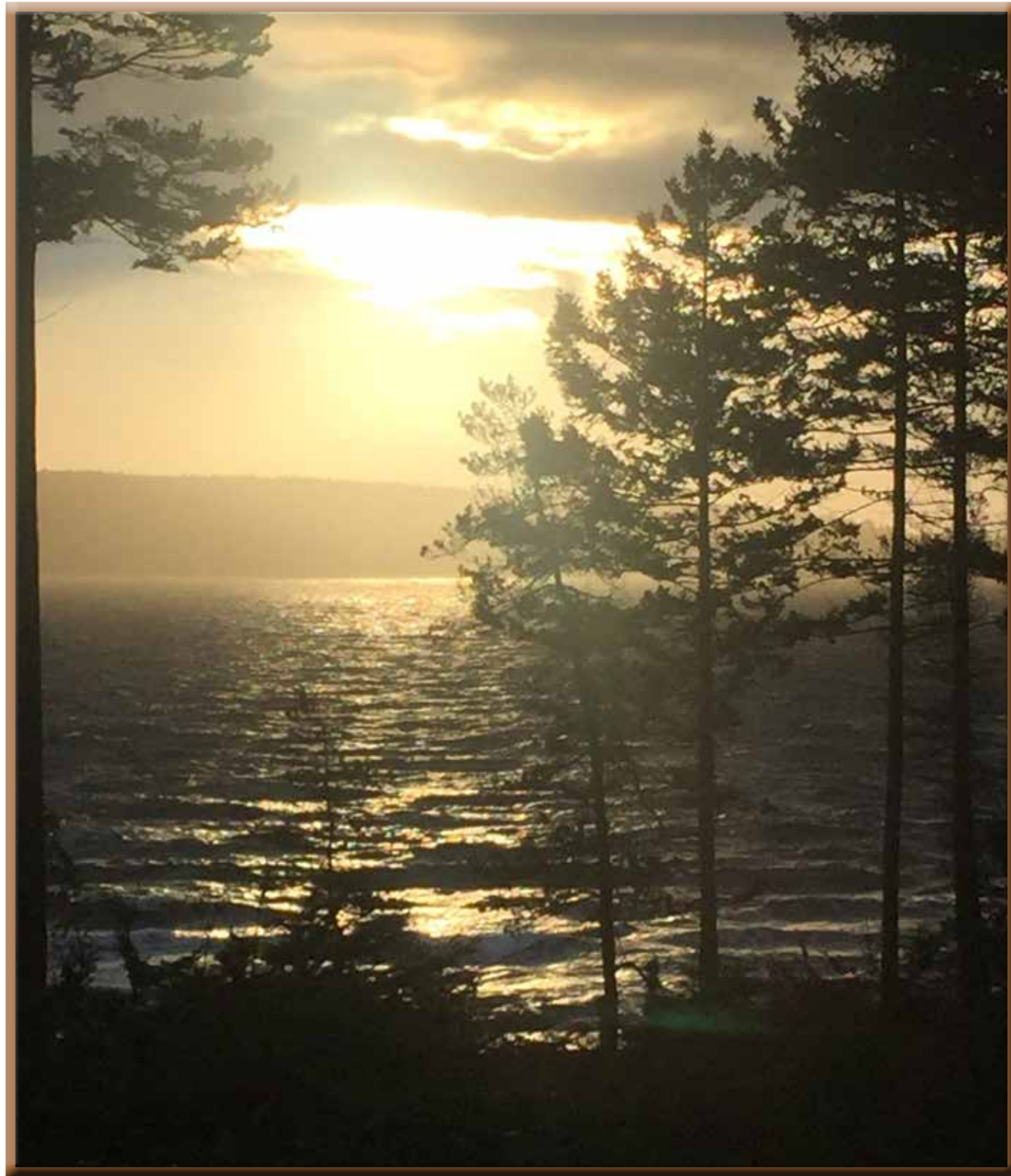




ALIGNMENT HOUSE

quest for an ideal design
text and photography by Mark Braaten

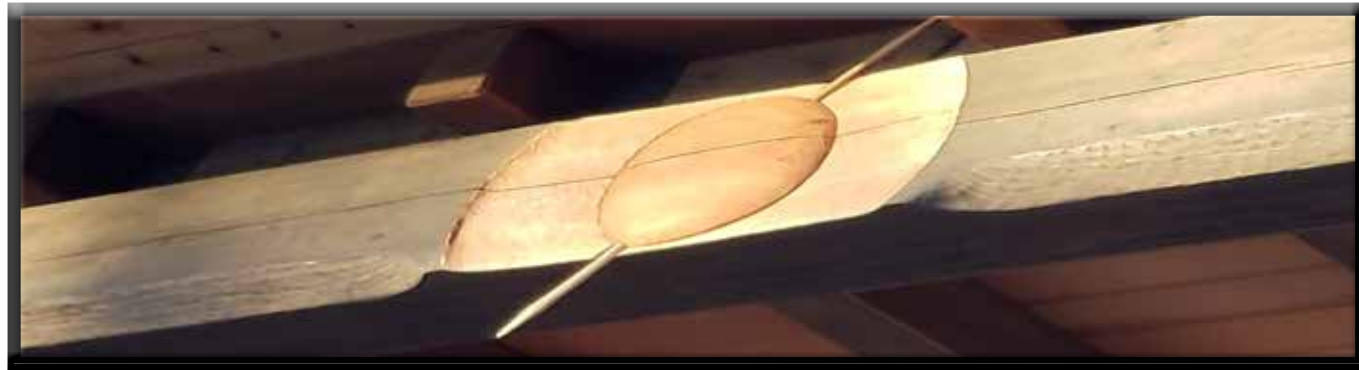


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contents

1. dedicated
2. visionary
3. aligned
4. geometric
5. organic
6. alchemical
7. grounded
8. bioregional
9. abundant
10. renewable
11. passive
12. enduring
13. healthy
14. harmonious
15. human
16. integral
17. endnotes
18. owner's manual
19. about the author



Dedicated

TO Steve Rooke - whose fearless optimism and broad vision empowered shooting for the stars. A self-proclaimed “early adopter”, he was on the first wave aiming for self-sufficiency when he built a “net zero”, “self-powered” home in Arizona. This gave me confidence that Steve already had a deep understanding of the challenges we would face. He inspired us to dream big. He supported me; to seek the best building science and materials known, integrating best practices and holistic values.

TO all those who contributed to this creation with such passion, skill and artistry. It truly is the work of a community, reflected in every grain and fiber. This must be the way that all such works are achieved. Conceptions of beauty and style arise through experimentation within local means, materials, and skills. This house encodes ancient arts rediscovered. We brought our best selves forward and grew in the process. It will always be among our fondest memories and proudest accomplishments.

TO all who would follow our path. Our aims are directed towards evolving “the house”, not only for the benefit of its occupants but as an educational model that will inspire deeper understanding and striving for excellence. How we choose to live our lives affects the whole, and a house is central in our relationship to the environment of which we are a part.

We offer the results of this effort: the work of our hands, the prayers of our hearts and dedication of our minds, to the benefit of Mother Gaia, all her peoples and life forms.





Visionary

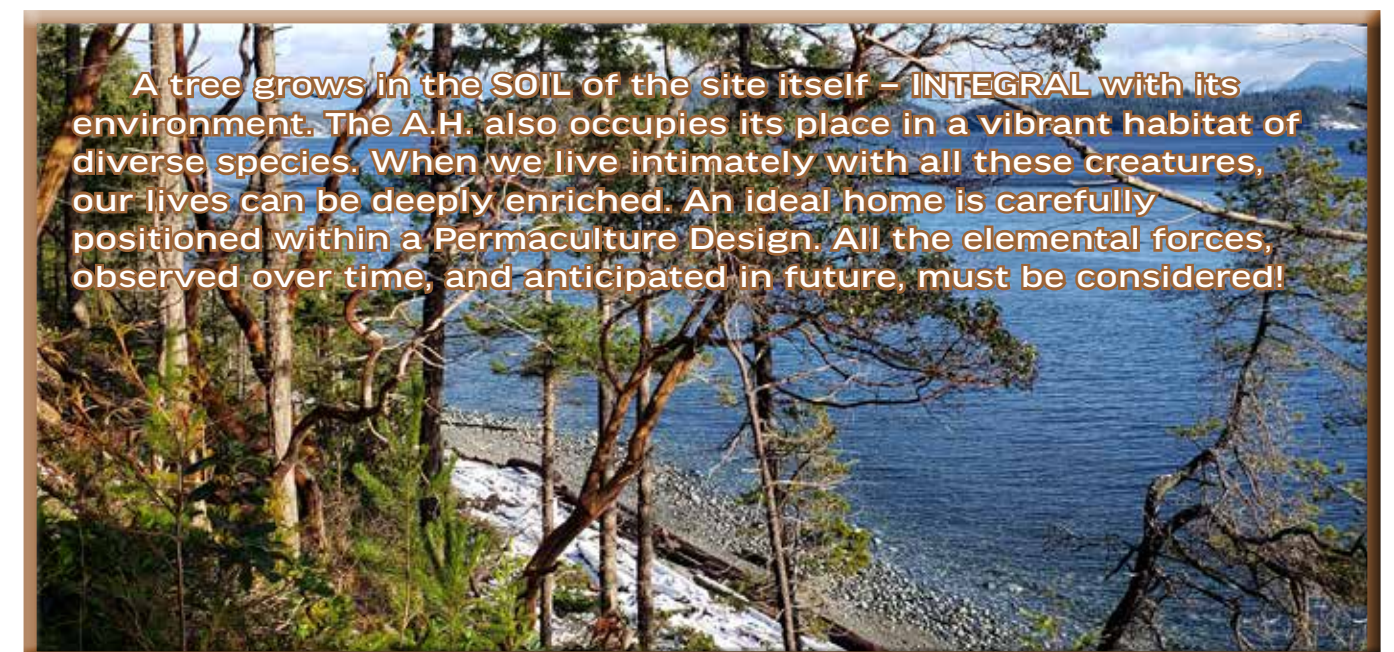
The Alignment House (affectionately known as The A.H.) grew from a singular devotion: to design an optimal home that would surpass all the shortcomings of conventional methodologies.

In fun, Steve called me T.O.T.B. (thinks outside the box). I naturally felt honored and challenged to live up to that name. Inside “the box” are all the well-established standards, practices and habitual assumptions that can quell innovation.

My prior years of experience as a self-taught designer/builder; working in remote rural communities, with limited resources and found materials; has given me a unique perspective. Although these conditions have been challenging to work in, they have supported me to come up with original ideas.

My knowledge comes from observation. I draw inspiration from an intense love of nature, and the beauty of life itself.

It is impossible to describe these qualities without an appropriate metaphor. A tree offers a perfect example of elegant complexity and symbiosis. Trees demonstrate how organisms can adapt and establish a balance with all the forces that surround them.



A tree grows in the SOIL of the site itself – INTEGRAL with its environment. The A.H. also occupies its place in a vibrant habitat of diverse species. When we live intimately with all these creatures, our lives can be deeply enriched. An ideal home is carefully positioned within a Permaculture Design. All the elemental forces, observed over time, and anticipated in future, must be considered!

fruit
leaves
branches
trunk
roots
soil



healthy
clean
economical
efficient
local
integral

The **ROOTS** of a tree always draw from **LOCAL** resources; meeting its needs from as nearby as possible, and with the least ecological impact. Using local materials and expertise (crafts people, manufacturing, trades etc.), always yields many simple advantages. Our remote location necessitated this Cooperating within these restraints amplified the benefits for both the project and the community.

The **A.H.** is built on an island within a **Community Forest**, where wood is sustainably harvested using **Ecosystem Based Management** practices. The **Community Forest** supplied almost all of the wood used. The milling and processing happened on island or nearby, reducing short term energy inputs and ecological impacts. Mixing hemp fiber with lime is an ancient formula that we used to build the exterior walls and insulating slab subfloor. The hemp was sourced from **Alberta** to reduce transport costs. Lime based mortar has a carbon footprint of 64% less than cement-based mortar. When mixed with large volumes of hemp hurd and some sand as an aggregate, it makes “hemp-lime” which can be called carbon neutral.

A tree **TRUNK** is **EFFICIENT** in transferring energy inputs and waste products. A tree maximizes energy absorbed and converted from the sun, air and soil; while conserving energy by recycling and providing nutrients to a symbiotic family of lifeforms who co-inhabit its own ecosystem. The **A.H.** mimics these same natural relationships in all of its processes.

A tree’s many **BRANCHES** are **ECONOMICAL**; working together for the whole, occupying their own space without conflict, and supporting the leaves to perform their function. Houses; when viewed as commodities to be bought and sold, emphasize lowest cost materials and fastest construction methods in order to reduce sale price. This is a false economy which ignores long term costs and remote consequences.



Progressive “performance based” building systems emphasize energy efficiency in order to reduce operating costs, but they most often have shockingly low expectations of longevity; typically 30 years; the average duration of a mortgage.

To accurately understand costs, a full Life Cycle Cost Analysis must be considered. The National Institute of Standards and Technology defines **LCCA** as follows:



LIFE CYCLE ICEBERG 4

“...all costs of acquiring, owning, and disposing of a building or building system.”²

“In The Federal Energy Management Programs analyses, the service period is limited to 40 years”³

The longest time frame criteria in **LCCA**; called “Lifetime” was our criteria for as many of The **A.H.** components as possible, motivated by an sober awareness of the existential challenges we face as a species “on the planet”.

A **Douglas Fir Tree** invests its first 80 years to reach the point of maximum growth, and sustains that until the age of 250 years, after which time it can continue to live another 600 years up to the age of 1000 in the right conditions.

I think a lifespan in this magnitude is a more responsible objective. Wooden churches built in 11th century Norway still stand. Should we not strive to do as well today?

DURABILITY dramatically reduces maintenance costs. It is far too easy to ignore future disadvantages when pushing to meet tight budgets and deadlines. We thought about repair and replacement in the light of; potential cost increases, materials shortages, Time Value of money, and inflation.⁵





Good TEAM-WORK with camaraderie, communication, and balance, improves everything including; safety, endurance, reliability, resilience, and enjoyment of the process. A flexible SCHEDULE allowing for a longer overall timeframe and working with the SEASONS, flows easily compared to tight market driven schedules.

Without compromising any of these guiding principles, we

conserved money by all other means possible. In this case the savings were reinvested back into quality.

The LEAVES of a tree are CLEAN and cleansing; to the organism itself, and to the environment in which it lives. Carbon neutrality and reduction of all other forms of pollutants associated with manufacturing, makes The A.H. among the greenest homes ever built.

