Ripple

LAGI 2020 Fly Ranch

In nature, no two ripples are the same. Each ripple reflects differently the beauty around it, as it is propelled by the unique energy that guides its motion. And so, in explaining this conceptual artwork, it should be noted that Ripple is a self-organizing system and can be as vibrant and lively as we humans choose to make it.

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The name Ripple was chosen to represent the literal and metaphorical effect of waves spreading outwards from a single *drop* of water. In this same way, waves of plants and wisdom ripple outward from our central *drop* of inspiration. An oasis for native plant propagation and cultivation, Ripple is a central point for the restoration of people and planet, and a safe, comfortable space for periodic habitation.

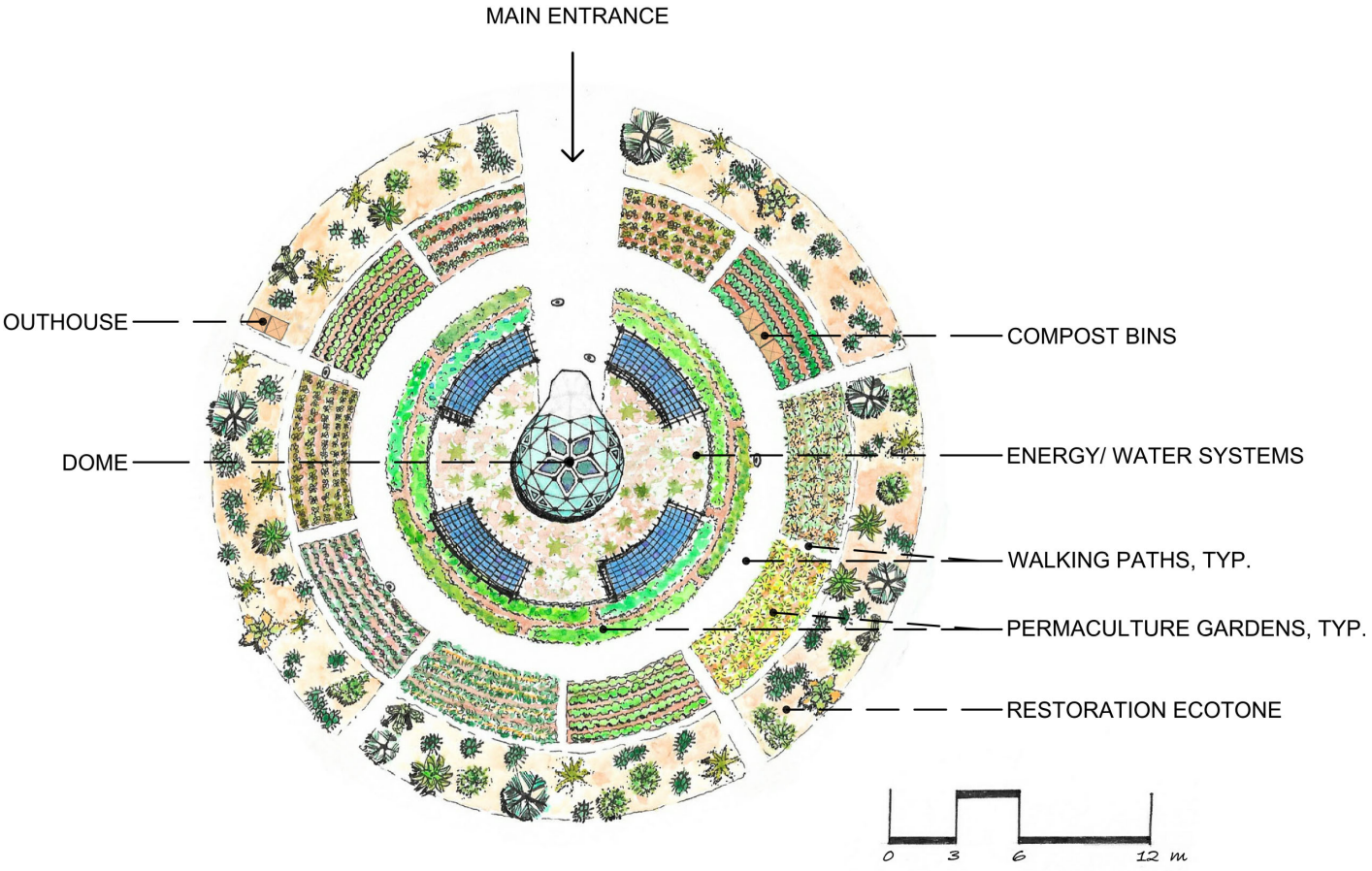

Figure 1 Schematic Plan

The central dome, or "drop", is surrounded by a series of concentric rings, or "waves," which consist of permaculture gardens to grow predominantly edible and medicinal plants and a restoration ecotone that blends the site into the surrounding environment and provides crucial ecosystem services. Walking paths contain a novel water drainage system and connect the site to allow for mobility of Fly Ranch guests and volunteers.

Ripple's scalable, adaptable, and replicable nature make it resilient to a changing climate, and flexible to the wide array of uses and activities that can take place, as seen in **Figure 2** below.

