***Coastal Reservoir***

Gathering Water, Energy, and Biodiversity

*Coastal Reservoir* stands as a new paradigm for creating power and water at the coast: the *atmosphere* of southern California is bound together with its *landscapes* in a resource-harvesting cycle--an integrated energy ecology. Great pillars of steel and mesh once again punctuate the horizon--recalling the rigs and derricks of an oil-hungry past--but now as symbols of a clean, sustainable energy and water generation. Though driven by wind and waves, this is not a kinetic sculpture. Though modular and floating, the assembled structure is stable and durable. Coastal Reservoir leverages the subtle but continuous shifts in the environment. From the undulating water levels, the shifting daily and seasonal weather patterns, the invisible migrations of seeds.

*Sculpture: Solid & Void*

The total dynamism of an environment is carried in its atmosphere--its temperature, its pressure, its humidity, its chemistry. In *Coastal Reservoir*, we imagine carving into this volume of air to reveal these properties. With a geometric slices, we cleave the volume into a *solid,* contained in the red A-shaped steel pillars;and a *void,* framed and filled by the V-shaped mesh funnels.

*Coastal Reservoir* sits beyond the breakwater, parallel to the beach. It is a structure that dominates its section of the horizon, but its appearance is constantly changing. Heavy steel, ghostly mesh, and framed void are in continuous play. In summer mornings, it appears as a slender radiant band; in winter months, the morning sun breaks the form into three distinct volumes. At mid-day, the mesh enclosures glow green from the interior vegetation. As the sun sets, the back-lit pillars emerge and the meshes dissolve in shadow. When fog rolls in, the entire structure is obscured, its fuzzy corners merging with the atmosphere. At night, lacey shadows of the up-lighted interior vegetation play across and through the mesh scrims.

Three plate-steel Pillars, nine steel-mesh Funnels, and one Forest form a single island unit. For the Santa Monica site, we propose a collection of 15 island units. The structure is simple, and employs construction techniques common to barge and rig-building. Each island measures 40 meters square in plan, and stands 55 meters above the water’s surface. The units are tethered side-to-side, into a zig-zag formation and the total assembly fill an imaginary box roughly 460m by 120m.

*Coastal Reservoir* is a scalable, flexible proposal. The proposed formation amplifies wave energy into the pillars, and the scale of the arrangement is balanced by the adjacent pier. However, the sculpture would still function if built as a single unit or in small formations. As the islands are mobile reservoirs of water and energy, we also imagine the city of Santa Monica could “donate” islands to nearby communities in times of need. An annual spectacle might see some of the island units ‘dock’ at other locations throughout Los Angeles, where they would function as devices to educate the greater public about the ecology and clean energy.

Actions: Displace, Filter, Seed

*Coastal Reservoir* generatespower, water and nature by manipulating the natural properties of the surrounding atmosphere. Quite literally, it gathers its resources out of thin air. Atmosphere has a local pressure: the steel pillars trap a volume of air that is cyclically pressurized and displaced by the surrounding wave action to drive a bi-directional fan turbine. Atmospheres hold water as vapor and condensate: the mesh funnels filter atmospheric fog to precipitate fresh water onto the platform below. Atmospheres move: the Forest block at the center of each island will be established but unmanaged--as any new island, open to colonization by seeds carried on wind and wing.

The Landscape Core

Giles Clement, a landscape architect, theorized the importance of inaccessible and unmanaged landscapes, described by him as *Third Landscapes*. These fragments of territory exist outside of the cultivated, designed, and exploited landscapes that dominate cities and urban regions. Clement argues that *Third Landscape*s are essential, but unrecognized, repositories of biodiversity, “the genetic reservoirs of the planet”.

At full build-out, *Coastal Reservoir*, consists of 15 linked island units with nearly 5 acres of fog-fed, spontaneous forest--a platform for preserving and expanding the genetic stock of the larger territory. Each of the Forest blocks is central to the water harvesting and energy generation cycle on the device, acting as a filter to clean particulates and salts that have accumulated on the collection mesh. During and just after a fog event, water rains from the mesh directly over the plants and into the soil below. Thick vegetation, root-fixed soils, sand and artificial bedrock will filter excess water before it is finally transferred for storage to the ballast tanks at the base of each island unit. The mass of vegetation, soil, and stored water also acts as a dampening mechanism, stabilizing the Pillars to maximize the internal air compression. Finally, the landscape component of *Coastal Reservoir* is an educational and engagement tool. The unmanaged ecology a tool for understanding biodiversity, restoration practices, and associated concepts of island biogeography.