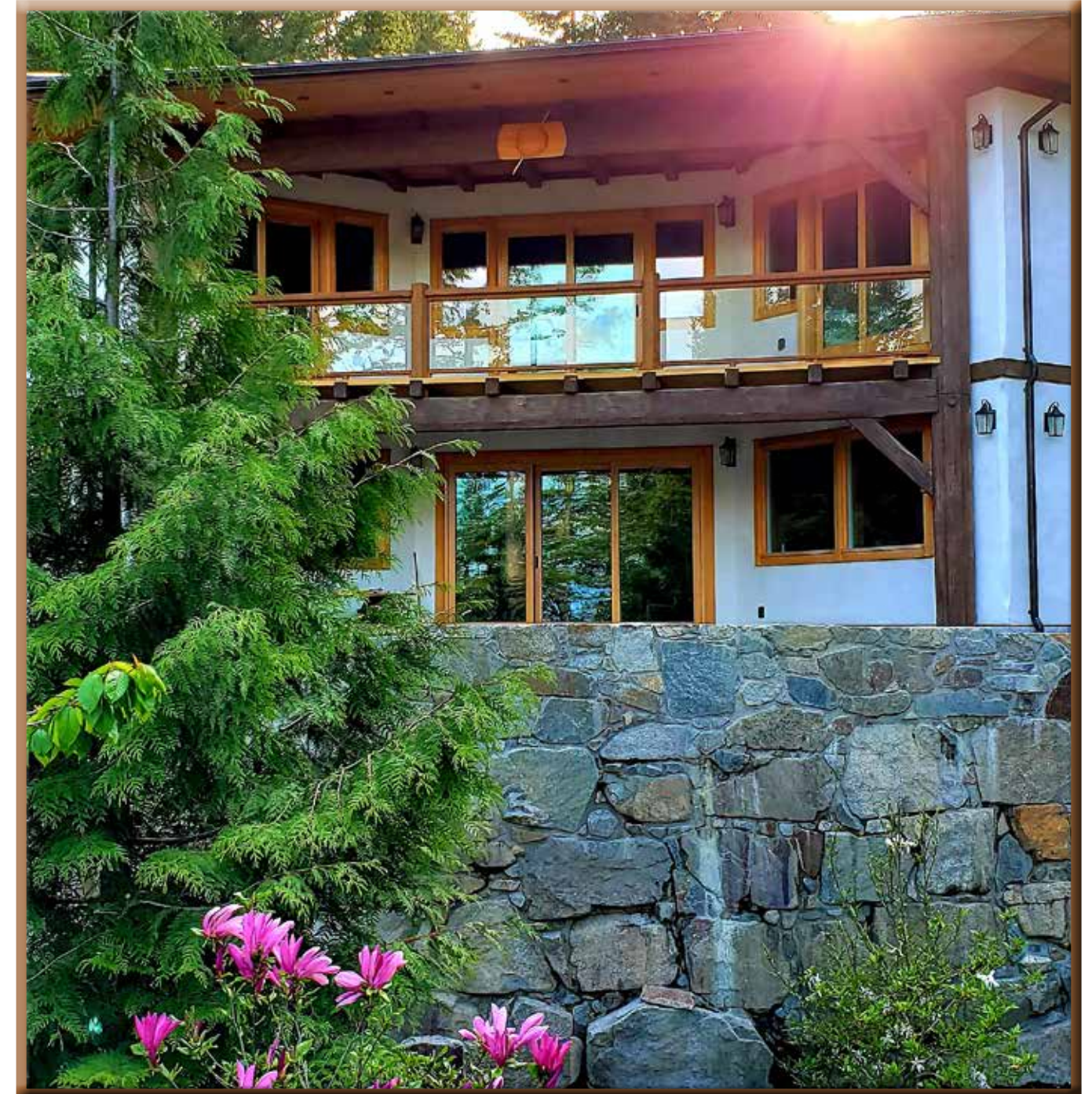


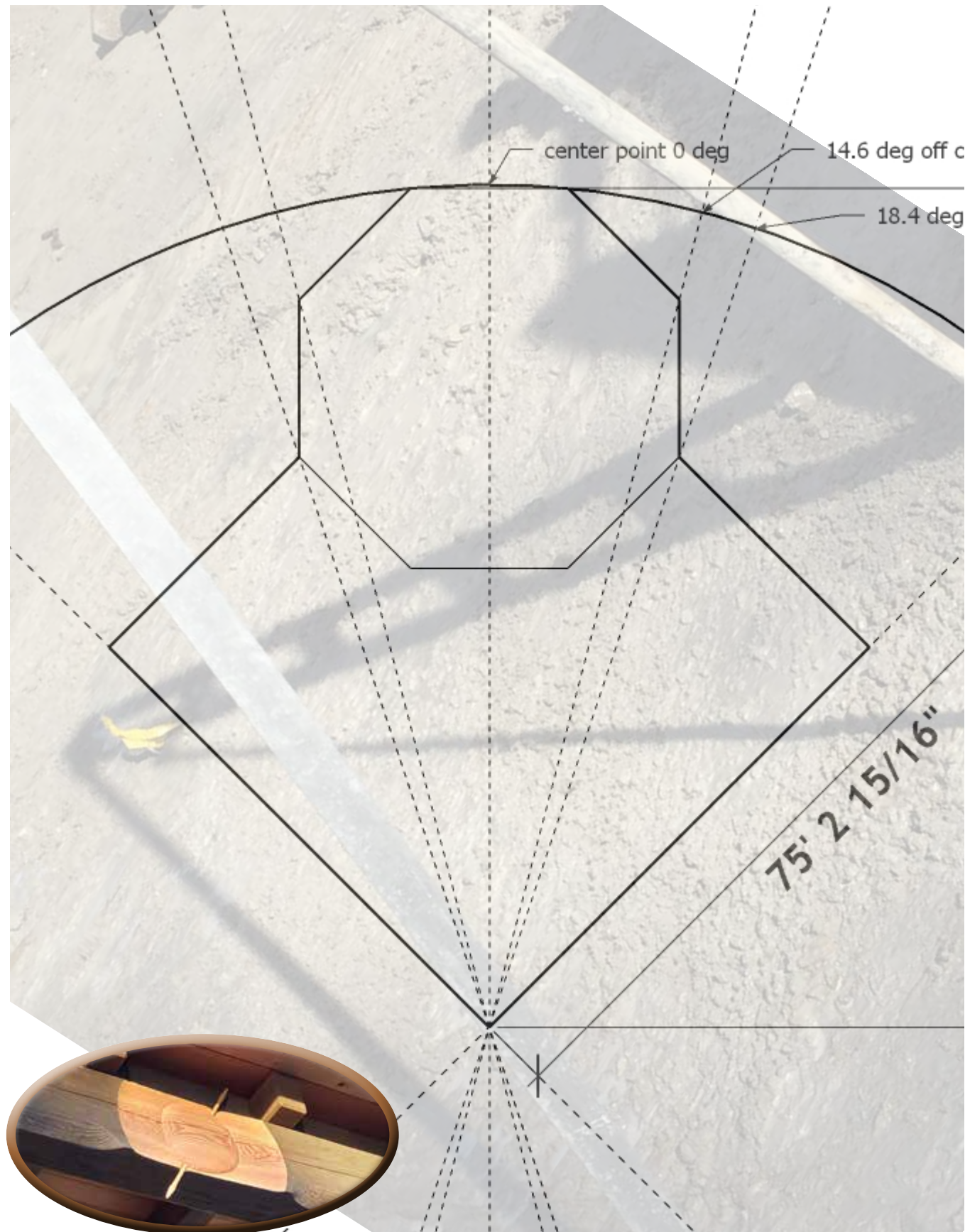
RENEWABILITY of the organic raw materials, RECYCLABILITY of the inorganic materials, REUSABILITY of the end products; all these together support REPLACEABILITY. These qualities are not as yet factored into the assessed value of a home. This design is progressive and AHEAD OF ITS TIME!

The FRUIT of a tree is HEALTHY.

All the primary concerns of building science are elegantly met in The A.H.; grounded in the Earth's electromagnetic field, shielded from harmful radiation, surrounded by an organic hygrothermal envelope, vapor open, temperature consistent, and humidity buffered. This is an ideal human habitat! This set of conditions is most easily met through the use of natural materials which are inherently nontoxic.

In the chapters that follow, I will offer more insights into the many ways that we achieved this vision.



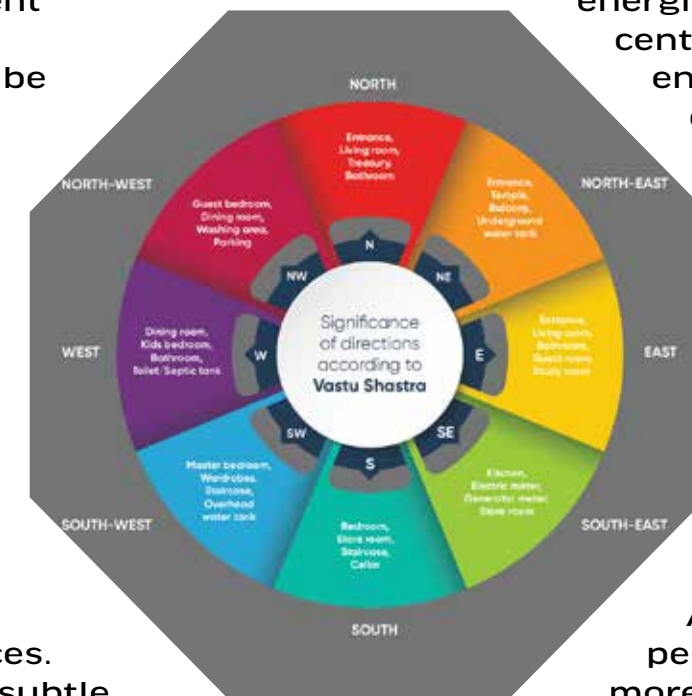


aligned

The priority of alignment is affirmed in the name! Why is alignment so important? Steve is an amateur astronomer, his point of reference is from earth towards the cosmos. For example, he even considered which constellations he would see, out of which windows, at different times of the year. In this house, awareness is brought into alignment with a cosmic connection.

The forces beyond earth do affect life here in strong and subtle ways; from gravity, magnetics and light to subtle archetypal energies that act on consciousness.

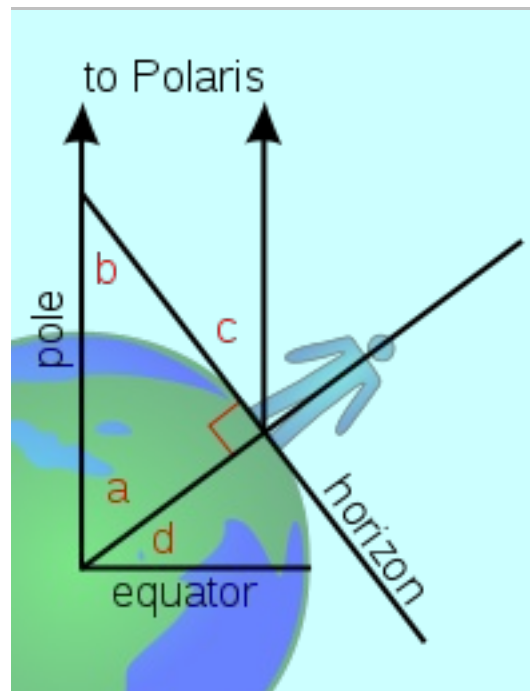
The ancient arts of Vastu Shastra “describe functional relations and adaptable alternate layouts for various rooms or buildings and utilities”⁶ Fung Shui is a similar approach to working with energetic correspondences. Both consider subtle aesthetics, directional



VASTU WHEEL 7

energies and honor the center. Vastu Shatra encodes the power of the Mandala in square directional geometry. I have been working with some awareness of these symbolic languages, and have been observing the results of my own experiments over time. The A.H. presented the perfect opportunity for more practice!

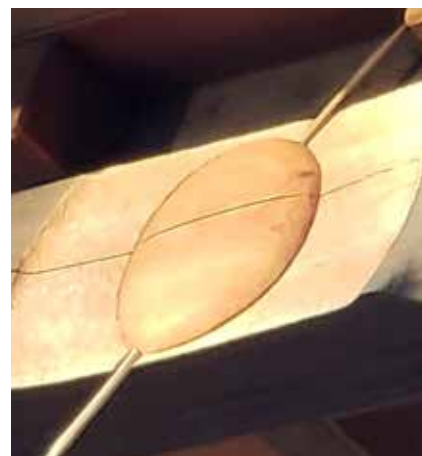
The entire geometry of The A.H. floor plans and surrounding features is directionally aligned and balanced in the light of these principles. The Sky Vault, a 21” Solatube Skylight, is positioned at geometric center of the building and is open from sky to ground. This holds space for Spirit and invokes illumination within. The fireplace Hearth is directly West of center, the terrace entry faces directly East towards the source of life and the rising sun.



ANGLE OF POLARIS SCHEMATIC 8

Steve, and I ceremonially established layout lines from sightings to the celestial bodies. North was established with a nocturnal sighting of Polaris and confirmed by observation of the shadow cast at Solar noon. They corresponded!

Polaris lies at a declination angle of 50deg in this location. Equal to our degree of latitude. We engraved this angle into a central carving of the uppermost exterior beam.



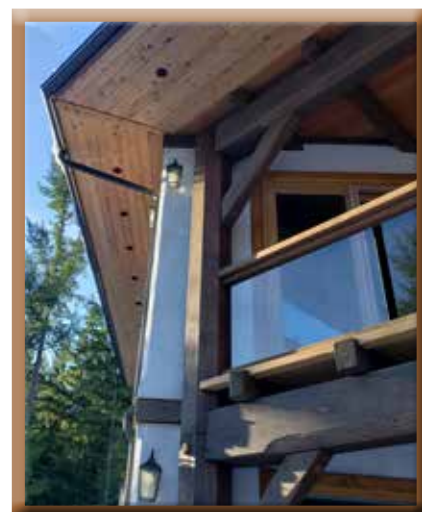
Steve wanted the entire house to act as a sundial, with light parallel to the east wall at solar noon each day, the exact time of which corresponds to the season. The east wall also acts as a reference to the seasonal position of the rising sun.

We have been experiencing the power of this building during the entire construction process which particularly "came alive" at completion. I believe it will take years to experience the full benefits celestial alignment will impart.

As we worked on the design together Steve and I corresponded daily. Here's what I said in one such conversation dated March 16, 2018.

"I arrive at a kind of Gestalt after opening up to consider changes in our design. I think we were right to reconsider... There will be a cascade of advantages that will follow throughout the project."

Our perception of beauty comes from the meeting of many dimensions. Your art speaks of that relationship. Form interacts with function, and other subtle layers. That is the meeting point between aesthetics and practicalities.



We started at the point of origin and worked outward. I can see now how it grew from awareness of the interaction of all these forces. It has an extraordinary balance.

Right now, I will highlight a few of my main perceptions:

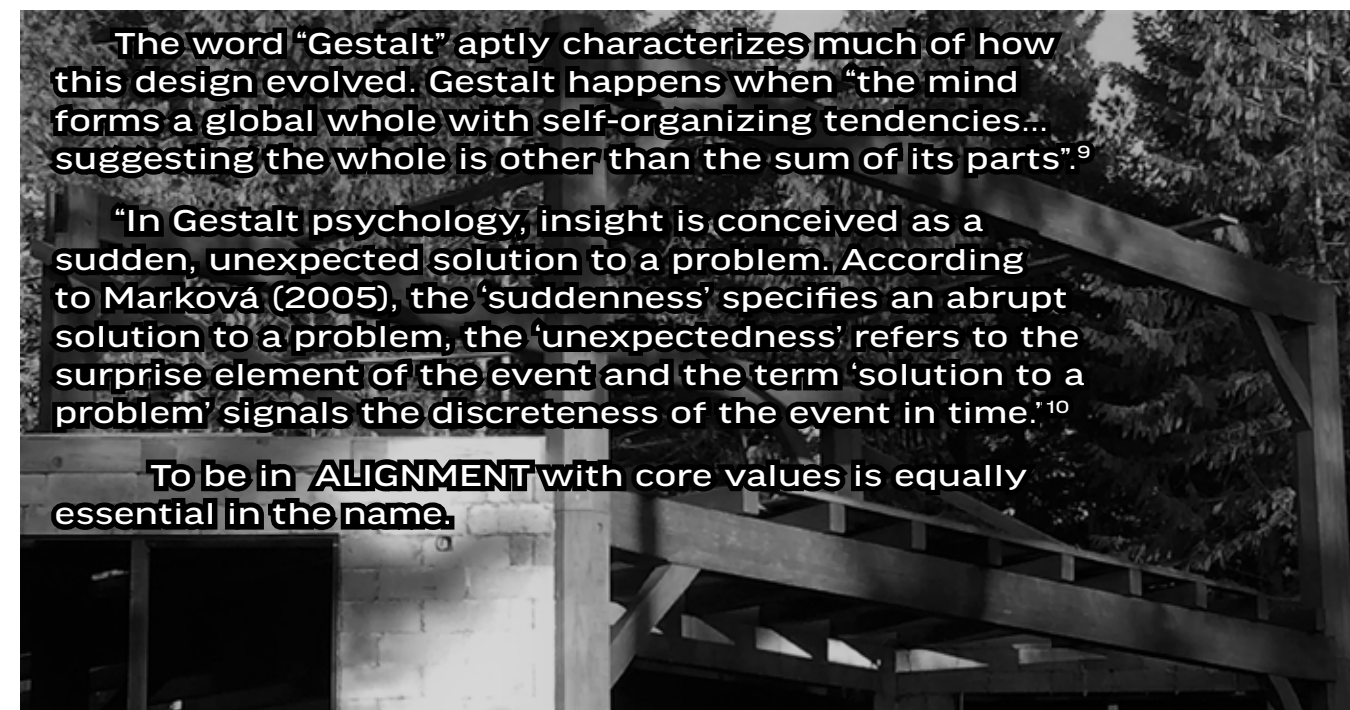
- *The alignment and aspect grew into a geometric pattern*
- *The structure grew out of the geometry.*
- *The geometry has given rise to an over-engineered condition. One thing is clear, there could not be a stronger way to build a structure using the same basic materials. We have put a high priority on strength and longevity since the start*
- *This in turn established the 4 directions and the room locations evolved from that. The orientations are very functional and have good correspondences.*

Your artistic vision and practical suggestions have contributed immensely. It can't be very beautiful if it doesn't work well. I don't think there is anything impractical about our design, and it is getting more practical all the time. It will be extraordinarily beautiful and well worth it."