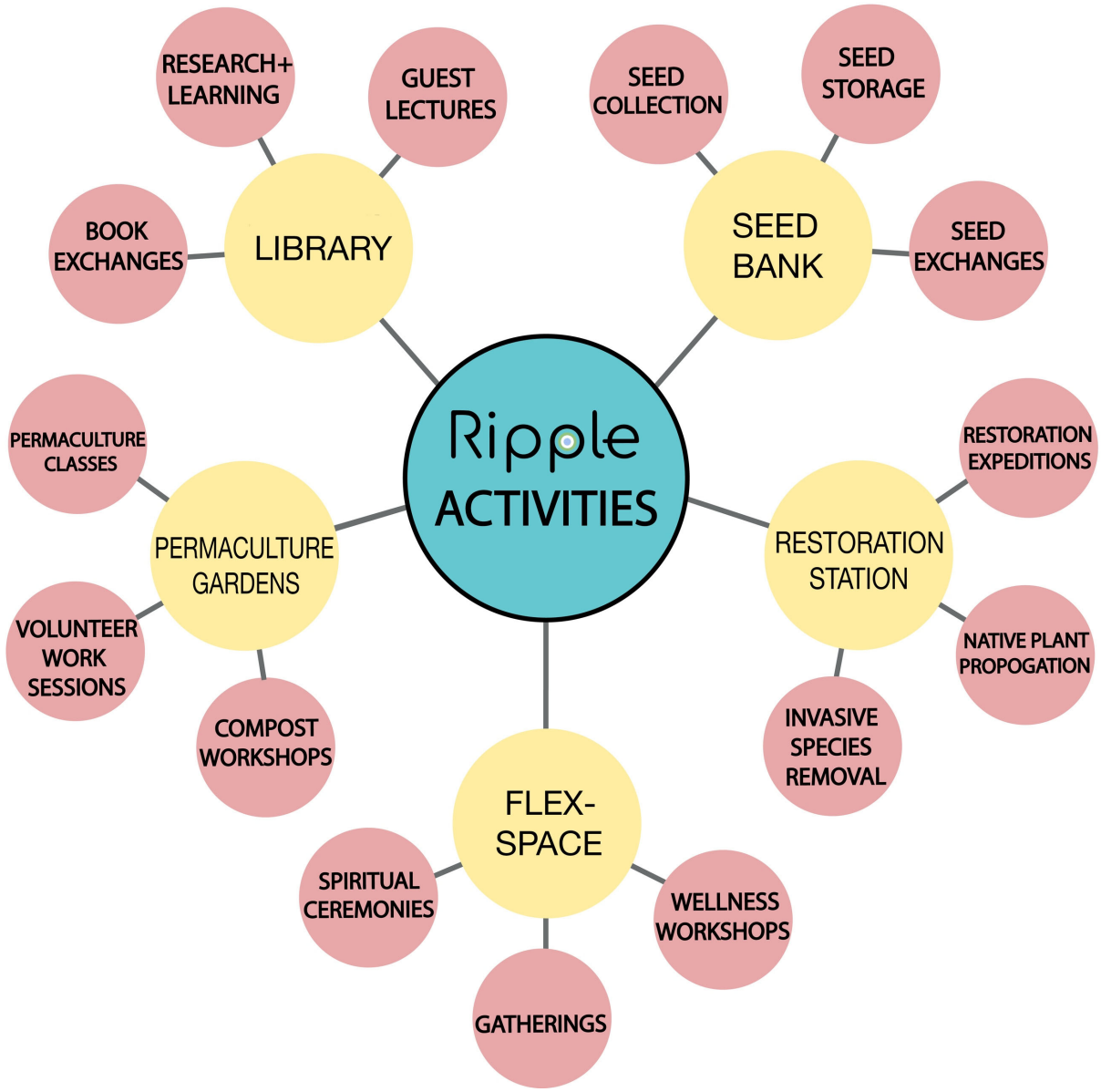

Figure 2 Activities

Diagram of some of the various activities Ripple supports. Humans are central to Ripple, as they are the life force behind the transfer of materials, information, and energy. Humans truly push the boundaries of the artistic reaches of Ripple, as the collective energy that goes into the space are reflected in the waves that extend outwards in all directions.

Solutions to all five support systems of shelter, water, energy, food, and regeneration create the backbone of how the system sustains itself in an off-grid fashion with minimal inputs from beyond its borders.

SHELTER

The evolutionarily astounding geodesic dome central to Ripple can survive in harsh climates such as Fly Ranch's for over 500 years. This sixteen-foot dome is crafted from uniquely sustainable bioceramic materials similar to bone and shells, and takes advantage of passive heating and cooling using electrochromic glass skylights and automated vents.

This zero-carbon, low-waste shelter is a non-toxic living and event space that exceeds the highest levels of environmental and architectural standards. The dome is extremely energy efficient and is built in a few short days. Fly Ranch would be one of the first places on earth for humans to interact with this novel technology.

Staying in the dome will be similar to visiting a base on the moon. In a challenging and sometimes dangerous landscape, this resilient structure provides the essential provisions of home to act as a small overnight shelter for two rangers managing the site. A seed bank and library inside the dome are located along the sides, leaving in the center a cleared event space that is adaptable for many uses.

The seed bank stores seeds in two ways after sorting and desiccation. For long term preservation (>20 years), seeds store in sub-freezing temperatures in the refrigerator. For short-term annual storage, seeds are organized in labelled drawers. A consistent replenishment of foraged native seeds balances seed dissemination to the gardens and to the public. A library sits across from the seed bank and preserves important cultural and scientific information such as traditional ecological knowledge of the Great Basin region.

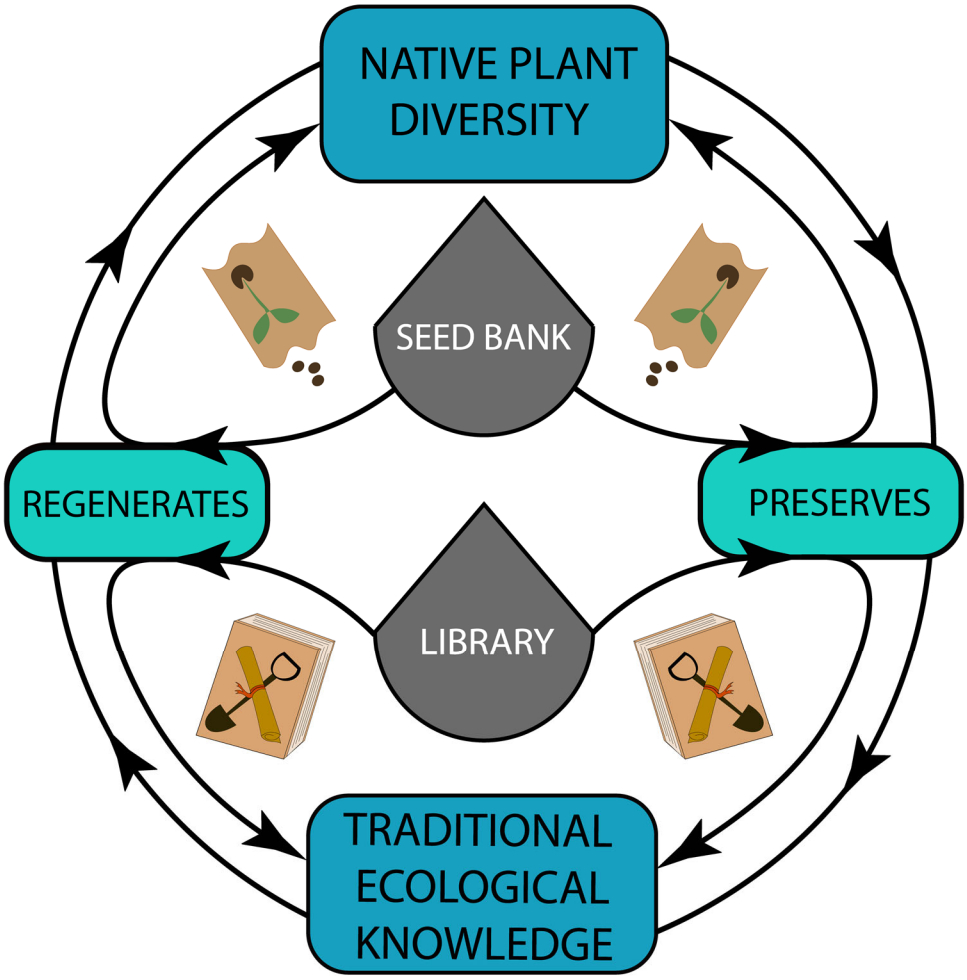

Figure 3 Seed bank and Library

The seed bank and library are a dynamic bridge between the past, present, and future. Native seeds ripple outward as humans visit the library and apply their newfound knowledge on how to plant, grow, and maintain them. In this way, regeneration of both human wisdom and native ecosystems evolve symbiotically. The hope is to invite regional Native American tribes and farmers of the region to be active in the library and seed bank from day one. Relationships with local historians, anthropologists, archivists, and universities would further bolster the literary and scientific resources to preserve the ethnobotanical and ethnoecological wisdom of the area and create a community resilient to a changing climate.

