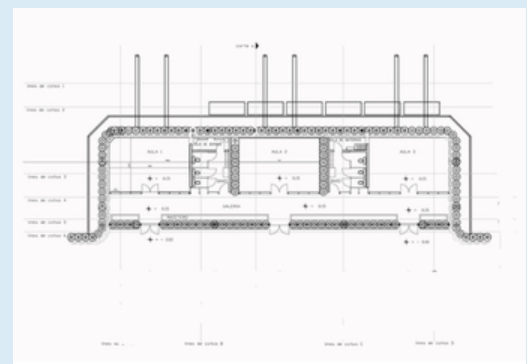
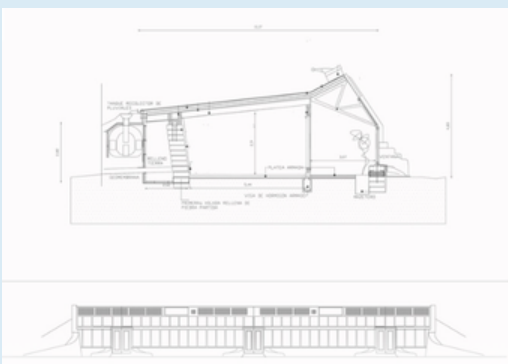
- Although the materials that are used for the construction of earthships are materials that would have been otherwise found within a landfill, concrete represents more than half of the volume of the materials used. Concrete is used for elements such as the foundation and ensures better structural integrity. Unfortunately, concrete has a high carbon footprint.
- In the case of a private project, there is a low cost efficiency for these homes unless the manual labour is executed by the owners themselves. The transportation of materials and the labour costs would be as costly as buying the standard homes today.
- The slanted windows at 60 degree angles can become problematic, sometimes causing water infiltration. Therefore, its installation is important to monitor. Waterproofing membranes are vital to seal the window frames.



# Conclusion and Takeaway

Earthships are a practical method of sustainable housing for low income families. These projects are mainly volunteer projects, reducing labour costs. Their use of reclaimed and natural materials such as tires and compacted earth, reduce their environmental impact. They allow for indoor harvesting and organic architectural designs. Although they are practical in arid climates, many adjustments must be made if their climate is modified. Their limitation to certain regions can be problematic but could encourage sustainable housing within these areas. Overall, their sustainable functionality and unique exteriors make earthships memorable to those who have the opportunity to live, visit or experience this new type of housing.

## Sustainable school built in Jaureguiberry, Uruguay



Section and Elevation

Plan

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