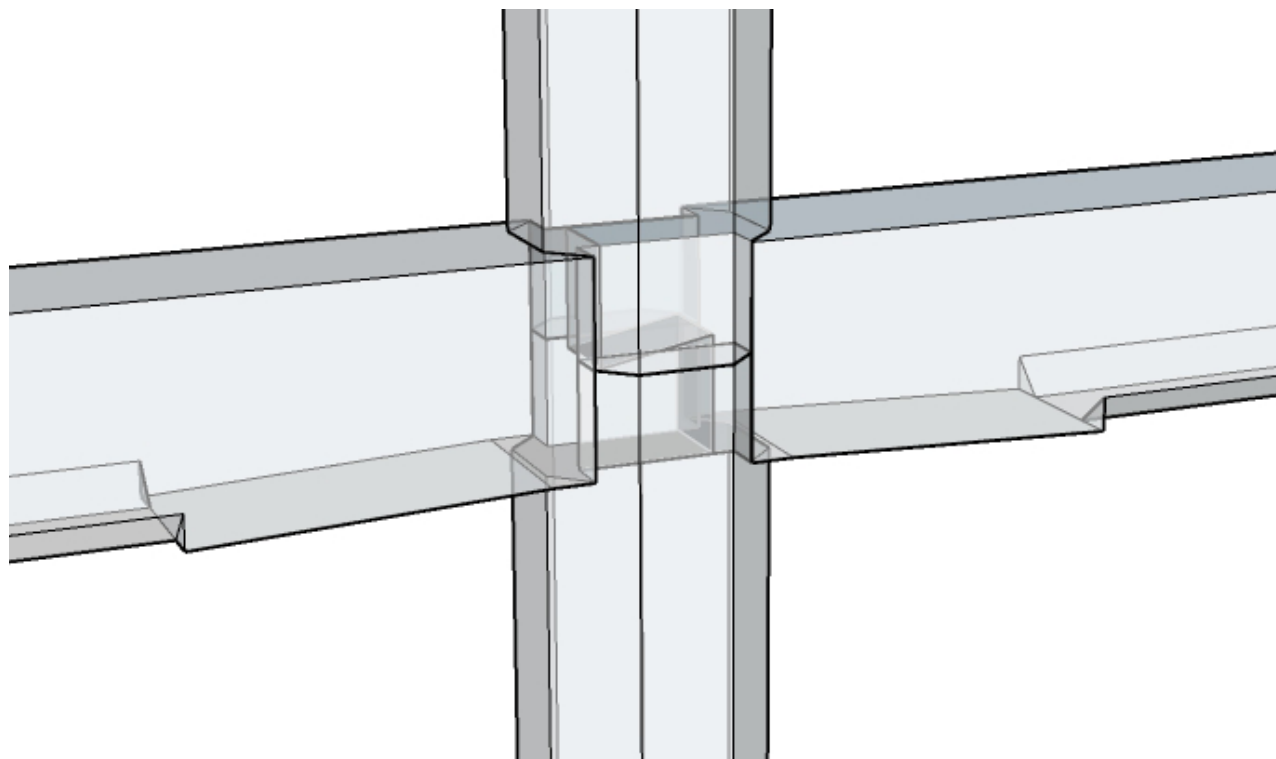
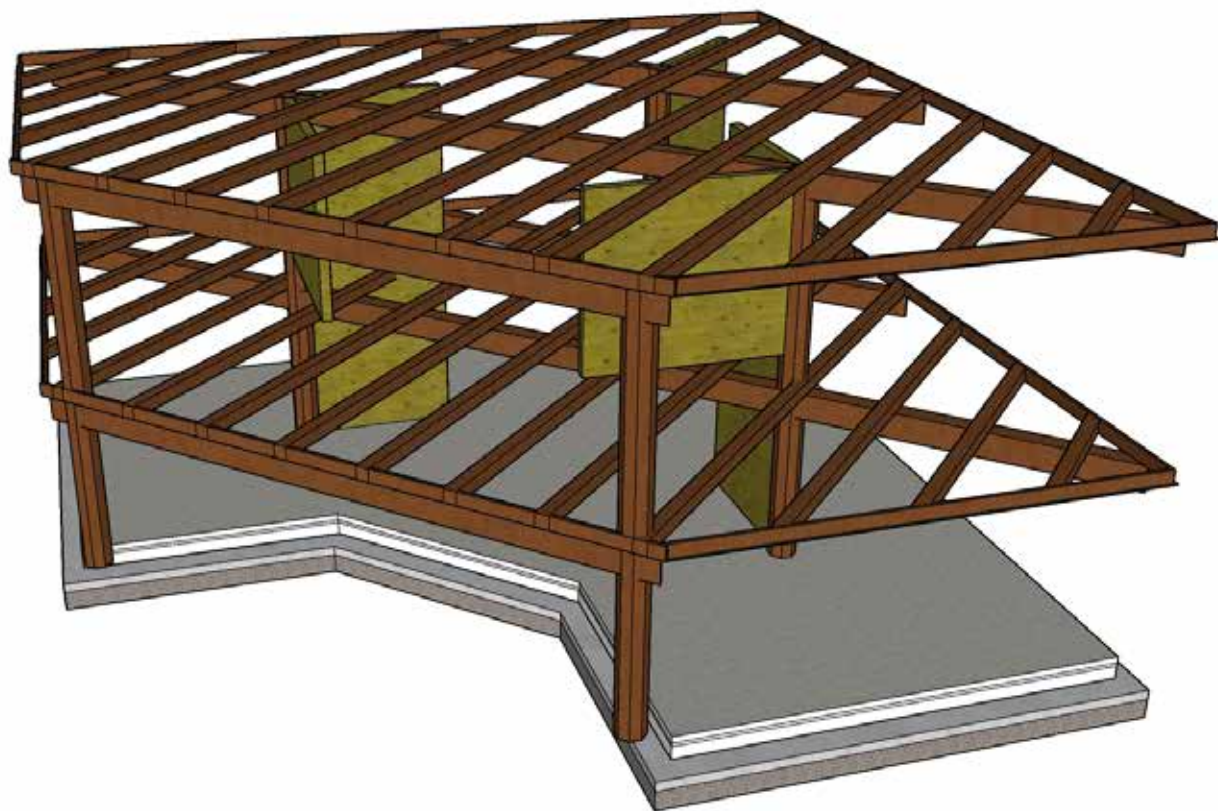
The word "Gestalt" aptly characterizes much of how this design evolved. Gestalt happens when "the mind forms a global whole with self-organizing tendencies... suggesting the whole is other than the sum of its parts".⁹

"In Gestalt psychology, insight is conceived as a sudden, unexpected solution to a problem. According to Marková (2005), the 'suddenness' specifies an abrupt solution to a problem, the 'unexpectedness' refers to the surprise element of the event and the term 'solution to a problem' signals the discreteness of the event in time."¹⁰

To be in ALIGNMENT with core values is equally essential in the name.



geometric



Sacred Geometry encompasses patterns observed in the natural world. The energetic stuff of matter crystallizes into stable shapes of dynamic balance. “As above so below”, exclaims the Emerald Tablet

Our cultures have evolved expressing these patterns and laws of architecture. Perception of beauty have evolved from them.

Nikos A. Salingaros proposes in his “Laws of Architecture from a Physicists Perspective:

Three laws of architectural order are obtained by analogy from basic physical principles. They apply to both natural and man-made structures. These laws may be used to create buildings that match the emotional comfort and beauty of the world's great historical buildings. The laws are consistent with Classical, Byzantine, Gothic, Islamic, Eastern, and Art Nouveau architectures.

1. Order on the smallest scale is established by paired contrasting elements, existing in a balanced visual tension”
2. Large-scale order occurs when every element relates to every other element at a distance in a way that reduces the entropy”.
3. The small scale is connected to the large scale through a linked hierarchy of intermediate scales with scaling factor (fractal)¹¹

Steve is a graphic artist striving to perfect fractal geometric animations with single-minded focus. This passion is encoded into every element of The A.H. In so doing, we glimpsed the essence of these ancient arts.

The circle embodies unifying forces while the square manifests stable opposing forces. Their dynamic interaction creates the octagon where heaven and earth / unity and duality, both meet.

In structural engineering, an octagon triangulates the right angles of the square into a rigid form with superior core strength. Using this shape in building is a tremendous advantage that contributes enormously toward an “all hazards approach” The cube is also the shape with the lowest surface area / volume ratio. The A.H. approaches the optimal form to reduce surface area where thermal transfer occurs.

The integration of alignment and geometry as foundational in The A.H. design, has led to most extraordinary results. When views through windows are geometrically positioned, they awaken our perceptions of what lies beyond. The effect is enhanced as daylight shifts and reflects with varying color and intensity on geometric surfaces.



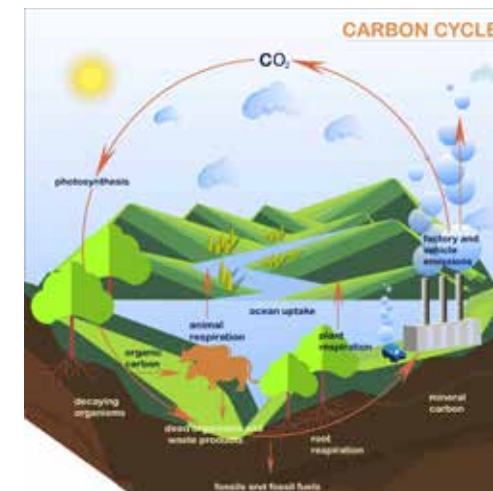
organic

“Organically grown” has come to mean; a natural process of development using local materials and following the path of least resistance. It also means standards of purity that ensure low toxicity and efficient renewable resource use.



Organic compounds are life derived and contain the element carbon. The A.H. is organically grown in all these ways. Most of the total mass and volume of the building materials is composed of wood and hemp.

12



There is increasing understanding of the carbon cycle role in our planetary atmosphere and the contribution of plants to that cycle. As we look for solutions to the climate crisis it becomes clear that reducing emissions alone will not solve the problem. Preservation of the biosphere - the thin layer of life and organic compounds on the surface of the earth - is our only hope to restore balance. Our vast forests in British Columbia have become net carbon emitters.¹³

CARBON CYCLE 14

Logging practices cause loss of biomass in the soil, reduction of biomass in standing timber, huge volumes of waste and increasing emissions due to fires. Here on this island, we are discovering that forest health can be preserved, while increasing biomass, reducing fire risk and still yielding excellent timbers for building.

The timbers used to build The A.H. were milled from logs harvested from our local community forest. I selected the logs from a small volume harvest of 1750m³. The age range of these logs was 80- to 120-year-old Douglas Fir. The trees in our community forest from this age range are just entering their peak stage of growth (80-250 years old). Our aim is to harvest at a rate that will age the forest and yield a sustainable annual harvest of large trees for timbers



in perpetuity. Bioregionally appropriate materials must be used to build houses in other regions, as there are not enough timbers to use these same methods worldwide.

Log quality is central to success in timber framing. Older logs contain a smaller percentage of sap wood (xylem or alburnum), which is the living part of the tree trunk containing more water and sugars. Sap wood is not as strong as heart wood (duramen), which is the dead central core of the tree trunk that provides structure to the tree and is resistant to rot. We needed large enough logs to mill timbers that are free of sap wood.



Modern timber frame builders often specify kiln dried old growth timbers, to be milled “free of heart center” which is most suitable for Computer Numerical Control (CNC) machining and not prone to twisting, checking, or warping. The industry is now turning toward engineered wood products as old growth forests disappear.

There is only 2% of the original coastal low elevation old growth forests remaining in B.C.

We chose to accept the challenges involved with using second growth trees for our timbers and adapted our methods to suit. Milling with a “boxed heart” means the core of the tree runs up the center of the timber. Logs must be selected to avoid twist, ideally aged, (although we did not have that luxury), and then carefully milled and re-sawn where required. We used Broda Pro Tek Tor (water borne natural oil stain) to coat the timbers immediately after milling, sealing in moisture, slowing the drying process, thus reducing; checking, twisting, and warping. Stain also prevented discoloration and mildew on the surface of the wood during the construction process, and blended the appearance of any remaining sapwood with the heartwood. Our timbers were locked together in place before they were completely dried, which further reduced deformations. Some shrinkage was observed but almost no movement. The A.H. demonstrates that traditional timber frame methods do work with second growth Douglas Fir. A revolutionary accomplishment!

The benefits of Hemp are manifold! As the A.H. is made largely out of Hemp, I feel compelled to list some of these benefits:

ENVIRONMENTAL BENEFITS OF HEMP

- Hemp grown for the production of biomass fuels can provide all of our gas, oil and coal energy needs and end dependency on fossil fuels.
- Hemp is the #1 producer of biomass per acre in the world. Biomass energy expert Lynn Osburn estimates that 1 1/2 to 3 1/2 million acres of hemp would replace all of Canada's fossil fuel demands.
- From 75 to 90% of all paper was made with hemp fiber until the late 1800's.
- An acre of hemp will produce as much pulp for paper as 4.1 acres of trees over a 20 year period.
- Hemp paper is suitable for recycling 7 to 8 times, compared with 3 times for wood pulp paper.
- By utilizing hemp pulp for paper, we could stop the deforestation of our country and produce stronger, more environmentally sound paper
- Hemp produces the strongest, most durable natural soft-fiber on earth.
- Hemp cloth is stronger, more durable, warmer, and more absorbent than cotton. Best of all, hemp can be Grown in Canada, while cotton cannot.
- An acre of land will produce 2 to 3 times as much fiber as cotton, about 1,000 lbs. of fiber per acre.
- Hemp grown in most parts of Canada will require no herbicide, fungicide or insecticide applications.
- A fully mature hemp plant may contain 1/2 of its dry-weight in seed.
- Hemp seed has an oil content of 34 % more than any other seed. Hemp seed oil is second only to whale oils in its quality and has the same burning qualities and viscosity as #2 grade heating oil without any of the sulphur-based pollutants.
- Once hemp seed oil has been extracted, the remaining seed cake is second only to soya bean for protein content and is an excellent source of nutrition for either farm animals or humans.



AGRICULTURAL BENEFITS OF HEMP

- farmers are receiving in excess of \$3000 per acre for their hemp crop.
- hemp works very well in rotation with bean and corn crops.
- In the 1930's, a South Western Ontario newspaper reported that Canadian grown hemp was among the best in the world
- In Canada hemp can be grown successfully from our southern borders to approximately 60deg North Latitude. This remarkable range is possible due to hemp's short growing season, usually 90 to 110 days.
- The hemp plant will reach a height of up to 5m and sink a main tap root down 30cm. This tap root will draw nutrients from deep in the soil and make them available to subsequent crops when the hemp leaves are shed on the soil.
- Hemp is very easy on the soil and returns up to 60% of the nutrients it takes from the soil, when dried in the field.
- hemp has been observed to grow on the same land for 14 consecutive years without resulting in soil depletion or reduction in yield.
- Hemp is a very economical crop to grow since it requires virtually no pesticide applications.
- Hemp is also relatively drought-resistant and has been historically relied upon during drought-induced famine for its high protein seed.
- Hemp is very resistant to increased UV radiation and should not suffer decreased yields, unlike soya bean and corn.¹⁶

Not listed above is that hemp hurd is a by-product of; fiber, seed, and oil production; and is not used for much else. However, the hurd excels as the insulating aggregate in Hemp-Lime formulas. Development of agricultural hemp will yield immense volumes of hurd for use in



building. Reduction of the use of wood in buildings in combination with an increase in use of hemp is an ideal environmental combination.