MORE THAN JUST FOOD

The permaculture gardens offer a space for a wide array of plants, anywhere from annual crops to perennial medicinal herbs. Plants are grown mostly for their edible, medicinal, or otherwise ceremonial uses and are shared with Fly Ranch guests and volunteers. The restoration ecotone makes up the outer wave of plants and acts as a transition zone to the native Fly Ranch ecosystem beyond. This wind-blocking wave supports useful plants that offer habitat, pollen, and nourishment for native animals and insects, especially for pollinators and birds. This area also has the ability to act as a nursery to provide young plants for restoration projects throughout Fly Ranch.

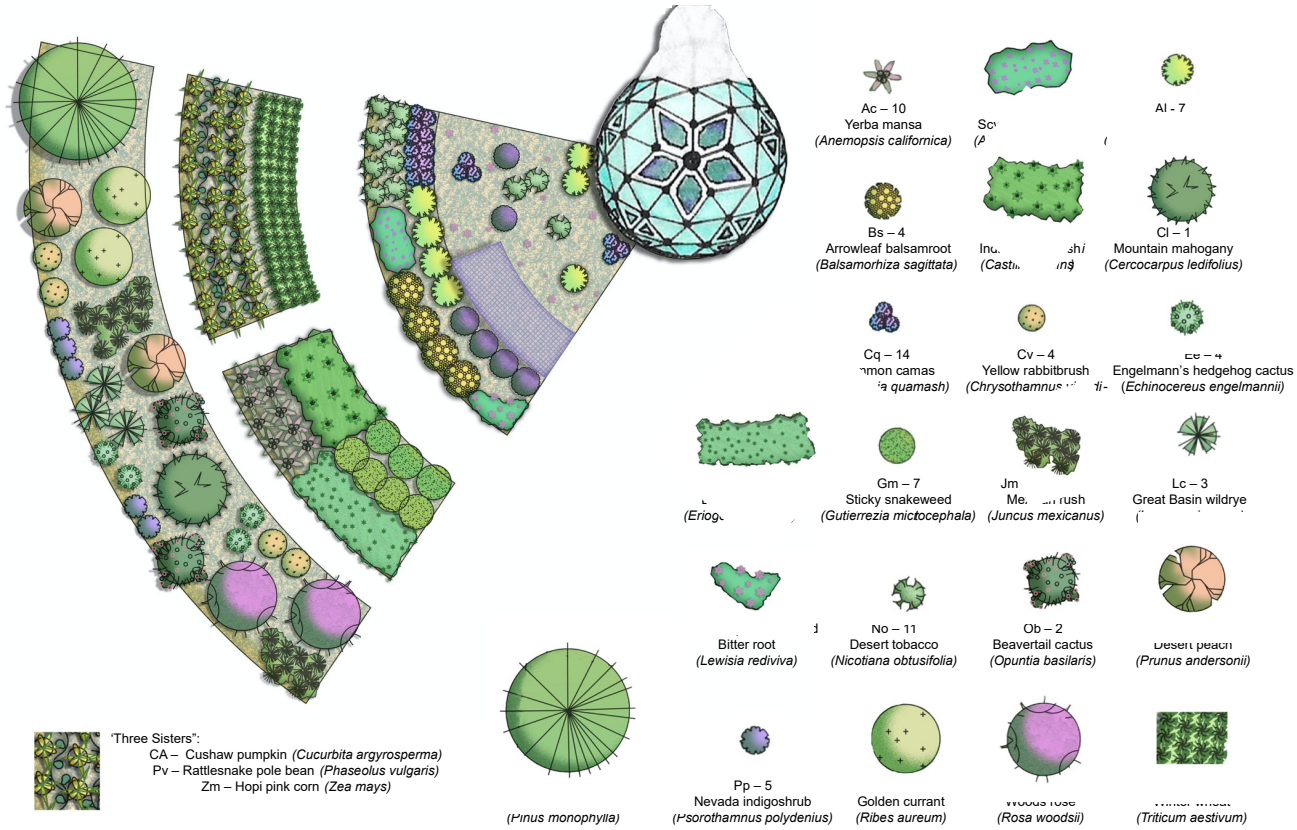

Figure 4 Sample Plant Palette

Diagram showing the potential species that can thrive on one-fifth of the total plantable area at Ripple. All plants shown are drought resistant and native to Fly Ranch. Once established, species other than crops will not require significant amounts of water to thrive. For further information on plants including their type and historical uses, see **Figure 12** *in the Appendix.*