Towards an Ecology of Energy and Water:

Fog is an important dimension in coastal California’s native ecosystems. Fog supports the once-grand Redwood stands and their ferny understories in Northern and Central California. In the much drier climate of Southern California, fog is the cornerstone in stabilizing unique coastal oak and pine woodland ecosystems. With over-grazing and urbanization, many of these habitats have disappeared. Without a tree canopy, water cannot be collected from the fog; without water, trees cannot grow. Scientists are now experimenting with artificial methods to capture fog and establish oak and pine forests on the nearby Channel Islands. *Coastal Reservoir* is not intended to provide a native habitat, but it is expected to provide optimal habitat. The vegetation and animals thriving within this machine begins from the concept of the Third Landscape, a genetic reservoir, but evolves into a New Nature, an environmental sublime.

**Power Capacity: 2 MW**

Oscillating Water Column (OWC) energy generation technology was first developed in the 1940’s, and today are one of the simplest methods for extracting power from wave energy. The technology consists of two parts: a collector chamber (here, the red Pillars) and a power take off system (here, a self-rectifying fan turbine). *Coastal Reservoir’s* design is based partly on a floating 110kW, 3-chamber OWC demonstration in Gokashoa Bay, a water body with similar wave characteristics as the Santa Monica site (1m average wave height, 6-7s period). Given this precedent, and accounting for a 10% increase in turbine efficiency, and a 10% increase in wave power based on optimal layout, we have calculated, a similar power output potential of 44kW per chamber, 132kW per unit, or 2 MW across the full assembly. Large-scale, low-cost battery technologies are rapidly advancing, and it is expected that some of the generated energy could be stored in *on-board* cells. Each island is also equipped with an articulated boom to and attachment mechanism to deliver electricity (and water) directly into the grid.

**Water Collection: 4 million gallons**

Clean water is a mightier problem in California than clean energy. *Coastal Reservoir* piggybacks water collection onto the OWC column and ballast structure. Fog harvesting is an established practice in off-grid areas and offers great potential in the foggy coastal climate of Santa Monica. Each of island unit contains 9 collection funnels constructed of corrosion-resistant ½” industrial wire mesh on a steel-tube frame. Given any wind direction, the structures have a minimum facing area of 1300m2. Collection efficiency is achieved by arranging multiple layers of mesh in sequence, creating a *volume* of collection. Fog harvesting yields vary greatly, but conservative estimates in similar climates suggest 10L/day/m2, or a raw potential of 13,000L per island per day. Accounting for some loss to wind-shedding (10%) and of water absorbed and transpired by soil and plants (30%), we calculate a potential collection of 8,200 L/day on each of the islands, or 123,000 L across the cluster. With more than 100 days of fog on the Santa Monica shoreline each year, the annual fog collection would amount to 12.3 mega-liters (3.25 million gallons). Rain is also collected, filtered and stored. Given 1200m2 of horizontal surface area, 30 cm of annual precipitation, and similar soil/vegetation absorption/transpiration rates, each island would collect 180m3 of water, or 2.7 megaliters (710,000 gallons). The water storage capacity for Coastal Reservoir is over 8 million gallons.

**Environmental Impact Statement:**

*Coastal Reservoir* utilizes a trapped volume of air displaced by wave action, to drive a fan-turbine. Other than the turbine, which is housed in the steel chimney, the system has few moving parts, and none are located in the water. This is ideal for maintenance and long-term durability, but also creates very low impact on wildlife. The structure floats and is moored so to minimize impacts on the seafloor ecologies. No structure is built into the ground or into the shoreline. Shadows cast by the structures are not expected to cause negative impact, as there is no known coral or extensive permanent plant communities around the rock wave-break. The Coastal Reservoir does not generate significant noise. The turbine housing is sheathed in the steel pillar and not externally exposed.

Energy production is continuous with at least minor ocean surface movement (it can generate electricity even with as little as .3 meter (1 foot) waves). Minor energy costs include on-board sensor and computer systems (which collect data to maximize fan systems) and occasional night lighting. The island units cannot move under their own power and must use a tug, so additional energy costs would be carried when the island is positioned after construction, or if it is relocated.

The landscape core of the project is intended to create functional plant and animal habitat. This project could be seen as part of an ongoing effort to stabilize and regenerate rare and threatened ecologies in the region. The landscape is intended to be entirely self-sustaining, both in terms of water and in terms of species management. Whatever arrives may grow—which is important to establishing a balanced, biologically diverse community, quite apart from the sorts of growth allowed in green public spaces of the city.