“The buildings and construction sector accounted for 39% of energy and process-related carbon dioxide emissions in 2018”¹⁷ while “residential energy use accounts for roughly 20% of green house gas (GHG) emissions in the United States.”¹⁸

Just Bio Fiber (JBF) is the Alberta company that manufactures the

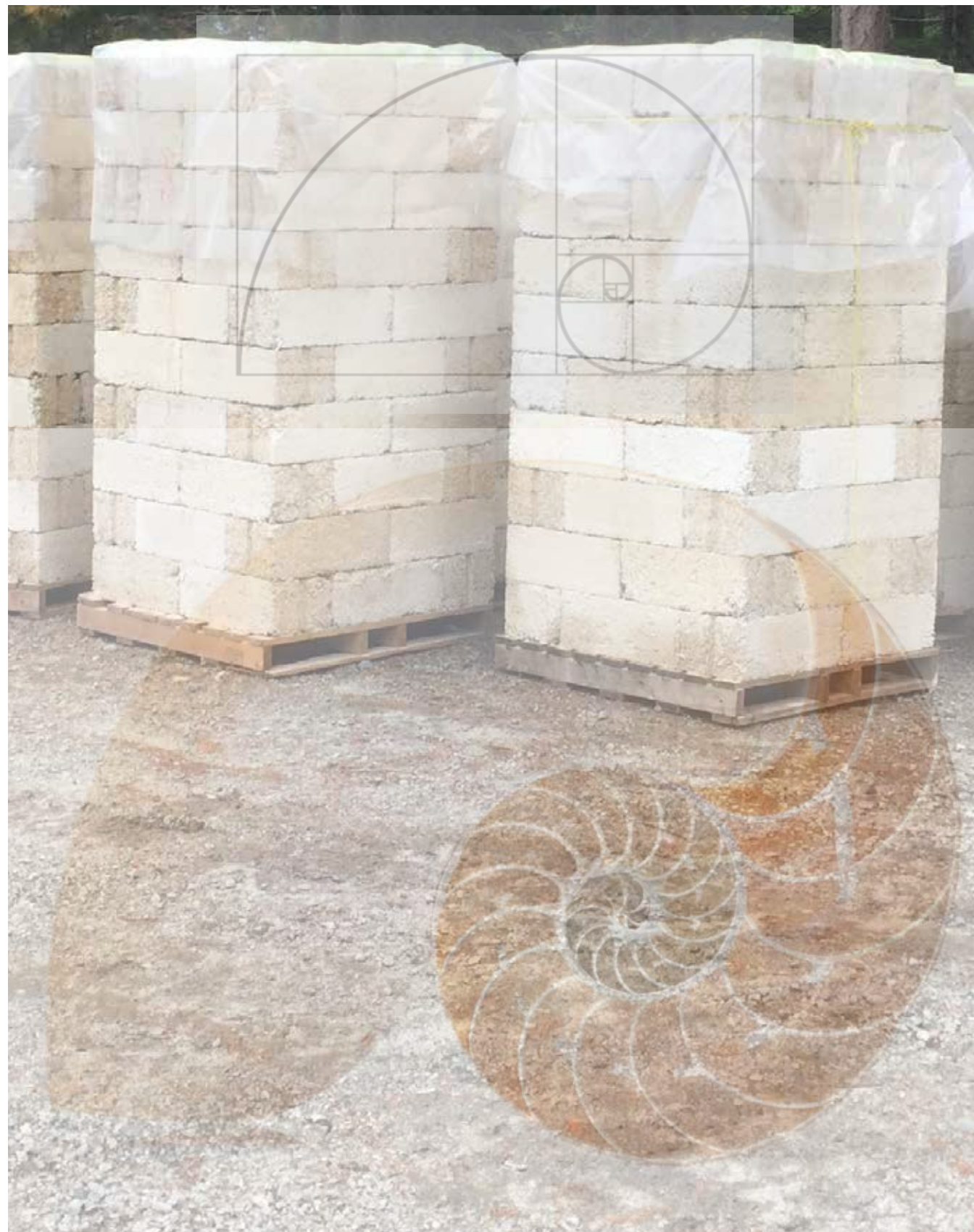


CEMENT FACTORY¹⁹

Hemp-Lime blocks we used to build the exterior walls of the A.H. JBF commissioned a life cycle carbon analysis of their Hemp-Lime blocks that proves carbon negative results.

The net embodied carbon of The A.H. wall system is minus 17.6 kg CO₂/m² due to carbon sequestration in the hemp hurd, carbon adsorption from the curing lime and energy efficient manufacturing processes. The exceptionally high effective R Value of R33-35 results in a 64% reduction in GHG emissions due to heating and cooling a home when compared to current building codes.²⁰





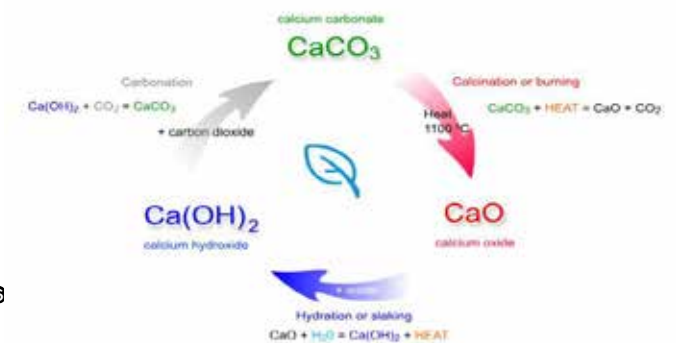
alchemical

Life achieves an accumulation of energy as it expands towards complexity; breaking net zero. An alchemical transmutation into gold! Transforming and combining substances in ways that resists entropy is called "Syntropy". Syntropic systems yield energy instead of dissipating it. Syntropy develops through a succession of strata in an ecosystem - increasing in differentiation and complexity.²³

A house sits at the foundation of a complex relationship to the ecosystem that surrounds it. The house is classified as "Zone Zero" in Permaculture Design²⁴

By mimicking the adaptations of other life forms, humans first discovered the joy of life in a shell. Lime, which has been used in construction for millennia, originates most commonly from the shells and exoskeletons of living organisms. Calcium Carbonate, CaCO_3 , when accumulated over hundreds of millions of years in just the right conditions, can solidify into biological sedimentary limestone.²⁵ The amazing properties of this substance demonstrate perfect adaptation to the conditions of life on this planet.

LIME CYCLE 26



Here on our island we can find piles of clam shells called middens which accumulated over thousands of years surrounding first nations clam harvesting grounds. These clam shells show very little deterioration to the structure and color of the shell material to this day.

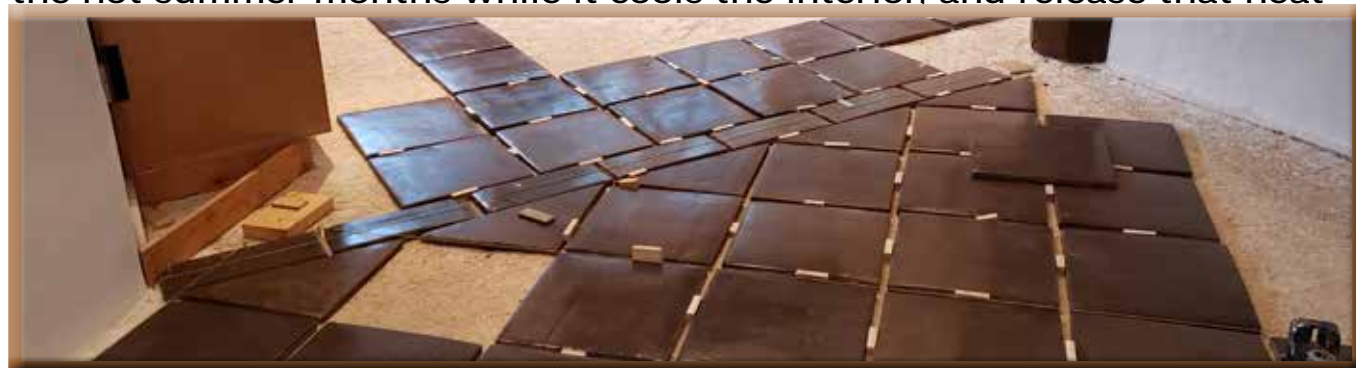
Hydrated Lime, Calcium Hydroxide Ca(OH)_2 , is the form of lime used in Hemp-Lime and lime plaster formulas. It has a high Solar Reflectance and a low Infrared Emittance which earns it the title "cool coating"²⁷ Lime plaster blocks radiant heat from entering the building. These properties act independently of resistance to "thermal conductivity", the property quantified with R Values. Cool coating with lime imparts a passive cooling effect with this inert substance. The A.H.'s interior coating of lime also reflects radiant heat back into the space contributing to passive heating in the winter. Therefore, Hemp-Lime walls exceed performance values attributed to R Value alone.

The same substance is also alkaline, a property that discourages the growth of all kinds of microorganisms that contribute to poor indoor air quality, including the fungi that feed on wood and hemp fiber. The lime solution effectively impregnates, “pickles” and reinforces cellulose fibers preserving them indefinitely. When humidity is encountered, it only serves to strengthen the matrix and refresh the protection by redistributing alkalis.

Hemp-Lime is hygroscopic and has high vapor permeability.²⁸ When coated with hydraulic lime plaster and lime wash; the walls shed water, resists liquid water penetration and diffuse water vapor. This regulates The A.H. interior humidity within a healthy and comfortable range throughout the year.

Interior and exterior walls have a high volumetric heat capacity, also known as “thermal mass”. This modulates temperature swings throughout the day, and even seasonally.

A simple system of Passive Annual Heat Storage²⁹ uses the insulated Earth below The A.H. to store heat in the summer and release it in the winter. The JBF foam block perimeter achieves R40 insulation to a depth of 50cm below grade. This super insulated perimeter contributes to a steady earth temperature underneath the house all year long. A 15cm thick structural insulating slab of Hemp-Lime under the floor provides R10 insulation but still allows some thermal transfer with the earth below. Thus, the interior is never too hot or too cold. Comfort is achieved with reduced energy requirements. The thermal mass under the house stores heat slowly over the hot summer months while it cools the interior, and release that heat



over the winter months warming the interior. The interior temperature is maintained at an average of 20deg C year-round with very little energy inputs. Our West Coast Marine Climate with mild winters and moderate summers is particularly suited to this system..

The Hemp-Lime slab was laid directly over a drained gravel substrate with no additional insulation boards or vapor barrier. Hemp-Lime is a firm substrate that supports 75psi, plenty strong enough for the unsealed natural clay tile we installed on top. Hemp-Lime insulation used in the floors, as in the walls, must be allowed to breath in both directions to maintain the beneficial hygrothermal properties. A lime screed technique was used to set the tiles, again to maintain vapor permanence.

Effective U Value takes into consideration the combined results of radiant and conductive thermal exchange. The exterior walls of the A.H. have an Effective U Value of 0.025. which is equivalent to a performance of R40.³⁰

These same walls have amazing acoustic insulation properties, achieving a Sound Transmission class of 35-42 decibel reduction.³¹ Particularly on the southeast shore of our island, the sound of relentless winter wind can be very unsettling. Many who live here seriously wonder if they can continue endure the constant stress. In The A.H. you can forget that a storm is raging outside until you poke your head out the door.

JBF TORCH TEST 32



Fire resistance is another incredible gift of Hemp-Lime. Unlike raw cellulose, when treated with lime and coated with lime plaster, organic fibers cannot burn. A 2 hour fire rating is an incredible accomplishment comparable to a wall built with steel studs, insulated with rockwool and covered with a double layer of 5/8” drywall inside and out. Our 12” thick JBF block walls have done it!³³ To achieve that rating, a test wall was built, loaded with 35,000 kg of pressure, and put against an oven set to 1800 deg C degrees for 2 hours. When the test was completed, the wall was glowing red on the inside but never exceeded 95degC on the outside!

All these services are given free of charge, tirelessly, year in year out, in all seasons without asking a thing in return.



grounded

Not only is the A.H. thermally connected to the earth it is also electrically connected to the earth. Without synthetic insulation, vapour barriers, or sealers; the hemp lime slab exchanges electrons with the earth below dissipating positive electrical charge. Stepping on the ground floor of the A.H. or touching its walls effects an electrical ground. Being grounded is associated with optimizing the human body's bio-electrical systems, resulting in broad health benefits.³⁴

The A.H. is shielded from EMF's, within and without. This can result in reduced cell phone reception inside the house. Awareness is growing globally of the harmful effects of EMF exposure, while wireless technologies proliferate and intensify. Studies prove biological effects at levels far lower than Canadian safety standards. The long-term consequences of these effects remain unclear. Awareness of negative effects of EMF's are suppressed by industrial profit motives, and our own personal desire for constant connectivity. For the electromagnetically sensitive, The A.H. offers a sanctuary from radiation. Key locations are hardwired for Fiber Optic and Ethernet cables to provide connectivity without contributing to EMF exposure. Where electrical wiring was routed in proximity to the bedrooms, it was run through grounded metal conduit to shield the body from prolonged low frequency EMF's during resting hours.

When the floor is in contact with the earth, it connects interior spaces with the outdoors. It is only one step down to enter Permaculture Zone 1, (the area immediately surrounding a home). Here we find the ideal growing environment for edible and aesthetic gardening. Excellent solar exposure will benefit plants, and plants will benefit the house by providing shade to the ground and exterior walls, reducing summertime heat. The gravel sub-grade surrounding The A.H. at the time of writing can be built up an additional 30 cm in elevation with landscaping materials: stone pavers, soil and garden beds. This potential will be creatively developed in the years to come.

Natural materials connect us with nature through their subtle beauty and depth of texture. With natural daylighting, an ever changing interior experience harmonizes with the surrounding landscape, though the passing time of day and season.

All of this supports the experience of emotional groundedness, sense of embodiment and restful ease; qualities we have always associated with home.



bioregional

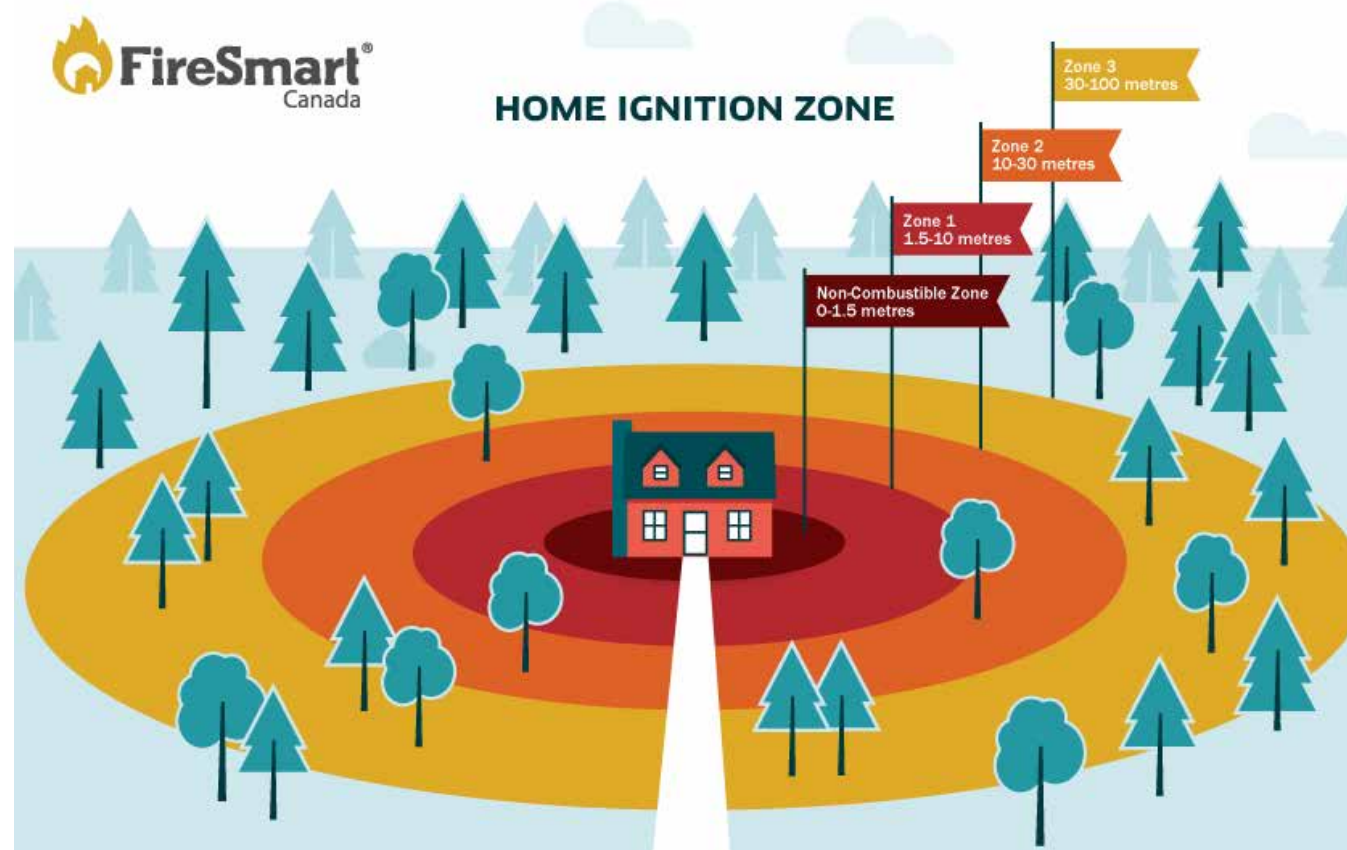
The A.H. was built in such a place where people come just to BE - attracted by the powerful beauty of the landscape. To live in such a place is a rare privilege. Those who do, often feel a deep responsibility to preserve the experience for themselves, their neighbors, and the generations to come. The Coastal Douglas Fir (CDF) Biogeoclimatic Zone including Arbutus trees, is a rare and endangered ecosystem.³⁵

Use of natural materials helps to blend the building with its surroundings, enhancing the beauty of both. Care of the land, particularly before construction begins; with diligence, moderation and restraint; preserves this delicate balance. It can take years for a site to recover from the impacts of construction.