WATER

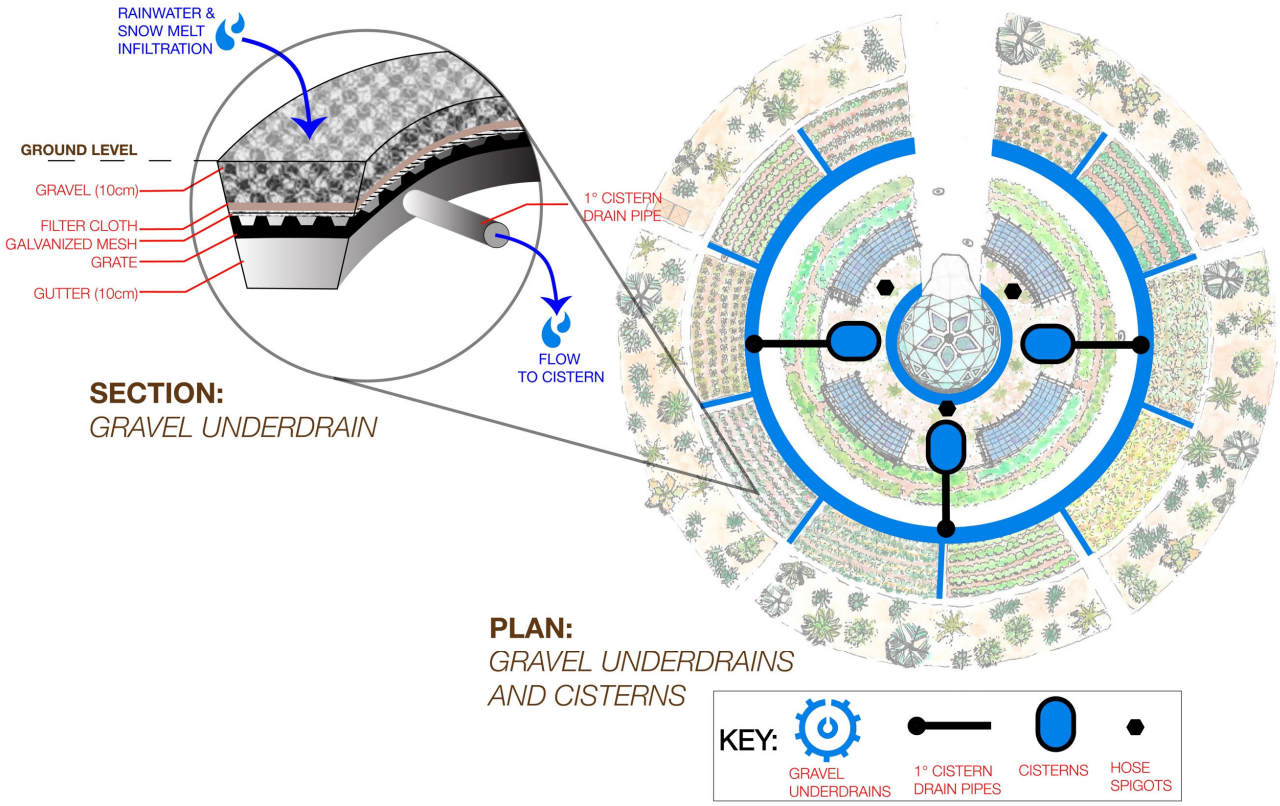

Figure 5 Water System

Rainwater and snowmelt collect off of major walking paths and are mechanically filtered before flowing via gravity to store in underground cisterns located near the dome. When water is needed for plants, cistern pumps send pressurized water to exterior hose spigots for manual watering or drip irrigation. When potable water is needed, water is redirected inside the dome to be further filtered via reverse osmosis and supplied through a sink faucet before going into a hidden grey water basin. In the event cisterns are filled, overflow drains send water to the lowest elevation point of the site.

Ripple uniquely mimics poikilohydric desert mosses that live in a dormant state when there is a lack of water, but seemingly resurrect within minutes of rainfall. During a prolonged drought of several months or years, Ripple goes into a semi-dormant state to only grow plants that do not require additional irrigation. When a drought ends and precipitation returns water storages to levels that can support irrigation for the growing season, the plant palette expands to plants and crops that require irrigation. As a backup, cisterns can be manually filled up via trucking in water if desired. Sensors in cisterns will allow for remote sensing of the water levels at the site, such that prior to going, rangers can plan accordingly for potable and irrigation needs.

The number of cisterns installed and their sizes are adaptable to the water needs of a given plant palette and scalable to fit the water budget in the occurrence of adding more waves of plants. Water storage is decentralized to reduce energy needs via smaller pumps and bolster the resilience of the system to pathogens or contamination. The design in **Figure 5** shows a three-cistern application which can store a maximum of 57 m^3 of water.

By expanding the surface area of the gravel underdrains and adding larger cisterns, as much 244 m^3 of water could be captured in a single year with this site plan. (Note: measurements were calculated using 2018 precipitation data at Fly Ranch.)

E N E R G Y

A robust, scalable power plant provides the electricity required for cistern pumps, lights, power tools, sensors and metering, and the refrigerator. This scalable system generates 1.5 KW and is expandable to 11 KW. A 12 KWh battery bank is expandable to 48 KWh. The power plant is scalable to facilitate expansion of the water system and other technologies, or more generally, to allow the site to scale up as a whole.

System electronics are selected with safety and ease of installation in mind. The inverter, charge controller, breakers, disconnects, and metering are built together into a field-tested NEC 690.4b, NEC 705.4/6, and UL safety-certified package. System features ground-fault detection, PV rapid shutdown control, PV arc-fault detection, PV lightning protection, and input and output overcurrent protection.

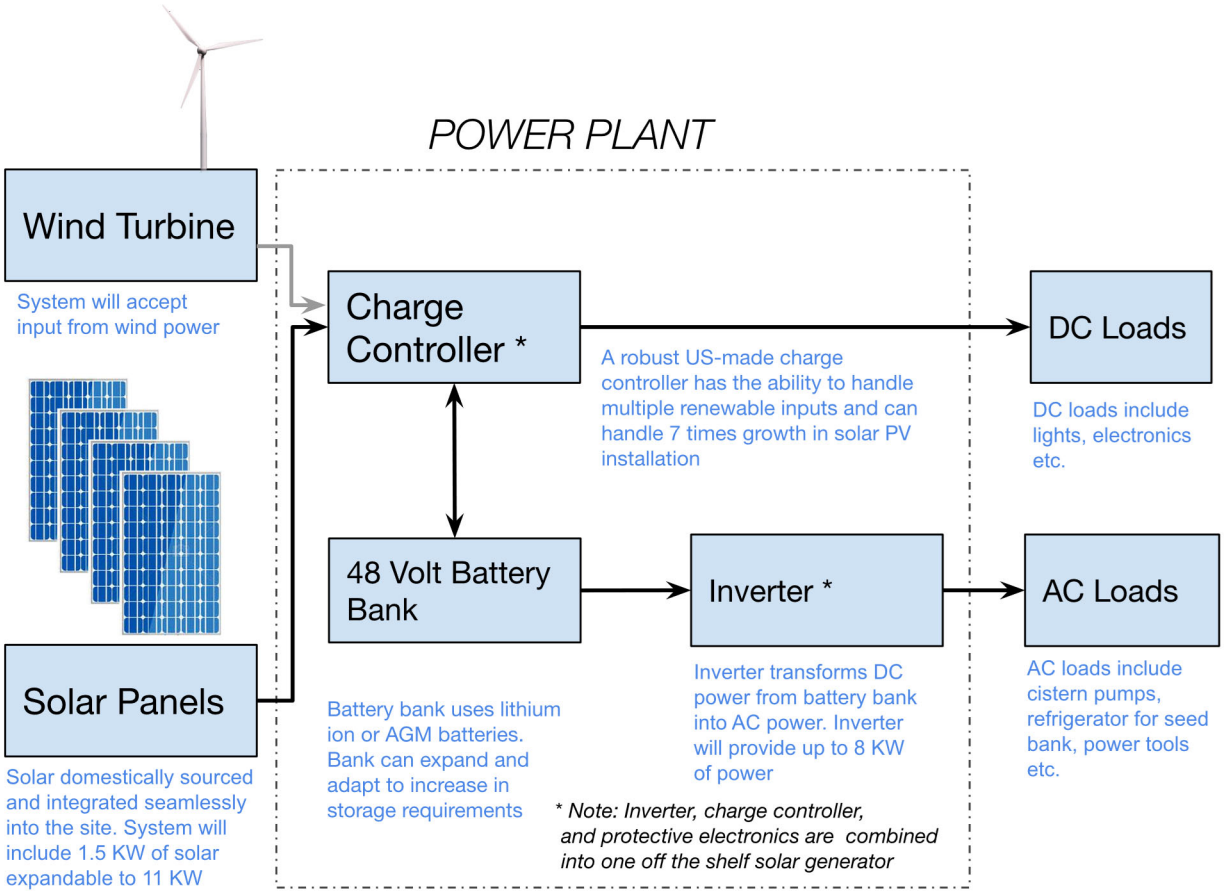

Figure 6 Energy Systems

Diagram showing flow of electricity from PV solar panels through charge controller into battery bank. Battery bank powers direct current loads through charge controller and alternating current loads through inverter. The system can grow with additional solar panels and is also adaptable to work with wind turbines. Inverter and charge controller are combined into a solar generator made from recyclable materials. The generator has appropriate UL and NEC safety features and a unified user interface.

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REGENERATION

A composting toilet requiring no water nor electricity provides fertilizer to non-edible plants found in the restoration ecotone. An established ring of naturally antimicrobial desert mosses ensures no contamination occurs between the permaculture gardens and the restoration ecotone.