Most importantly, siting of the house must be chosen with the deepest and broadest consideration. The A.H. is ideally positioned within its site. The southeast ocean front is exposed to the strongest prevailing winter winds and intense storms. Conservation of forest cover on the oceanside bluffs was essential to prevent an increase of wind on the site. The house is set back from the bluff which directs wind up and over. Forest on the leeward side keeps the air flow high and protects against summer Northwesters. Maximum setback from the waters edge is respectful of visual quality from the oceanside, which is a boater's paradise. Sacrificing views on a waterfront lot is something few owners are willing to do. The best views are obtained in the worst places to build a house. Here on the west coast, we see many examples of that. Recreational homes with grand architecture and spectacular aspect, in exposed locations, can require prohibitive annual maintenance.

Generous setbacks from the shore also provides a long-term safety buffer against the risks of erosion along the bluff edge. Subsoil testing revealed a thick layer of clay hard-pan deposited by ancient glaciation, underlying the entire property up to the bluff edge. The strength of this layer accounts for the endurance of these shores to centuries of extreme weather. The hard-pan layer increases in elevation towards the west of the property where we chose to build, and the foundation is firmly embedded in it.

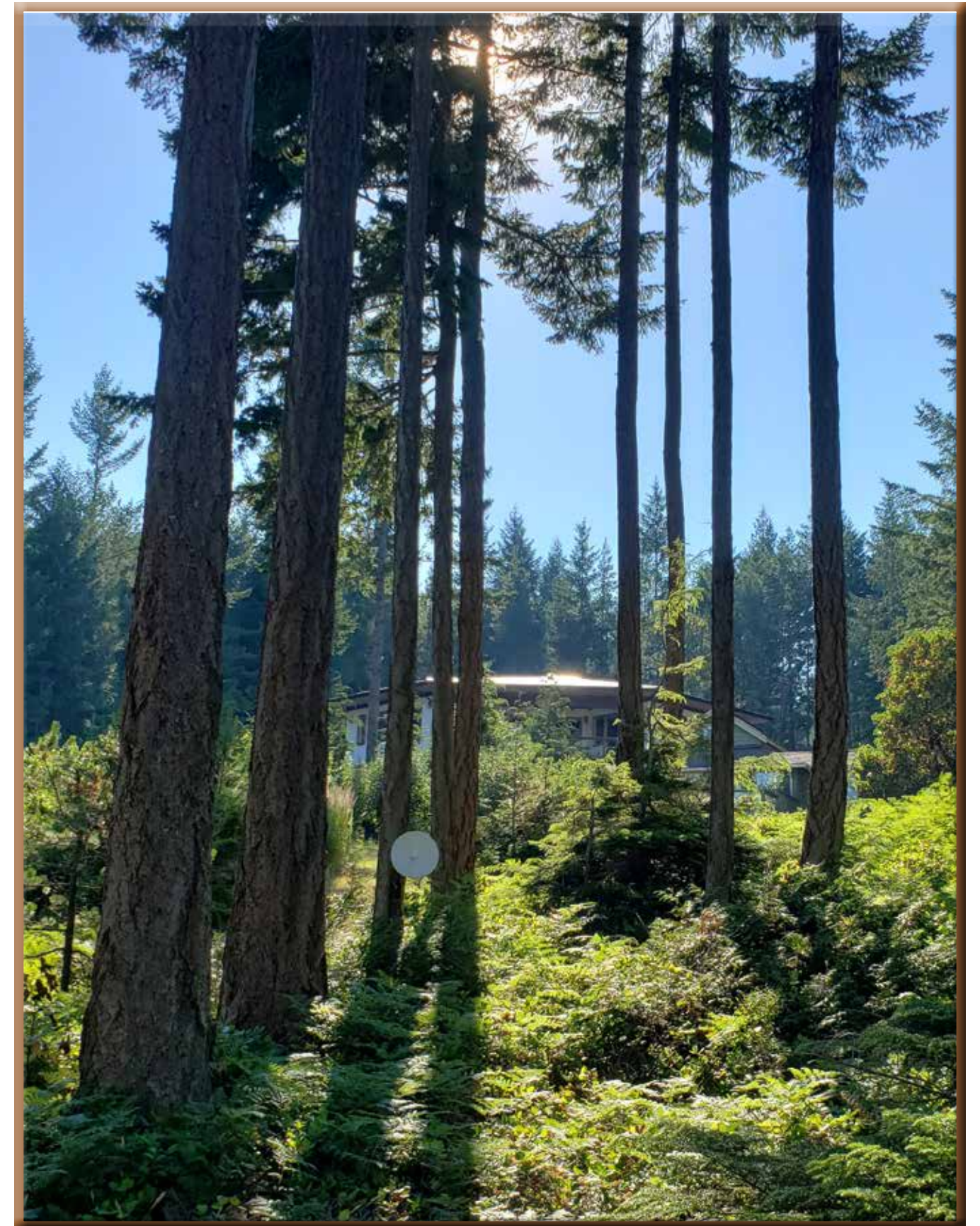
The building footprint was situated in an area of dense regenerating forest that needed to be remediated in preparation for building.



HOME IGNITION ZONE 33

Fire-smart protocols³⁷ were implemented immediately surrounding the house site: All coniferous trees and flammable brush were removed within 10m surrounding the house. This has the added benefit of allowing more light to enter the surrounding forest; increasing the growth rate, vitality and beauty of the retained trees.

For an additional 30m into the forest any trees smaller than 15cm diameter and all coarse woody debris were removed. Dangerous or unhealthy trees were felled, and all the remaining healthy trees limbed up to 10m high. All the wood was chipped and scattered into the forest to retain moisture, nutrients and carbon. Growth of mycelium through wood chips distributes nutrients and accelerates decay. These measures reduce fire risk to the house and impede fire spread from neighboring properties to the wilderness zones. This is another example of syntropic agroforestry methods in which human interventions benefit the ecosystem.





abundant



The A.H. is big and spacious: A total 335 m² floor plan; with a floor-to-ceiling height of 335cm downstairs, and 300cm upstairs. All passageways in the house meet ADA standards for wheelchair accessibility. The extra space is not only practical but has strong aesthetic value. Rooms are open and bright with views in all directions imparting an expansive feeling. When conditions are right, all the doors can be left open to allow the breezes and sounds of the outdoors to migrate freely throughout. With such low maintenance and energy efficiency, the extra space has very few disadvantages, passing on its gifts for the life of the house, and leaving more time and energy to spend in the garden!



Permaculture zone 2 (intensive vegetable gardens), and zone 3 (orchards), are already well established by some of our island's master gardeners, and are proving to be highly productive.

Solar and wind energy pours in from the southeast exposure. The house is ready to add 20kW of solar PV to the sunny sides of the standing seam metal roof and there's a place for an Archimedes wind turbine prepared at the apex of the roof when that day comes.³⁸



Abundant rain seasonally provides fresh water which helps recharge the abundant aquifers below the site. Use of drip irrigation to all garden beds prevents wastage of this precious resource in the dry season.

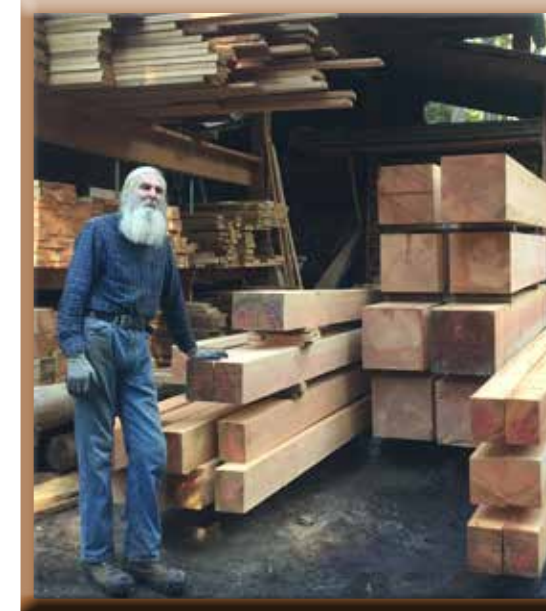
A shop and guest cabin on-site contribute to a functional self-sufficient complex. Proximity to the town center makes walking and biking a practical alternative. Cooperation with the vibrant community of amazing people here, has deep potential for long term resilience. At least we will provide each other some good entertainment! All this works together to support a life of abundance.

Damage done by the current consumer culture is made worse by inefficient design. The A.H. proves that these obstacles can be overcome through implementation of creative life support systems. By maintaining focus and working together slowly over time we can approach what I call the "critical threshold of abundance" ~ once crossed, miracles start to happen!





renewable



The Marine West Coast Climate Zone is characterized by moderate temperatures and abundant rain. Trees grow well and fast here. Syntropic agroforestry practices enhance the abundance of the forest though human intervention in the processes of succession. Surplus biomass is yielded in such a system while preserving the optimum sustainable yield.³⁹

Vernacular architecture always stems from local means and materials. Here, its wood and rock. All the wood used in The A.H. was sourced locally from sustainably harvested or salvaged trees.

The timbers are milled from second growth Douglas Fir. The cabinetry features local Broad Leaf Maple, and exterior trim is made from Western Red Cedar. We had the privilege to use rare and endangered woods obtained through local salvage operations. Arbutus and Yellow Cedar are protected species and should not be commercially harvested as live trees. Enshrining sacred wood in this temple like home, is a fitting monument to their special presence in our region.



Renewable also means replaceable and repairable. Local wood will continue to grow here, and the same simple methods used to shape and join can be employed to repair and replace any components that wear. We considered ease of repair in every design and construction decision.

Heating by the burning of wood is an ancient practice that connects us to our roots. Fire has meant home to humans through our entire evolution. Heating with wood is a strong tradition on the West Coast where wood has always been abundant. Now coming under scrutiny due to carbon emissions and particulate pollution, we are reminded that woodburning should be done with greatest of care. Efficient homes require less energy to heat regardless of the energy source. Firewood is valuable too, now at \$300/cord, many would still rather pay than do the hard work of collecting it. "Waste wood" is abundant in a healthy forest. It is a renewable resource and part of the natural carbon cycle. When rigorously compared to other "green" sources of energy, I believe it still holds an ethical place in this bioregion.

A masonry wood heater is the most efficient ever conceived. We chose to install a Tulikivi, counterflow masonry wood heater. Made of Finnish soapstone it is the pinnacle of this art. Their website has this to say:

A healthy heating system cannot be judged by its BTU output only, but by the quality of heat released by it. A Tulikivi fireplace releases soft, constant radiant heat up to 24 hours. This heats up the walls of the building, thus preventing the generation of humidity (the main cause of mold) and therefore creating a fresh and healthy indoor



climate. Less movement of air and healthy walls are the be-all and end-all of a clean and healthy indoor climate. Radiant heat greatly differs from the hard convection heat of traditional stoves.

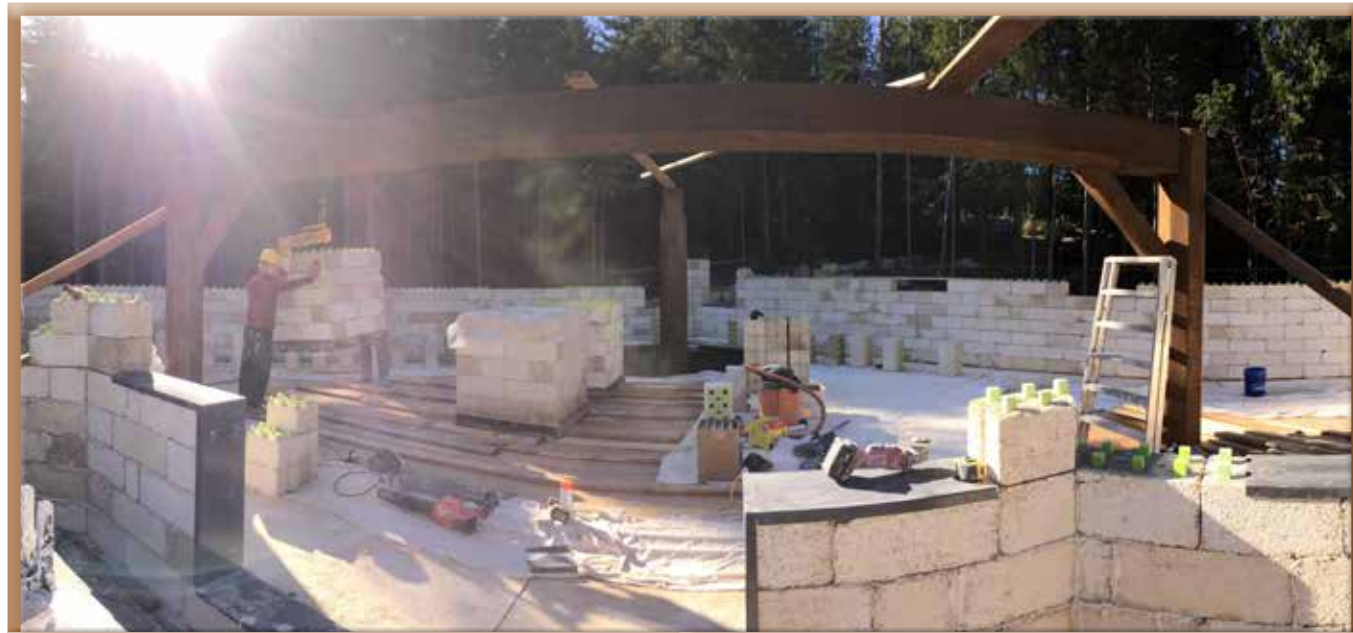
A Tulikivi fireplace burns wood fast and completely (with an efficiency of more than 80%) and therefore uses almost all the existing energy. The emissions amount to only a small percentage of the world's strictest allowances, which leads to a considerable reduction of carbon dioxide. A small amount of wood is enough to heat your space comfortably.⁴⁰



Winter 2021/22 set records for cold in our region with 2 weeks of minus 10deg average temperatures. With no heat source The A.H. maintained a temperature of at least +10deg C for 2 days due to the latent thermal mass and passive annual heating from the earth below. After lighting the Tulikivi once per day, the temperature rose and remained at a steady 20deg C with no other heat source. This is amazing performance. At night with the fire blazing, light from the 2 glass doors bathes the entire great room in a warm amber glow.

Summer 2021 saw a record-breaking heat dome in our region, lasting over a week with temperatures nearing 40deg C in the shade and nighttime lows in the 30s. During this time, we experimented with use of the Earthtube - a 60m long by 15cm diameter plastic tube buried deep beneath ground. With an efficient electric fan blowing air into the exterior opening of the Earthtube, we observed that the air flowing through the outlet and into the house had already undergone a 10deg C drop in temperature. This provided cooling ventilation to the house during the daytime. Free cooling or Night Flush is achieved by opening up all the doors at night and letting the cooler air purge heat from the thermal mass. In this way the temperature can be easily adjusted without any energy requirements for more than half of the year.

Solar and Wind generated electricity is referred to as "renewable", although it requires non-renewable materials to manufacture the technology. Improvements in efficiency and lowering costs of manufacture are serving to reduce the payback period, after which time, energy is yielded without additional cost for the remaining service life of the equipment. The A.H. is wired for grid- tied-solar, and plug and play Tesla Walls whenever the solar panels are installed.



passive

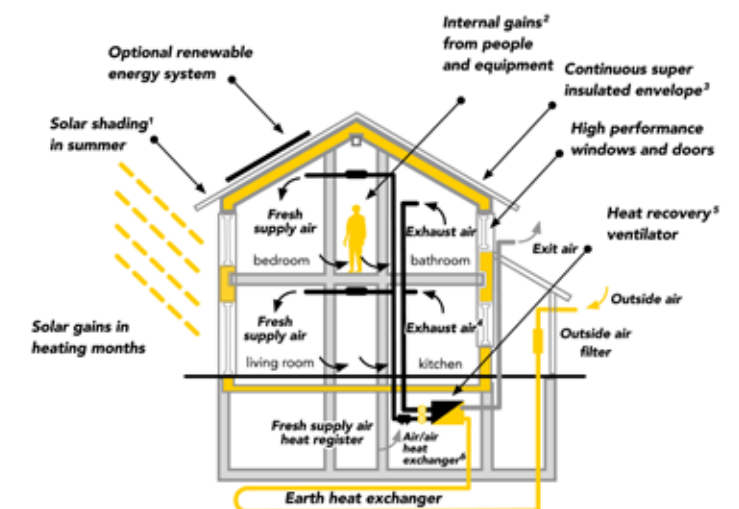
“Passive” in the context of building science refers to the materials and systems which yield constant benefits by virtue of their natural qualities, without any additional inputs. Many of the systems and features of The A.H. discussed in previous chapters have passive elements which support their efficient function.

Passive House^{41 42} green building standards focus primarily on the movement of heat and humidity through; air sealing, insulation, shading and controlled ventilation.

Heat Recovery Ventilation (HRV) achieves passive recapture of heat from exhaust air, The A.H. is equipped with one of the best HRV's available; the Zehnder Comfoair 550.⁴³ It boasts; 95% efficiency of heat recovery, the most efficient motor, quietest distribution and best filtration. It is one piece of high- tech equipment that pays for itself in a short time. As the Hemp-Lime walls are airtight and vapor open the need for an HRV is greatly reduced.

PASSIVE HOUSE DIAGRAM 44

Passive House Diagram



Hot air rises because it is lighter than cold air. This force called “the stack effect” can causes air leakage in homes that are not airtight, but it also enhances passive ventilation whereby large volumes of warm air up high can be evacuated while drawing in cool air from below. The A.H. can be passively ventilated simply by opening the lift and slide doors. Manufactured by Fenstur in Duncan B.C., these gorgeous creations are the first Passive House certified sliding doors in Canada. That means they meet the highest standard of air tightness and energy efficiency. The door rolls smoothly back and forth until a large lever handle is turned to lower the door, firmly compressing its air seals.

Heat pumps are another technology for the passive recycling of heat. We chose the SANC02 air to water heat pump. It consumes a



maximum of only 4500 watts of electricity but can output the equivalent of 18,000 watts of heat. This means it has a Coefficient of Performance (COP) of 4:1⁴⁵ We configured the heat pump as a “Combi System” that provides both domestic hot water and circulates hot water through Runtal hydrionic radiators

Our heating design intended that the SANCO2 would not be the only heat source during the coldest days of the year.

Supplemental heat from the Tulikivi may be needed in the winter. So far, observations indicate that the SANCO2 on its own can supply all the heating needs for the shoulder seasons, and most winter days. Some reduction in domestic hot water temperatures may result from peak loading. The house seems to rest close to an interior temperature of 20degC all year long - only extremes of hot or cold weather seem able to change that! This remarkable efficiency will save enormous amounts of energy over the full lifespan of the building.

19 large windows, 5 glass doors and 5 Solatubes supply passive daylighting from the sun for interior illumination. The many advantages of natural daylight are often compromised in Passive House design. Due to the high energy losses that most often occur through glass, windows and skylights must be reduced to the maximum tolerable degree. Most of my clients so value their views and daylight that they will not compromise on windows.



LiteZone Insulated Glazing Units (IGU's) achieve outstanding levels of efficiency, even when compared to the triple pane sealed units, which have become the industry standard in green building. For north facing windows, and others without primary views, we used LiteZone model L0679 which includes 2 layers of glass and 4 suspended films to achieve an incredible R17.2 center of glass.⁴⁶ This means that very little extra heat is lost (or gained) through the windows while they provide their daylight and views. These windows also increase comfort at a lower interior temperature, as

they conserve the radiant heat in our bodies. Cold windows decrease comfort by emitting radiant body heat.

LiteZone IGU's carry a 25 year warranty and have a life expectancy of at least 60 years. They are expected to last longer than sealed units because they allow pressure equalization between layers, avoiding fogging with long lasting desiccants that absorb the small amount of humidity that enters through a breather tube. Sealed units expand and contract with change of temperature, which can wear out the seals over time.

The large overhangs of the A.H. reduce passive solar gain in the summer but permit passive solar gain on sunny winter days when the sun's angle is lower, and heat is needed.

We used the LiteZone model L0479 with 2 suspended films wherever the views are most important, or some winter solar heat gain would be advantageous. Planting deciduous trees, installing blinds, or building shade structures to shade these windows in the summertime would reduce summer heat gain if that ever proves to be desirable.





enduring

My example of the tree gives a multi-generational perspective of longevity which we have all but lost in our modern consumer culture. I spent years doing renovations as part of my trade. That was a good education on what not to do. Seeing my clients cringe at the cost and inconvenience of major unsightly repairs, that come around all too soon, is strong motivation to improve! During the economically challenging times when the island was first settled; wood was cheap and abundant, while manual work scarce and underpaid. Slap dash methods were too often used to build "temporary" housing for resource industry workers. Now that land values have increased multi-fold, these homes are selling for many times the original cost of their construction and are now nearing the end of their useful life span. The cost of renovations have also increased and will probably continue on that trajectory.

My motto has become - "build to last". If it costs 50% more to make something last 4 times as long - do it. This policy was axiomatic in building The A.H.

Timber framing has proved its durability over centuries, as has the widespread use of lime. World travelers still witness the global application of these practices and their long-lasting results.

We chose standing seam metal roofing which is installed without screw penetrations. It can last at least 60 years, or longer if maintained clean and painted. It can easily be recycled and replaced. We used the only the highest quality 24ga metal roofing and flashings. Solar panels can be mounted by clamping to the standing seams, again without penetrations. Ample ventilation of the attic below the roof keeps temperatures down and further reduces the wear that results from thermal expansion and contraction. We used a Solar Star, solar powered roof vent, which rapidly extracts heat when the sun shines. Tree clearing surrounding the house also serves to reduce wind blown debris; which can cause impact damage, and accumulates seasonally, requiring regular cleaning to avoid corrosion. Metal roofing also provides the best fire protection.

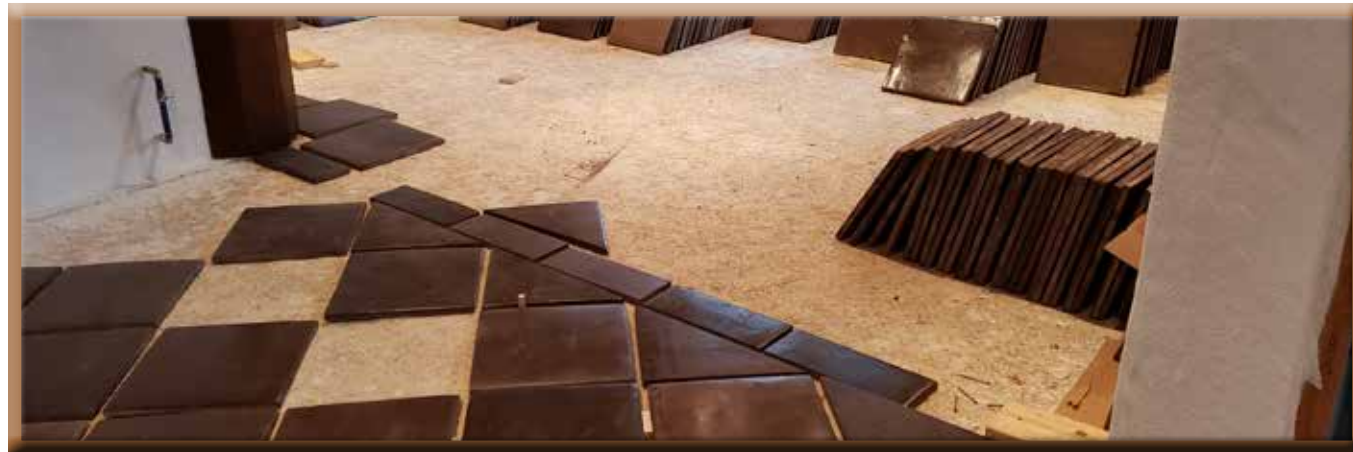
The truss framework that gives this roof its unique shape is installed on top, and independent from, the timbers below. The trusses could be repaired or replaced without damaging the interior.



A service chase between the ceiling of the first floor and the second floor can be accessed from below without damage to the structure or the flooring. Ceiling boards would need to be carefully cut and removed to access the service chase for a specific repair. Once removed, the ceiling boards can then be replaced with very little visible damage. This inter-floor service chase is the ideal place to route services with the shortest runs of ducting, wiring, and plumbing, eliminating the need to run services outside of the insulated envelope and thereby protecting them, and prolonging their lifespan.



Robust, natural clay tile on the ground floor is repairable without risk.



Unlike the vast majority of homes built today, all the materials in the house could withstand flooding or prolonged immersion without damage and would dry out intact without the need for replacement due to trapped water and mold growth.

Window frames can be easily removed and replaced in the event of window damage.

All the finishes we used are easy to re-apply without stripping or other labor intensive techniques. Lime wash is quick and easy to reapply periodically to renew the clean white antimicrobial finish of the interior and exterior walls.

The pure white and natural off-white tones that develop over time, are captivatingly beautiful and reflect colors from their surroundings. We have used unpigmented limewash on all surfaces, but color can be added to the subsequent coatings of limewash by mixing in



by mixing in natural pigments.⁴⁷

We chose soapstone for counter-tops and bathroom tiles, matching the Tulikivi. Soapstone is a unique material that is nonporous, inert and requires no finish other than food grade mineral oil to maintain its beauty indefinitely.



Scratches can be sanded out and re-oiled. A beautiful patina may develop over time, but these tiles need never be replaced. The tile substrates we used are waterproof and unaffected by moisture.



Premium electrical wiring was used throughout the The A.H. Under the ground floor, and through exterior walls, single conductor 12ga wire was run through conduit. This wire could be eventually replaced without any damage to the structure. Heavier 12ga wire was used wherever it is encapsulated in interior wall cavities, to prolong its service life.

Natural catastrophes can put a devastating end to a home's lifespan, and perhaps the longer a home lasts the greater the odds that it will experience one of these rare events. The greatest of these risks is fire, which accounts for major increases in homeowners insurance costs

We did not ignore the risk of fire in the A.H., starting with the Fire Smart protocols. The heavy gauge metal roof of the A.H. sheds fire brands that shower down during forest fires and resists ignition of the combustible roofing materials below. The hemp lime walls with their incredible 2 hour fire rating offer up the final barrier to fire dangers originating outside the house.

The addition of an interior sprinkler system greatly reduces the risk of fires starting inside the house.



In a study of over 400,000 house fires, less than 1% of them occurred in the presence of sprinkler systems.⁴⁸ Sprinklers reduce fire risk in residential structures more than any other fire reduction method.

Additional measures were taken to reduce the risk of fire ignition and spread. The interior lime plaster walls are naturally fire resistant.



A layer of Rockwool was also installed in the attic; above the second floor wood ceiling, between trusses, and around recessed light housings. This was covered with 19 inches of blown in cellulose insulation, a combination particularly resistant to fire ignition and spread.



We used fire resistant Rockwool Safe n Sound insulation in the inter-floor service chase with a concrete sub-floor installed on top to provide a fire resistant layer between the first and second floors.



JBF block's; monolithic and flexible structure, is earthquake and tornado resistant.⁴⁹ In combination with; the robust timber frame, interior shear walls, and geometric rigidity; this house can stand up to extremes of lateral loading. The blocks are also effective barriers to insects, rodents and mold damage.

Considering all these benefits The A.H. has a comprehensive "All Hazards Design".



healthy

Good health needs to be continuously nurtured during our entire lifetime. According to the American Time Use Survey we spend 62% of our waking time at home and up to 90% of our time indoors. Thus, the environment inside our home has a large influence on our health.

Indoor air quality is among the most important factors in a healthy home.⁵⁰ A Heat Recovery Ventilator (HRV) provides a constant flow of fresh oxygen rich air without wasting heat as it exhausts CO₂. The Zehnder Comfoair 550 installed in the A.H. is oversized for its needs but as such functions within its range of peak efficiency.⁵¹ The Zehnder has a built-in replaceable MERV 13 filters that remove over 90% of particles 1 micron or larger. It also has carbon filters that can remove woodsmoke from the incoming air-stream, a feature that may come into more frequent use with the increase of summer wildfire smoke.



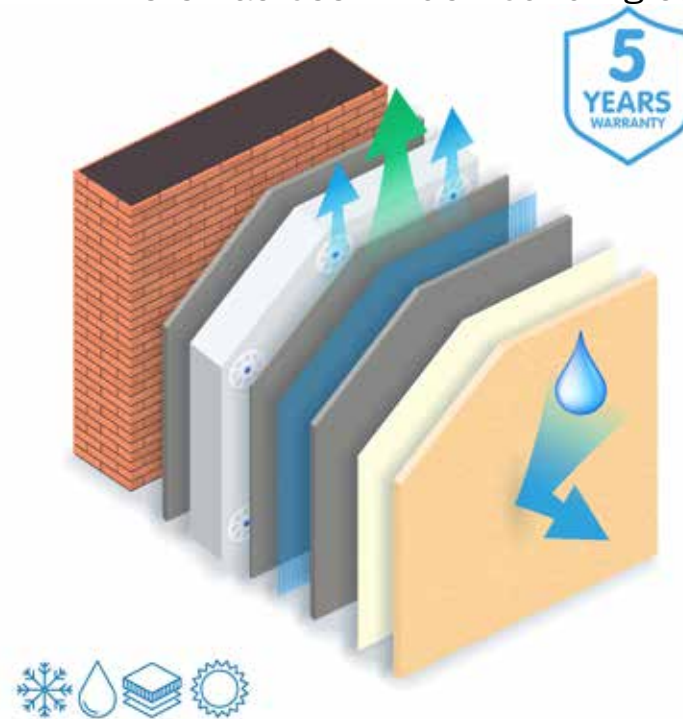
Eliminating sources of pollution originating inside the home reduces reliance on ventilation alone to maintain indoor air quality. We minimized the use of any building materials that off gas harmful chemicals. An electric range, with high quality range hood, extracts organic contaminants released during cooking and deposited on interior surfaces. Cooking with natural gas and propane is increasingly recognized to be a source of carbon monoxide and other harmful pollutants.

Mold is a huge problem affecting up to 50% of the homes in the US and increasing the incidence of respiratory illness 30-50% worldwide.⁵²

There has been much building science research aimed at reducing,

and hopefully eliminating mold problems in building envelopes. Airtightness and control of moisture flow underlies most methods that improve thermal efficiency. Almost all the strategies currently prescribed by building codes use a series of layers, each with different properties and functions. Each of these layers has a unique life expectancy and risk of defect. Common sense dictates that complex systems can be more prone to failure, as the designed performance of these systems depend on the correct performance of each of their layers independently.

MULTI LAYER WALL SYSTEM 53



Moisture movement through wall assemblies can cause condensation to become trapped leading to premature deterioration and reduced insulation.

Not so with our hemp-lime walls which avoid all these problems elegantly and simply. Hemp-lime has excellent Moisture Buffer Values and a low Vapor Diffusion Resistance Factor.⁵⁴ This rare combination results in a steady temperature and humidity along interior wall



surfaces, which prevents condensation. These conditions further support lime plaster's innate resistance to mold.⁵⁵ Hemp lime and lime plaster are considered fungicidal, as is the high pH lime leachate that impregnates the wooden lath and other wood features wherever they come in contact with lime plaster.