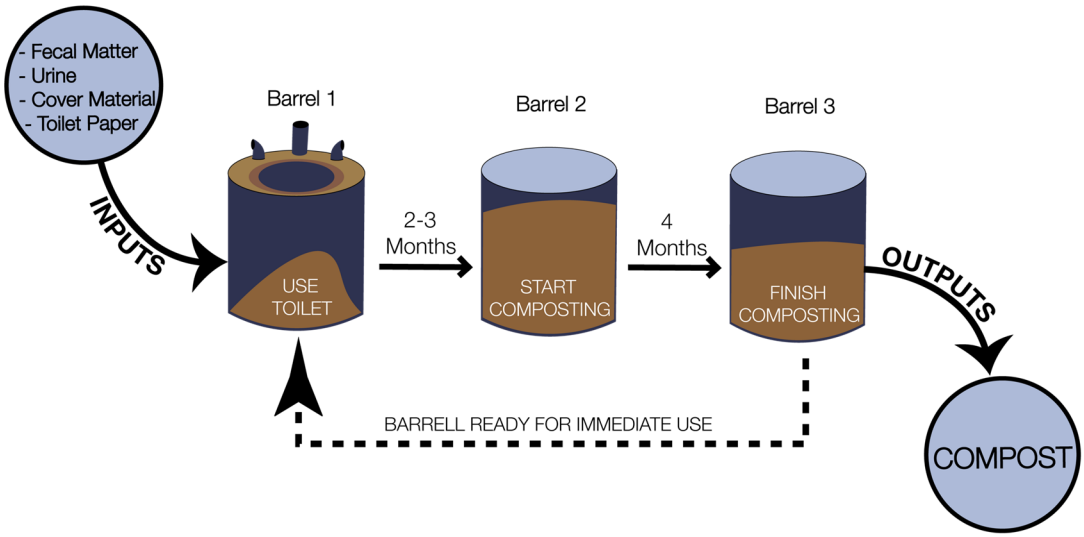

Figure 7 Composting Toilet (*see description on next page*)

Diagram showing the three-part cycle of composting in three 55-gallon barrels (.2m^3). Usage of the three barrels rotates; after two to three months of active usage by two people, the filled barrel is sealed to start the composting process. Lids and toilet seats are movable from one barrel to the next. After four to six months, the filled barrel will be finished composting and emptied, making the barrel once again available for usage.

A conventional three-part composting system regenerates plant wastes into soil for the permaculture gardens. This method prevents soil nutrient depletion and limits the need for fertilizer inputs. Non-native plants at Fly Ranch are turned into soil for native plants, as detritus from invasive species removal expeditions is piled up alongside other food and plant scraps collected from on-site and neighboring sites. Additional bins are built as necessary.

In conjunction to composting, a seasonal cover crop rotation keeps soil from going fallow during the fall/winter in areas without perennials. Cover crops such as wheat and alfalfa hay reduce wind/water erosion and groundwater contamination, and increase soil health and fertility, among the numerous other benefits.

INPUTS + OUTPUTS

	INPUTS	OUTPUTS	MAINTENANCE
Permaculture Gardens	• Sunlight • Water as needed • Seeds • Composted plant waste • Cover crops • Human effort and love	• Foods (yields vary) • Medicinal herbs • Teas • Botanicals • Seeds	• Seed annual plants • Tend to plants as needed • Weed plots as needed • Harvest crops • Plant cover crops in fall • Irrigate plants as needed
Restoration Ecotone	• Sunlight • Water as needed • Seeds • Composted human waste	• Wind blockage • Natural seed dispersal • Native restoration plants • Habitat for wildlife • Habitat, pollen for pollinators	• Irrigate plants until established • Weed plots as needed • Tend to plants as needed
Water System	• Rain • Snow	•Water -Dry year: 34 m^3/year* -Wet year: 56.8 m^3/year*	• Monitor cistern pumps once per year • Clean out sediments each year • Replace pumps after 15-20 years
Energy System	• Sunlight • Wind	•Electricity -9 KWh /day -Max 99 KWh /day (Expanded system)	• Clean off panels monthly • Inspect system annually • Oil wind turbines annually • Replace panels after 50 years • Replace battery after 10 years
Composting Toilet	• Toilet paper • Cover material (such as sawdust or straw) • Fecal matter, urine	• Soil amendment (for non-edible plants)	• Aerate once per week • Level compost 2-3x per week • Apply compost to restoration ecotone every 2-3 months
Composting Bins	• Plant litter and detritus • Food scraps • Invasive species detritus	• Soil amendment (for edible plants)	• Rotate compost between bins once per month • Apply compost to permaculture gardens every two months
Seed Bank	• Native seeds • Electricity (for refrigerating seeds long term)	• Native seeds	• Collect seeds • Sort, desiccate, label, & store seeds
Library	• Books • Information • Stories	• Traditional ecological knowledge (TEK) etc. • Books/ learning materials • Scientific, cultural information • Stories	• none
Geodesic Dome	• Electricity • Humans • Backup food reserves	• Human shelter • Sacred, communal space • Flex-space	• none (Note: if damaged, apply self-healing bioceramic material to dome to repair)

Figure 8 Inputs and Outputs (*see description on next page*)

*Ripple is a waste free zone, and acknowledges all resources are sacred. All water and energy are generated on-site and all wastes are regenerated on site for re-use. Minimal exterior inputs are used for any one system. The beneficial outputs from the permaculture gardens, restoration ecotone, seed bank, library, and geodesic dome permeate throughout all of Fly Ranch. (*Note: outputs for the water system were calculated using precipitation values from Fly Ranch Meteorological data from 2015 – 2018, when 2015 was considered a "dry" year.)*

D I M E N S I O N S

Ripple spans 35 meters in diameter with an area of just under 1,000 m^2 (one-quarter acre). The permaculture gardens and restoration ecotone each have equal plot sizes of 280 m^2 (3,000 ft^2). Additional waves are added as desired.

M A T E R I A L S

The materials can be interchanged or expanded upon depending on the exact nature of the installation. For the iteration of Ripple portrayed in this concept, see Appendix **Figure 13** for a list of the core components for all the technologies and activities.

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CONCEPTUAL COST ESTIMATE

The fullest realization of the conceptual model comes in at just over $80,000 USD after budgeting materials from **Figure 13** in the Appendix. This cost estimate acts a starting point for negotiations and further budgeting.