Lime plaster is the best coating to support the performance of hemp lime insulation as it too is vapor open. This superb hygrothermal envelope effectively performs as a single 63cm thick layer of homogeneous material; lime and sand on the surface, lime sand and hemp in the middle; which prevents moisture from penetrating deeper than 12cm, but holds, diffuses and releases humidity. For a deeper understanding of the performance of hemp lime please read

- "Moisture Buffer Potential of Experimental Wall Assemblies incorporating formulated hemp-lime" published in Building and Environment Volume 93, Part 2, November 2015, Pages 199-209⁵⁶

We have investigated many other health giving qualities of The A.H. in the previous chapters. This home supports holistic well being, which is both the foundation and fruit of good health!





harmonious

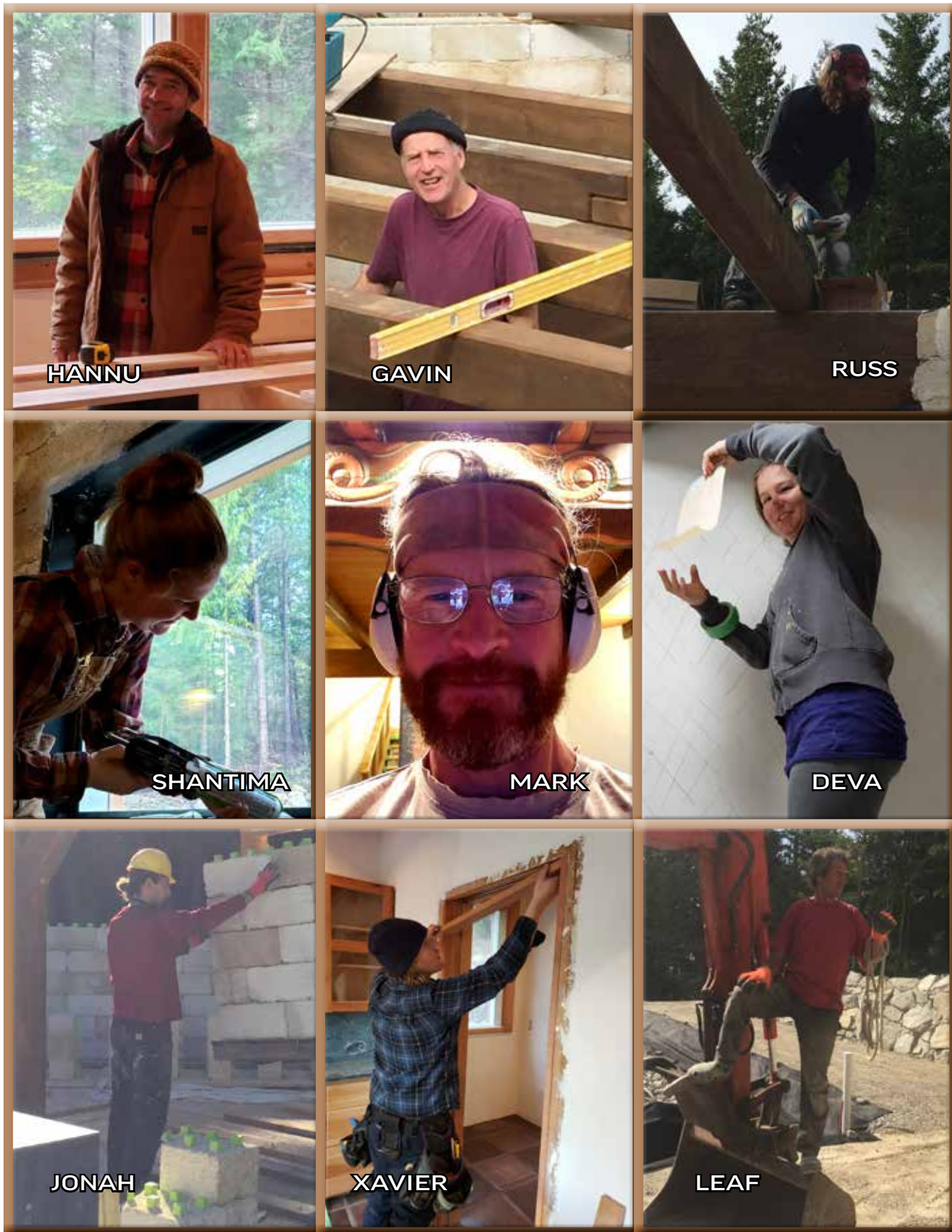
This home will be a place of peace and healing for all who spend time here; where sound and silence, light and shadow, scent and sensation; all come into balance. We are drawn into the natural world to become one with It, fulfilling a deep need for this connection.

Each room does not have a unique personality of its own, but rather is aesthetically connected to the whole. Use of similar materials, textures, geometry, and aesthetic details throughout the house imparts a harmonious atmosphere consistent with Salingaros's Laws of Architecture. This reflects the hidden integration within all aspects of the design. The A.H. embodies sophisticated complexity in beautifully simple ways that sooth the senses.

Wildlife responds to harmonious energies. Spending time in all seasons, at all times of the day in this special place; we have experienced the constant presence of nature. Birds are particularly abundant; bald eagle, red tail hawk, coopers hawk, barred owl, vultures, ravens, humming birds, herons, oyster catchers, scoters, loons, diverse sea birds and too many song birds to list. A constant symphony of the sea! Early one morning on the job-site, as the fog dissolved in blinding sun, a collared dove came to land on one of the timbers as it was lifted up high into its position on the roof. One of those magic moments!

Close enough to hear from the bedroom, the sea mammals are a frequent presence: breaching humpback whales, powerful orcas, surging white sided dolphins, curious seals, proud sea lions and other rare species. Beautiful coastal plants thrive in this ideal climate. Native and cultured; flowers, fruit trees and fungi; each with their tiny insect friends. The sun, wind, sea and clouds, fill us with energy and encouragement in every moment. With care, may they always ~ in this sacred place.





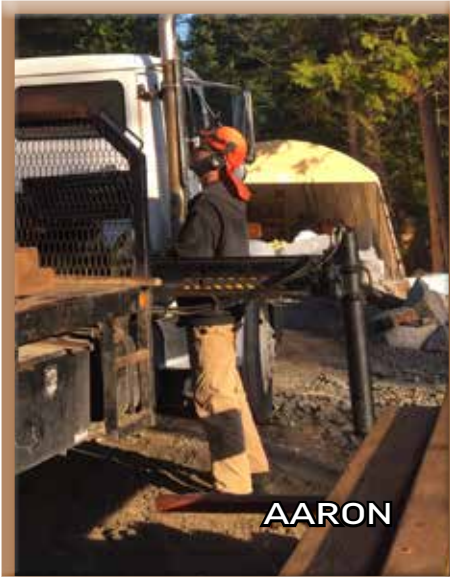
human

Built for humans by humans! Shelter is an essential human need and building shelter has been much of what we have done as a species here on earth. An archetypal element of our collective culture that connects us; to time, place and to each other. Humans need something to do! With their bodies. Not only with their minds, but with their hands; to engage, to work with their environment, interact with each other and all the elemental forces. Buildings have defined us and our relationships. They have been the creative manifestation of our highest values.



I seek methods that could be available to anyone in any place because humans are empowered when they have control over their means of shelter. The knowledge of how to build is empowering, and so needs to remain accessible to all. The skills of these local craftspeople are an archive of knowledge and experience, brought here from diverse origins, definitive of this special time and place, to be passed on to future generations. Our homes must not become divorced from our communities; commodified, complicated, and automated beyond our own means; leaving us vulnerable and dependent. The A.H. bucks this trend and re-establishes the path towards self reliance.

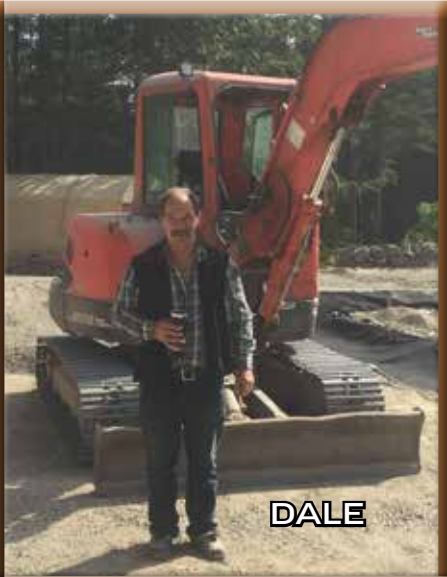
Onward! Through the mud!



AARON



VOLKER



DALE



CHRIS



HENRY



ELIJAH



MARTIN AND CORY



MATT



ISABEL



integral

When weakness is strengthened and noble virtues embodied. When all good things work even better together, and “the whole is greater than the sum of its parts”, we reap the rewards of integrity!

The A.H exemplifies a multidisciplinary approach; including the integrative design systems of Permaculture, Syntropic Agroforestry, Vastu Shastra, Passive House and natural building.

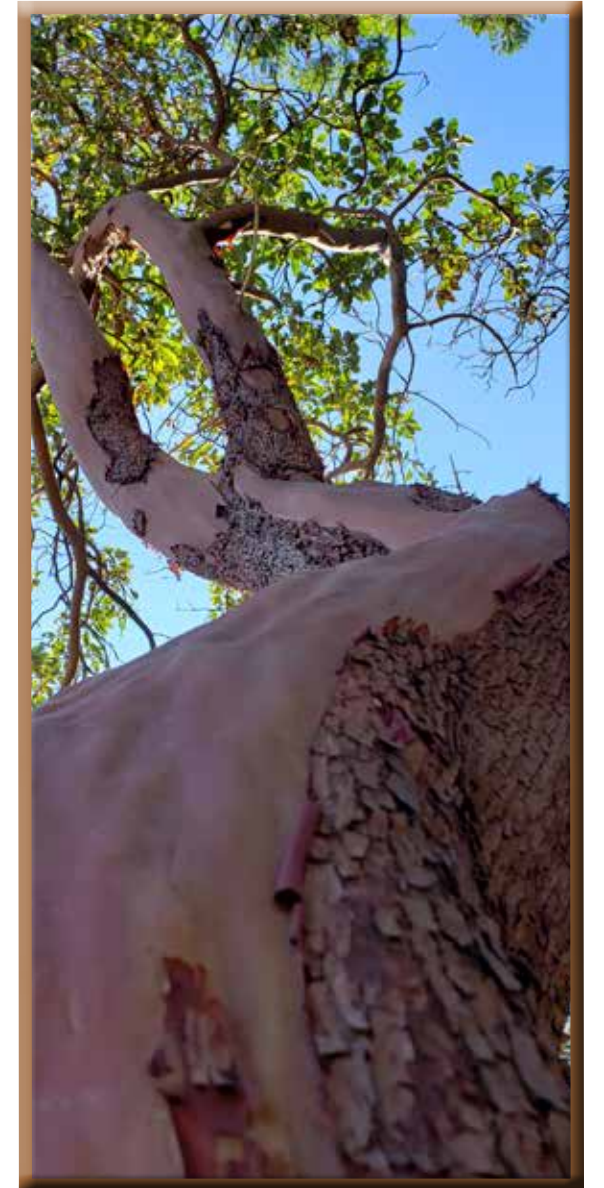
It is not in the scope of this book to delve too deep into each of these vast fields in which I consider myself to be just a beginner. By mentioning them now I hope to shed a little light on some of the deeper realizations of this beautiful creative process.

Working the builders trade has been great training! The daily work is practical and hands on. I have witnessed how practicing these skills has helped us all to develop our organizational memory, systems thinking, strength, coordination and so much more. Now that this project is complete, we return from an epic journey, experienced at all levels of our being; body, heart, mind and soul. An initiation that supported integration with ourselves, our communities, and the world around us.

I think a home needs to reflect our integration with the world around us ~ a place to go within from, and come out of.

By sharing our journey, I hope to inspire others on this path; to make our homes and the world better ~ more beautiful places to live.

- Mark Braaten 2022/02/22 2:22



endnotes

- 1 Sunrise over Earth – ©Tryfonov - stock.adobe.com, Sept 10 2018, Sunrise over Earth, Licensed Digital image
- 2 Carbon Footprint of PHL3.5 - <https://static1.squarespace.com/static/5c93e4458155122b65cc5173/t/5f20a83507367c42e520b355/1595975747279/Arcana+Restoration+Assessment+Report+Rev+1.pdf>
- 3 Lifecycle Cost Analyses LCCA - <https://www.wbdg.org/resources/life-cycle-cost-analysis-lcca>
- 4 Southwest Environmental Finance Center, LCC Iceburg, Digital Image, Retrieved from, https://swefc.unm.edu/iamf/wp-content/uploads/2021/04/kunskap_LCC_iceberg_EN_500.jpg
- 5 Time Value of money Inflation - https://sustainable.stanford.edu/sites/default/files/Guidelines_for_Life_Cycle_Cost_Analysis.pdf
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owner's manual

1. **VENTILATION** - The HRV control box is located left of the door just inside in the ground floor utility room. Low fan speed is normally adequate to take care of all ventilation needs. Medium fan speed can be used when there are more than 2 people in the house, or if more fresh air is desired for any reason. Booster toggle switches in the bathrooms and kitchen set the HRV to high fan speed for 10min, after which time the fan speed returns to the previous setting. Supply ports are located in the great room and bedrooms. Exhaust ports are located in the bathrooms and kitchen. Individual Supply or Exhaust ports can be manually adjusted by removing the trim cover, to increase or decrease the aperture and thus, the relative volume of air flowing through the port. Particulate filters located on the front of the heat exchanger need to be changed every 6 months for maximum efficiency. Carbon filters can be installed inside the large steel housing that sits on top of the heat exchanger. The carbon filters have a limited lifespan when exposed to air, and should only be used to filter out wildfire smoke when needed. Passive ventilation can be adjusted by opening the Lift and Slide Doors and/or the Entry Door with the Phantom Screens closed. During summer, the doors can be left open day and night for optimal interior temperature. During extreme heatwaves, closing the doors during the day maintains a cooler interior temperature. <http://zehnderamerica.com/wp-content/uploads/2014/01/Zehnder-ComfoAir-550-User-Manual1.pdf>



2. **EARTH TUBE** - A 50m long, 15cm diameter, Big O pipe is buried deep beneath the East wall. It can be used for ventilation instead of the HRV or potentially in combination with the HRV by connecting it to the HRV supply duct for greater efficiency. The Earthtube inlet is located just south of the guest cabin deck. As air passes through the Earthtube it exchanges heat with the earth surrounding it. In the winter, the incoming air warms up, and in the summer it cools down. A fan at the inlet drives the air through the tube. The outflow is located in the storage space under the main stairway of the house, accessed through a wall hatch in the ground floor



utility room. Preliminary experiments show good results for cooling incoming air during heatwaves. The outflow is sealed with an insulating cap when not in use.

3. **DOORS/SECURITY** - The Fenstur Lift and Slide Doors can be locked from the inside only. The Entry Door is the only one that can be locked from the outside. A special maintenance solution available from Fenstur is to be used on special wood finish of the doors only, 2 times per year, to renew UV protection and maintain the finish indefinitely. Keep the bottom tracks free of grit to protect the rollers. <http://www.fensturwindows.com/lift-and-slide-climatech.html>



4. **HEAT PUMP** - The SANCO2 air to water heatpump provides domestic hot water and space heat. This configuration is called a Combi System. The Taco X Block is a heat exchanger that extracts heat from the water tank and shares it with the Hydronic Heating Loop which does not mix with the DHW. Settings on the X Block determine temperature and flow rates. A thermostat on the wall of the entertainment room sets the shut off temperature for the entire hydronic heating system. The Hydronic Loop sends hot water through Runtal radiator panels and towel bars in each of the main rooms of the house. Each radiator has an individual control valve to increase/decrease or shut off hot water flow. The total output capacity of all the hydronic radiators combined, exceeds the capacity of the heat pump. When the heat pump is being used as the only heat source, mainly the 2 large radiators in the great room should be used. In cold months when extra heat is needed, using the wood heater downstairs and radiators upstairs is most effective. Over reliance on the heat pump in winter may reduce domestic hot water temperatures. In practice 20deg C is the maximum temperature achievable with the heat pump alone. The heat pump is on the back up panel. <https://www.smallplanetsupply.com/sanco2-for-combi-systems> <https://riada.ca/product-lines/runtal-radiators/>



5. **TULIKIVI** - Masonry wood heaters operate differently from other wood stoves. Wood should be finely chopped 40-50cm long and cured at least 1 year. 2 years supply on-site in advance is ideal. I expect 2 cords of wood per year will be adequate. Damper

operation is critical. Phase 1 Firing - damper must be in the vertical (full open) position and the air intakes below the ash drawers full open. Load the fire box completely, light it and close the glass stove doors after the fire gets going. Let the fire roar until flames die down. The draft of the chimney is excellent and there should never be any smoke escaping during the process. If smoke escapes at any time, check the damper or look for blockage! Phase 2 Embers - When flames are blue and almost gone the damper can be partly closed by rotating the handle counter clockwise into a diagonal position. Air intakes can be closed at this time if desired. Phase 3 Radiating Thermal Mass - when embers are almost gone close the damper by rotating clockwise until the handle is in the horizontal position. This will stop heat loss up the chimney and hold more heat in the thermal mass. The heater will continue to radiate up to 24hours. Frequency of firing can be adjusted to suit the demand. https://www.tulikivi.com/en/products/TTU2700_5



6. **WATER** - A shared deep well and pump provides water for all the domestic and irrigation needs to this property (and 2 other adjacent properties). The water is potable without filtration and is of excellent quality. There is a VIQUA UV purification system and particulate filter in the pump house. The filter needs to be changed every 6 months. The UV Bulb needs to be changed every 2 years. https://viqua.com/wp-content/uploads/MNL602936_RevAK-EN.pdf



7. **PLUMBING** - The Main Shut Off Valve to this property has a large red plastic handle and is located under a round green lid between the pump-house and shop. A shut off in the pump-house stops water flow to all 3 properties. There are 2 more square green lids nearby beside the Main Shut Off that contain valves for the garden irrigation system. The Main Cold Water Supply Valve inside the house is located in the storage space under the stairway - accessed through the wall hatch in the ground floor utility room. There you will also find a valve for supply to a future carport and to the kitchen sink. Secondary whole house Hot and Cold water shut offs are located under the Taco X Block. A frost free hydrant is



located on a standpipe between the sauna and the main house. A frost free hose bib is located on the NW exterior wall of the house. Hoses should be disconnected from these hydrants in freezing weather to avoid damage.

8. **BACK UP POWER** - The electrical back up system was designed and installed by Hakai Energy Alternatives and Cliff Mooney Electrical. The system was planned to be completed in 2022/23. The completed system will connect the generator to the house Generator Sub-panel, add 20kW of Solar PV to the roof and connect Tesla batteries to the already installed Fronius Primo inverter System. Rough in wiring is already installed to Grid-Tie the entire 400Amp service, enabling any extra power generated by solar panels to flow back to the grid. A 14kW propane generator currently supplies back up power to the guest cabin only during power outages. The generator automatically runs an exercise cycle once each week for 20min. A regular service contract is in place with Whites Diesel in Campbell River. <https://resources.kohler.com/power/kohler/residential/pdf/tp6804.pdf>



9. **TESLA EV CHARGER** - Located between the generator and the propane tanks. There is a design for a covered carport in this location which can be added in future. The charger is set for an 80A charging capacity for Tesla electric vehicles. The charger is wired to the Guest Cabin Generator Panel. <https://www.tesla.com/sites/default/files/pdfs/wall-connector-eu/tesla-80a-wall-connector-installation-manua-en-v1.pdf>



10. **PROPANE SYSTEM** - Superior Propane receives a wireless signal to inform them when the propane tanks need a refill, automatically placing and order for delivery through the customer account. Propane is used to fuel the generator, the guest cabin range and a propane on demand water heater in the shop.



11. **LIMEWASH** - The same formula was used for both the exterior and interior lime plaster walls. Very little maintenance is needed. Lime wash can be optionally reapplied to the exterior whenever desired. Its easy and fun in our opinion! In practice this may be done every

3-5 years or as desired to freshen up the bright appearance, The natural patina of weathered lime plaster develops beautiful tones. Lime plaster can be scrubbed with water and a stiff bristle brush to remove contaminants. <https://www.limestuff.co.uk/blog/how-to-apply-limewash>

12. **WOOD FINISH** - Broda Pro-Tek-Tor was the only pigmented stain used for interior and exterior woodwork. Acorn is the dark brown color and Woodland Clear is the light tan color. Exterior woodwork should be re-coated every 3 years with a combination of un-pigmented clear topcoat or pigmented coats as needed to maintain the desired coloration. No stripping or sanding is required. Minwax Water-based Polyurethane was used as a sealing top coat on interior woodwork. Saicos Wax Oil was used on the wood floors, bar-top and window frames for its exceptional durability and appearance. <https://cbrproducts.com/shop/broda-product-line/protector/pro-tek-tor-siding-log-timber-slt/>

13. **SOAPSTONE** - counters supplied by Granite Valley Stone in Merville and tiles from Greenville Soapstone. Soapstone may be treated with food grade mineral oil whenever desired, wipe on and rub off. The oil evaporates and disappears in a few days leaving a refreshed appearance. Soapstone can scratch so be careful, but scratches can be sanded out with 400 grit wet dry sand paper. <https://www.granitevalleystone.com/>



14. **FLOORING** - Bullnose Tile supplied the authentic Mexican clay tile used on the ground floor. It can be refinished every few years with Sealers Choice Gold (only) - a vapor permeable sealer that is easy to paint on. Washing with mild soapy water is all that is required. The tiles are durable but dropping heavy sharp objects may cause chips or cracks. <https://www.bullnosetile.com/> Upstairs flooring is spalted Red Alder with golden honey stain from Woodland Floors. It is a softer wood and needs to be treated with care. It should be cleaned with Saicos Ecoline Concentrate and refinished only with Saicos Wax Oil, all available at Woodland Flooring in Comox BC. <https://woodlandflooring.com/> <https://saicoscanada.com/product/saicos-premium-hard-wax-oil/>

15. **FIRE SPRINKLERS AND ALARMS** - The sprinkler system is designed to meet NFPA 13D standards for residential fire sprinkler systems. Sprinklers are activated at 155deg F, except for the one nearest to the wood heater which activates at 175deg F. Once a sprinkler

head has been released it cannot be shut off and will need to be replaced. Shut off valves stop water flow from an activated sprinkler head. A manifold with 4 shut off valves is located in the utility room. Shutting off water supply to all the sprinklers disables the fire suppression system. A service chase is accessible behind the large office bookshelf - if inspection of the Solatube or chimney is required. A trap door on lower right side gives access to a set of sprinkler zone valves. These would only be used in case one of the zones of the system needs to be deactivated while the other zones are still active. Hardwired smoke/CO2/CO alarms are installed throughout the house as per code requirements and are connected to the generator panel.



16. **CENTRAL VACUUM** - Beam Alliance Central Vacuum is top quality for residential use. The power unit is installed in the second floor utility room. The unit exhausts air indoors for energy efficiency. The exhaust air is HEPA filtered. Filter bags are optional. Empty dust collector when half full. Internal ductwork allows connection in every location of the house. Do not allow large objects to get sucked into the ducting system. The end of the suction hose must be correctly positioned in the vacuum port to make correct electrical contact. Look for the blue light to come on the power-head. A switch on the power-head turns the vacuum on and off. <https://www.beamcentralsystems.com/central-vacuum-systems/beam-alliance>



17. **LIGHTING** - LED lighting used throughout the house is extremely energy efficient. In areas where the most vivid coloration is needed, or eyestrain would be of concern; such as the kitchen, dining area, office and bedrooms - incandescent bulbs were installed. Interior and exterior wall sconces can use standard A19 base bulbs - 60W incandescent or I like Satco 7.5W warm white LED bulbs. Recessed lights require MR16 GU10 base bulbs either 50W halogen or 4.5W Phillips Warm Glow LED. Incandescent bulbs and LED bulbs should not be mixed on a single switch. <https://www.satco.com/search/S21714> <https://www.lighting.philips.ca/consumer/p/led-spot--dimmable-/046677474546>

18. **LIGHT SWITCHES** - The switch system was kept as simple and intuitive as possible but it is a nuanced lighting design. Experiment

with dimmers and different lighting combinations at different times of the day. Except for the stairwell, there are no 3 way switches hard wired into the house, to avoid extra wiring in the walls. If 3 way controls are desired on some circuits, a Casita dimmer switch can be installed to replace any toggle switch. The Casita can be controlled remotely with 1 or more Pico wireless remote switches. Pico switches can be mounted on the wall like an ordinary switch, set in a table top stand or carried as a remote control. We used this system to create a 3 way switch configuration in the ensuite bathroom. <https://www.casetawireless.com/>

19. CEILING FAN - Designed to enhance air circulation when required. The On/Off switch is located at the bottom of the stairs. When On, the fan is controlled by a remote. The best setting is On - Low, with blades turning to lift air to the second floor, distributing heat in the winter and helping extract heat in the summer. The fan can also be left in the Off position as air is also circulated by the HRV and force of convection.



20. ATTIC - Access can be gained with a tall stable step ladder placed in the center of the balcony deck. The T&G ceiling boards must be individually removed and set aside, starting at the west central position. Climbing up into the attic requires a strong grip on the truss frame and should be done with care. Crawling is required. There is a service platform suspended above the insulation layers for ease of movement inside the attic. A Roof Access Skylight lets daylight into the attic. When the skylight latch is opened, pistons raise the dome and hold it in the open position. It is easy to climb out onto the roof for service. Fall arrest equipment should be used for roof maintenance, ropes can be securely tied to the truss structure. Roof perimeter gutters are equipped with leaf guards and should not need frequent cleaning. A Solar Star roof vent has a solar powered fan that extracts air from the attic when the sun shines. Fresh air flows into the attic through copper soffit vents located around the perimeter of the roof. Ventilation occurs naturally by convection when the Solar Star fan is not running. Sola tubes and chimney can be inspected from inside the attic. Wiring and 12V drivers are affixed to trusses in accessible locations. Chimney is relatively easy and safe to access for cleaning.

21. SAUNA - The beautiful yellow cedar sauna is heated with a Tylo 8kW electric sauna heater. The main breaker for the sauna is found in the Guest Cabin Main Sub-panel. The "Sense Pure" control box is simple, just push the power button, green light turns on, and

the heater is activated for 1 hr. The heater turns off automatically after 1 hr. By manually pressing the power button off and on again the timer is reset. There is a breaker on the heater that trips if the temperature gets too high. Wait for the heater to cool a bit and restart at the panel. Pouring ladles of hot water aiming for the rocks makes steam and the sauna hotter. Don't be shy, but avoid pouring water directly on the electric element when its red hot. Healthier steam results when rocks are hot but electric element is cycling off. Air vents should be opened while the sauna is in use, and when not in use, but can be closed during the warm up period. Hot and cold water is supplied to the sauna outdoor shower from the cabin. "Stop+Drain" valves under the cabin are used to winterize. Close the stop and open the drain plug to evacuate water from the shower lines before freezing temperatures. Rinse the sauna seats and floor after each use, squeegee excess water off the wood and tile floor and out the door. Towel dry the seats. Enjoy regularly! [https://www.saunafin.com/uploads/upload/pdf/SENSE%20PLUS%20with%20PURE%202.0%20control%20\(OSG%20%26%20Full%20Manual\)-2021.pdf](https://www.saunafin.com/uploads/upload/pdf/SENSE%20PLUS%20with%20PURE%202.0%20control%20(OSG%20%26%20Full%20Manual)-2021.pdf)

22. SEPTIC SYSTEM - Biomicrobics type 3 system. Wired to the Guest Cabin Generator Sub-panel. High water alarm and blower alarm are located on the wall beside the cabin Sub-panels. Occasionally the blower alarm trips in a power outage. Holding the reset button stops the alarm and resets the blower. The blower is located near the septic tanks and dispersion field. It accelerates purification of effluent before it is pumped to the dispersion field. Septic tanks should be pumped and inspected every 2 years when there has been year round occupancy by more than 2 people onsite. The field is sized for the combination of all main house and guest cabin facilities.



23. LIFTMASTER GATE OPENER - There are 2 remote controls already included. Additional remotes can be purchased. There are accessories available to enable gate activation from smartphones and even video cameras to view who is at the gate from inside the house etc. The gate arm can be locked, disengaged and reengaged manually by turning the large lever on top of the arm. <https://www.liftmaster.com/ca/-12vdc-solar-residential-linear-actuator-package/p/LA412UL>

24. WOLF INDUCTION RANGE AND COOK-TOP - Special cookware is required for the induction cook-tops. The smaller cook-top is on the backup panel for use in a power outage with a generator or

whenever battery power is low. <https://www.subzero-wolf.com/wolf/ranges/induction-range/36-inch-professional-induction-range-legacy> <https://ca.subzero-wolf.com/en/wolf/cooktops-and-rangetops/induction-cooktops/15-inch-transitional-induction-cooktop>

25. **WOLF RANGE HOOD** - This commercial grade range hood will serve for roasting, grilling and sauteing with the oven and both cook-tops! Ordinary cooking exhaust ventilation should be achievable with the HRV only - on boost mode. This will exchange the entire interior air volume but particularly in the kitchen where there are 2 exhaust ducts with 2x the volume of exhausted air. The range hood disrupts the balanced ventilation of the HRV and can in extreme situations draw smoke out of the Tulikivi when in use. In the winter, when the range hood is needed on High speed, open the east Lift and Slide door a crack to provide make-up air. Range hood on Low setting is not likely to cause depressurization. <https://ca.subzero-wolf.com/en/wolf/range-hood/42-inch-cooktop-island-hood-black>



26. **COVE DISHWASHER** - <https://ca.subzero-wolf.com/en/cove/dishwashers/24-inch-dishwasher-panel-ready>
27. **ASCO WASHER AND CONDENSING DRYER** - The laundry room is configured to have these models installed. There is no dryer vent in place, as the design includes a condensing dryer which saves electricity by recirculating heat like a heat pump. There is space for folding tables on either side of the washer dryer. <https://www.askona.com/washer/w4114ct> <https://www.askona.com/dryer/t208cw>
28. **PANTRY** - Design includes custom shelving and a SubZero stand-up freezer. The kitchen is specified to have the matching SubZero fridge installed in place of the existing Whirlpool fridge/freezer combo. <https://ca.subzero-wolf.com/en/sub-zero/full-size-refrigeration/builtin-refrigerators/36-inch-built-in-freezer> <https://ca.subzero-wolf.com/en/sub-zero/full-size-refrigeration/builtin-refrigerators/36-inch-built-in-refrigerator> https://www.whirlpool.ca/en_ca/kitchen/refrigeration/refrigerators/french-door/p.36-inch-wide-counter-depth-4-door-refrigerator-19.4-cu.-ft.wrqa59cnkz.html
29. **2ND FLOOR UTILITY ROOM** - Design includes a Franke utility sink already purchased to be installed in a custom wash table with workbench and shelving. A water filter can be installed here with

existing plumbing connection to the freezer ice maker.

30. **COATROOM AND BEDROOM WALK IN CLOSETS** - Design includes hanging racks and shelving for clothes boots and shoes.

31. **SHOP ELECTRICAL PANELS** - The electrical system is complex with panels in different locations on the property. 400A power drop enters at the north side of the shop. Inside the shop are the 2 Main 200A panels. On the left is the House Panel with a disconnect - includes feed to the House Sub-panel(s). On the left the 200A Guest Cabin Panel with disconnect - includes feed to the Shop Sub panel located on the east wall. The Shop Generator Sub-panel with Pump House Circuit is also located on the adjacent east wall of the shop - with it's feed coming from the Guest Cabin Generator Sub-panel.



32. **HOUSE SUB-PANELS** - Located in the ground floor utility room. Divided into 2 sub-panels - Main Sub-panel on the left and Generator Sub-panel on the right. The Generator Sub-panel includes all the essential circuits that would remain active in the case of a power outage when the generator or Tesla batteries are in use.



33. **GUEST CABIN SUB-PANELS** - Guest Cabin Main Sub-panel and Guest Cabin Generator Sub-panel. The Automatic Transfer Switch disconnects the Guest Cabin Main Sub-panel and sends generator power to the Guest Cabin Generator Sub-panel in the event of a power outage. Breakers for the Septic alarms, Tesla charger and feed to Well Pump Sub-Panel are located here.



about the author



Mark Braaten left the city of his birth, and a chosen career in medicine, to embark on 4 years of world travel, that served to enlighten him about diverse cultures and their ways of life. He became among the first to earn certification as a Yoga Therapist at the Vivekananda Kendra Institute in Bangalore India.

He and his wife returned from their travels to the remote wilderness of British Columbia. There, they helped to found 2 unique intentional communities based on spiritual and ecological health. Together they home-schooled their 3 daughters and experimented with many arts of self sufficient living.

Mark has worked as a carpenter since the 1990's after building his first house; a 900ft² Earthship in a remote off-grid valley of the Kootenay Mountains. The Earthship was built with hand tools and recycled materials, costing only \$10,000 to complete. Since that time he has been particularly interested in alternative and natural building techniques.

Mark and his family moved to the remote shores of Cortes Island in 2001 where they lived seasonally on a sailboat and cruised the inside passage from Cape Caution to the Straights of Juan de Fuca. His youngest son was "born on the ocean" and raised on the boat where the whole family learned the ways of the sea. The sailing lifestyle, and work restoring sailboats, provided excellent training and demanded the expansion of Mark's skill set.

Mark's career as a builder evolved into designing homes with local islanders who came with a desire to finally manifest their dreams, after renouncing life on the mainland. Life on the island inspires people's creativity but also confronts their vulnerabilities, demanding resilience and self reliance. Mark was a pioneer in the early green building movement when he started his company, Gaia Tree Construction in 2015, and is now becoming a thought leader in green design.

Together with his wife, he manages a 36 acre homestead practicing the arts of Permaculture and Syntopic Agroforestry. He has been a director and secretary of the Cortes Community Forest Cooperative since 2014.