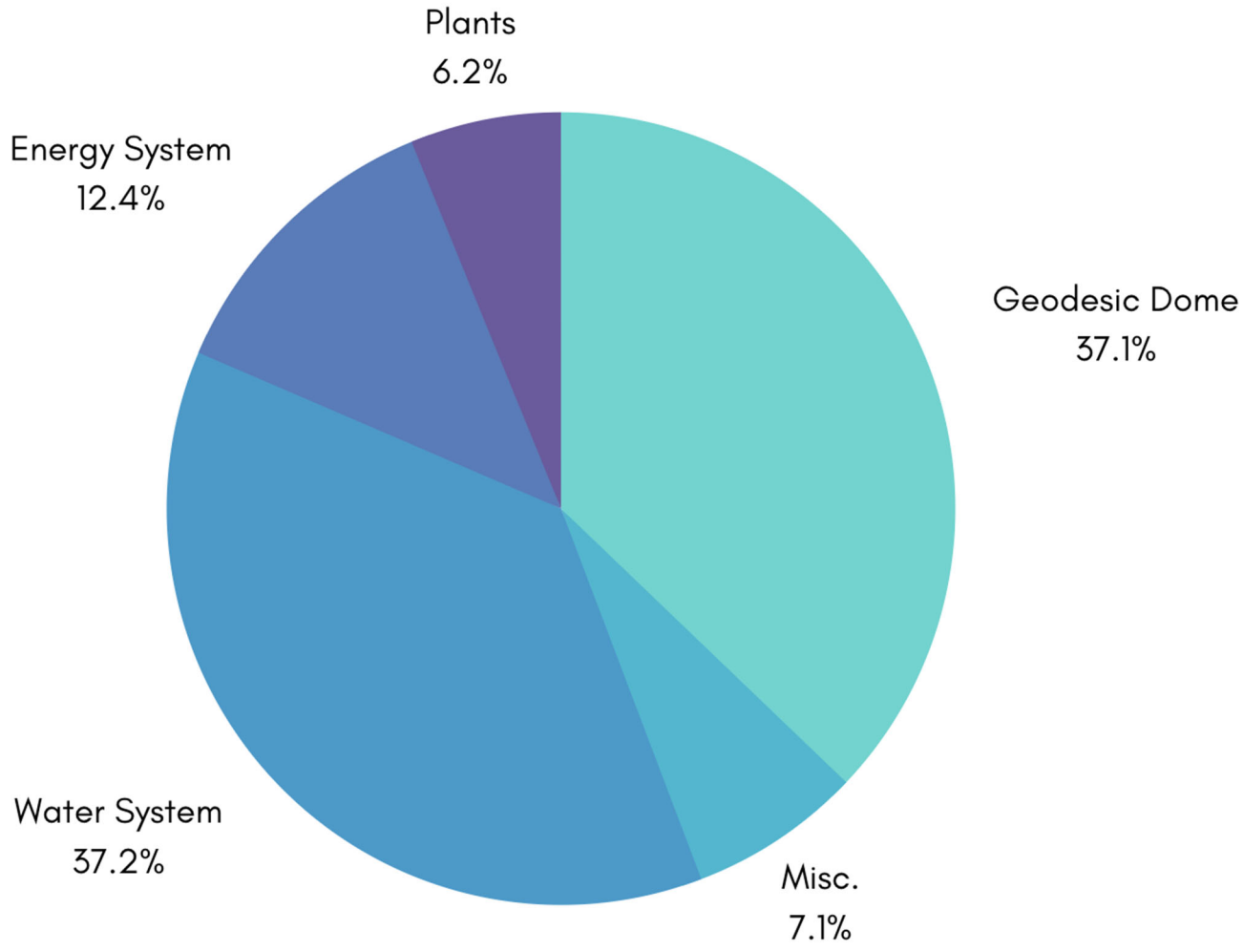

Figure 9 Concept Cost Breakdown

Pie chart outlining the conceptual cost estimates for each aspect of this project. Shipping costs and manual labor costs for installation are not included in these estimates. Though this budget is conceptual, it highlights all of the main costs to make this full vision come to fruition. (Note that the budget for water systems reflects a three-cistern design as shown in **Figure 5**.*)* *For more information on Misc. items, which occupy 7.1% of this budget, see* **Figure 10** *below.*

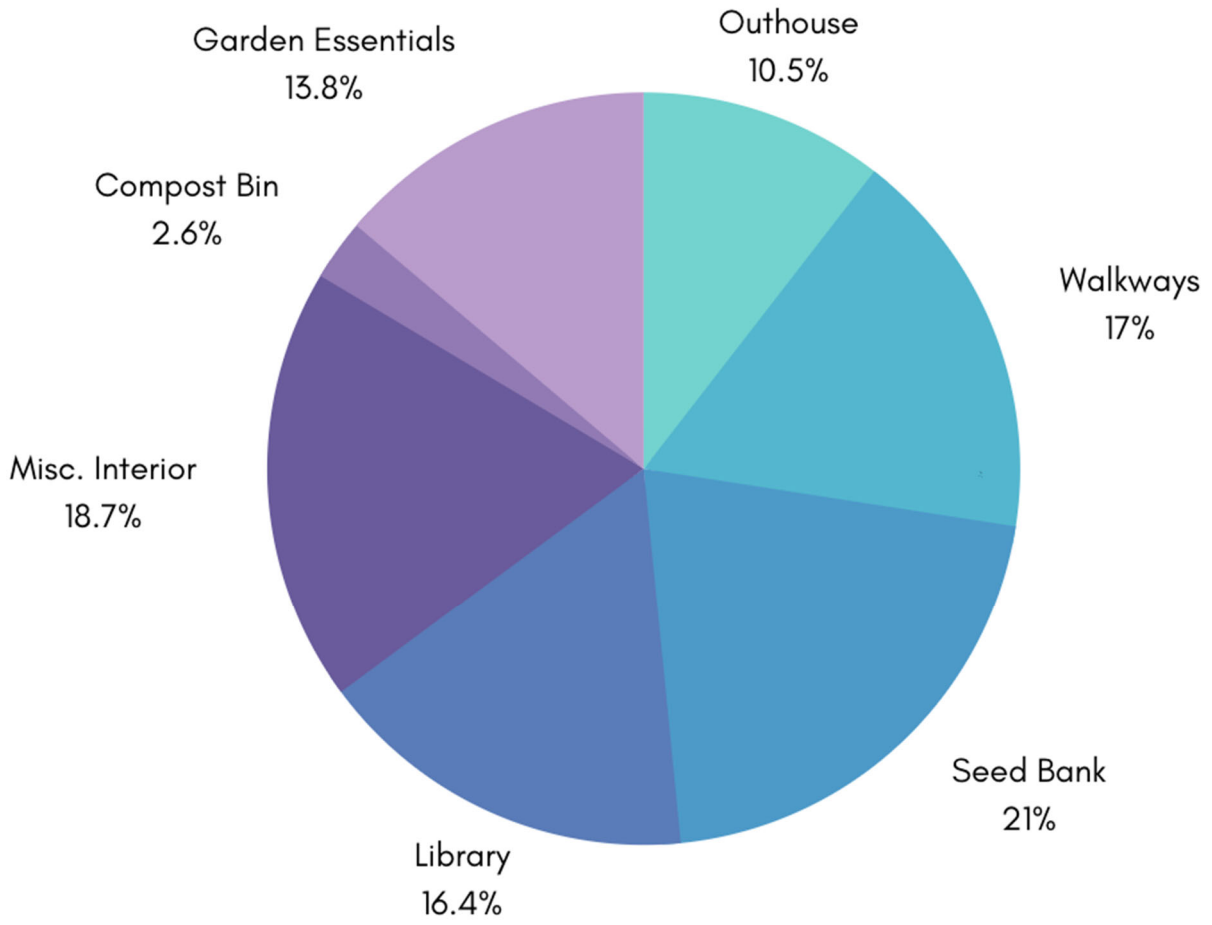

Figure 10 Misc. Items Cost Breakdown

Pie chart outlining the Miscellaneous lower cost items at Ripple (shown in **Figure 9***). These items total 7.1% of the total project, conceptually estimated at $5700. Misc. Interior items as shown on this chart contain items such as the cost of a vanity countertop for the sink and fridge, and other interior furnishings such as lighting and carpeting.*

PROTOTYPE DEVELOPMENT

In the event RIPPLE is chosen for an honorarium grant, a full-scale prototype will be located near the access road at middle Fly Ranch in a Primary Site Boundary area. Ripple will sit on *Haybourne sandy loam* soils (designated as 616 on Fly-Ranch-Soil-Quality map), because this soil is prime farmland when irrigated and has a water table depth over 80".

This prototype will feature the same water system shown in **Figure 5,** but scaled down to a one-cistern design. An inexpensive low-volume solar system will pump water to an outdoor hose spigot for irrigation capabilities. Gardening tools, walkways, an outhouse, and a composting bin will serve as the basis for the continual development of the permanent installation. With additional fundraising, the dome will be erected, the seed bank and library will be constructed, and water and solar technologies will be expanded.

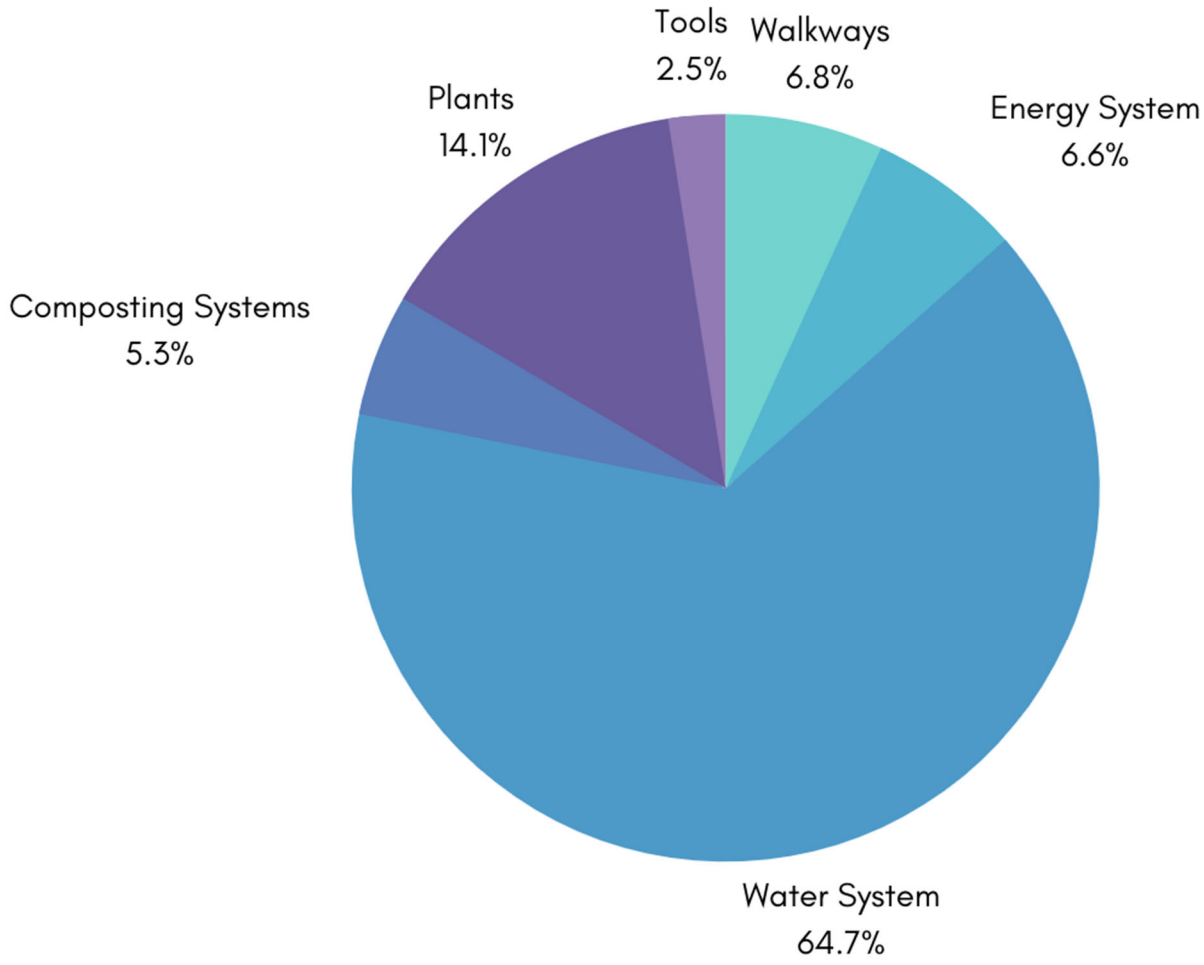

Figure 11 Honorarium Grant Budget

Pie chart outlining how a $15,000 honorarium grant would be divided in the event a prototype is built at Fly Ranch. Fortunately, the low-cost essentials of this project are still incredibly useful.

ENVIRONMENTAL IMPACT SUMMARY

Like all living things, Ripple inevitably impacts the environment in ways that can be deemed 'positive' or 'negative' for life on earth. Ripple's net-impact, however, is overwhelmingly positive for the surrounding ecosystems and the environment as a whole.

First, the negative impacts mostly surmount to ground disturbance, the resources used to transport materials and build the site, and the resources used to keep the site functioning. As for ground disturbance, the site occupies roughly 1000 m^2 (one-quarter acre) of the native desert ecosystem, although, more than 550 square meters of this space grow native plants. The dome and three-cistern water system will disturb 9 m^3 and 89 m^3 of soil, respectively. The maximum excavation depth on-site is 2 meters (6.5') for installation of cisterns.

To transport materials to build the site, vehicles release emissions and use gasoline. One light-footprint input from off-site is a carbonaceous cover-material for the composting toilet such as straw or sawdust, which are common industry by-products that could be sourced locally and sustainably. The largest resource use, however, is in the pumps for the water system and the electronics for the energy system, which quickly pull their weight to save resources on other fronts. As all technologies, they have a shelf-life and are eventually disposed of outside of Fly Ranch. In order to keep these water and energy systems functioning, water pumps need replaced every 15-20 years, battery bank replaced every 10 years, and PV panels replaced after 30-50 years.

The positive impacts include the relatively low embodied energy of the site, the carbon-free shelter, the life-cycle of most materials used on the site, the fact that the site generates no greenhouse emissions nor pollution during its operational life, and most importantly the preservation and regeneration of native ecosystems.

The dome itself is constructed with extremely low embodied energy compared to conventional building materials, which is paralleled by the site itself, as the site's total embodied energy is minute in scale compared to the ecological benefits the plants put forth. With a looming climate crisis, it is important to know the dome is constructed from byproducts from non-toxic waste streams such as salt water desalinization plants and sewage treatment plants, making it a carbon-free shelter. Additionally, all plants that grow as a result of Ripple sequester carbon from the atmosphere and transform it into organic matter. Furthermore, the dome itself is recycled at the end of its 500+ year life cycle to build more domes or other ceramic materials, and this same shelter offers a library and event space that teaches people to be environmental stewards, and houses a seed bank that preserves genetic plant diversity.

Native species are propagated while invasive species are recycled into soil for natives. The limitless restoration potential lies with the humans who tend to the site. From the center of the dome outwards,

native biodiversity and ecosystem-honoring wisdom ripple outward in all directions, leaving a cascade of beneficial effects and a positive mark for life on this planet.

A P P E N D I X

Figure 12 Plant Palette

In respect for the native bands of the Northern Paiute and other Native tribes from the region, such as the Shoshone and Washoe, an initial plant palette has been selected as a basis for Ripple's gardens and restoration ecotone. It is our hope that input from respective native tribes and bands will inform and enhance future plant selection processes. (Note: To see where each plant goes on the site plan, match "Plant Key" column to the plants in **Figure 4**.*)*

PLANT KEY	Scientific Name	Common Name	Type	Past Uses
Ac	Anemopsis californica	Yerba mansa	Perennial herb	Medicine, Food, Disinfectant
AC	Atriplex canescens	Fourwing saltbrush	Shrub	Medicine, Food, Soap, Dye
Af	Allium falcifolium	Scytheleaf onion	Perennial herb	Food
Al	Artemisia ludoviciana	White sagebrush	Herbaceous perennial	Medicine, Smudge stick, Tea, Ceremonial
Bs	Balsamorhiza sagittata	Balsamorrhiza sagittata	Perennial herb	Medicine, Smudge stick, Food
Ca	Castilleja affinis	Indian paintbrush	Perennial herb, Annual herb	Soap
Ca	Cucurbita argyrosperma	Green striped cushaw squash	Annual	Food
Cc	Castilleja chromosa	Northwest indian paintbrush	Perennial herb, Annual herb	Soap
Cl	Cercocarpus ledifolius	Mountain mahognay	Tree	Medicine, Bow crafting material
Cq	Camassia quamash	Common camas	Perennial herb	Medicine, Food
Cv	Chrysothamnus viscidiflorus	Yellow rabbitbush	Shrub	Dye, Candy
Ee	Echinocereus engelmannii	Engelmann's hedgehog cactus	Shrub, Succulent	Food
Ei	Eriogonum inflatum	Desert trumpet	Perennial herb	Food, Pipe
En	Ephedra nevadensis	Nevada jointfir	Shrub	Medicine, Tea
EN	Ericameria nauseosa	Rubber rabbitbush	Shrub	Medicine, Dye, Candy

Gm	Gutierrezia microcephala	Sticky snakeweed	Shrub	Medicine
Jm	Juncus mexicanus	Mexican rush	Rhizomatous perennial grass	Dye, Basket craft material
Kl	Krascheninnikovia lanata	Winterfat	Shrub	Medicine
La	Lupinus argenteus	Silvery lupine	Perennial herb	Medicine, Pollination
Lc	Leymuss cinereus	Great Basin wild rye	Perennial bunchgrass	Medicine, Bedding, Arrow-making
Ld	Lomatium dissectum	Fernleaf biscuitroot	Perennial herb	Medicine, Smoking herb, Tea
Lr	Lewisia rediviva	Bitter root	Perennial herb, Succulent	Medicine, Food
No	Nicotiana obtusifolia	Desert tobacco	Perennial herb	Medicine, Smoking herb, Ceremonial
Ob	Opuntia basilaris	Beavertail cactus	Shrub, Succulent	Food
Pa	Prunus andersonii	Desert peach	Tree, Shrub	Medicine, Food
Pm	Pinus monophylla	Singleleaf pinyon pine	Tree	Medicine, Food
Pp	Psorothamnus polydenius	Nevada indigoshrub	Shrub	Medicine
Ps	Phlox stansburyi	Cold-desert phlox	Perennial herb	Medicine, Pollination
Pv	Phaseolus vulgaris	Rattlesnake pole bean	Annual	Food
Ra	Ribes aureum	Golden currant	Shrub	Medicine, Food
Rw	Rosa woodsii	Woods rose	Shrub	Medicine, Tea, Dye
Sd	Salvia dorrii	Purple sage	Woody Subshrub	Medicine, Smoking herb
Sh	Stipa hymenoides	Indian ricegrass	Grass	Food
Ta	Triticum aestivum	Winter wheat	Winter annual	Food, Cover crop
Zm	Zea mays	Hopi pink corn	Annual	Food

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Figure 13 Materials

Chart outlining the materials needed for the various components of the project. The costs of the items on this chart have been outlined in **Figures 9 and 10**. *Although headings are similar, they are not grouped in the exact manner for display purposes.*

DOME + INTERIOR	WATER	ENERGY	OUTHOUSE/ COMPOSTING BINS	EXTERIOR LANDSCAPE	SEED BANK	GARDEN ESSENTIALS
Geodesic Dome + Foundation	¼ Galvanized Steel Mesh (39 m^2)	48 V Battery Bank	Wood + Hardware:	Native Plants	Native Seeds, (Collected/ Donated)	Shovels/ Hoes etc.
Library Shelving	Grate + Filter Cloth (39 m^2)	8KW Hybrid Solar Generator	(3) Barrels (55 Gallon; .2 m^3 ;)	Crush & Run (16,000kg; 17 Tons) (for walking paths)	Seed Desiccator	(2) Wheel-barrows
Library Books	Gutter for Underdrain (39 m^2)	(6) 250W PV Panels or, (4) 375watt PV Panels	Plywood +Vinyl Paint (for Barrel Tops)	Gravel (6350 kg; 7 Tons) (for underdrains)	Germination Paper	Compostable Seedling Trays
Lighting	(3) Cisterns (19 m^3; 5,000 gallon)	System Cabling	Toilet Seat + Weather-proofing Spray	Sand (3m^3) (for cistern placement)	Mini-Refrigerator	Reusable Pots (Assorted)
Furnishing: Carpet, Pillows etc.	Hose Hydrants + (3) 100’ Hoses (30 m)	PV Panel and Mounts	Vent + Hardware + Bolts + Springs		Bulk 400 Foil Laminate Bags	Hand Trowels
Vanity (for Mini Fridge + Sink)	(3) Remote Water Level Sensors	Wind turbine + Mounts (Optional)	Screen Assembly		Seed Storage Furniture	Buckets (5gal; .012 m^3)
House Plants	(3) Cistern Pumps Kits		Rain Cover + Insect Trap		Heat Sealer for Seed Bags	Germination Kits
	Reverse Osmosis Water Filter		3 Urine Diverters		Temp/RH 2.5% Data Logger -	Soil for Propagation

	Greywater Basin (5gal; .012 m^3)		Compost Aeration Crank + Receptacle		Bulk 500 Seed Envelopes	

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End

Narrative: 1491 words (excluding figures, captions)

Environmental Impact Statement: 498 words