

■ **THESIS PROJECT**

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Arq. Beatriz Coronel



Luciana Antenucci



Agustina Saavedra

CEPARIO

AN ARCHITECTURAL HUB FOR AGRICULTURAL SOIL
BIOREMEDIATION

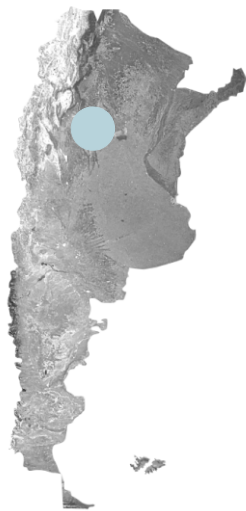


■ THE CATALYST

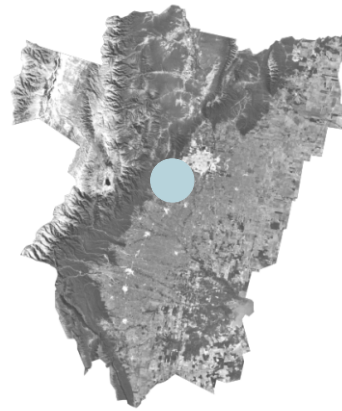
The catalyst for this project stems from a deep-rooted connection to our land. For those of us who live here, the surrounding mountains are not just a backdrop to be observed; they serve as our sanctuary—a place for peace and refuge. Yet, this very proximity has made us witnesses to their environmental scars, and seeing them degraded deeply affects us.

Driven by this realization, our primary motivation was to design an architecture that refuses to remain indifferent. This project proposes an active infrastructure of real, tangible impact—one born out of a shared sense of responsibility, designed to transform ecological wounds into architectural solutions.

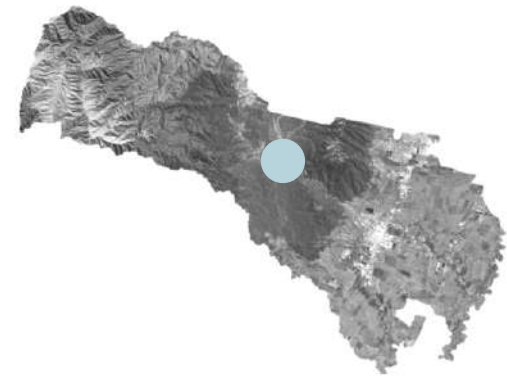




Argentina



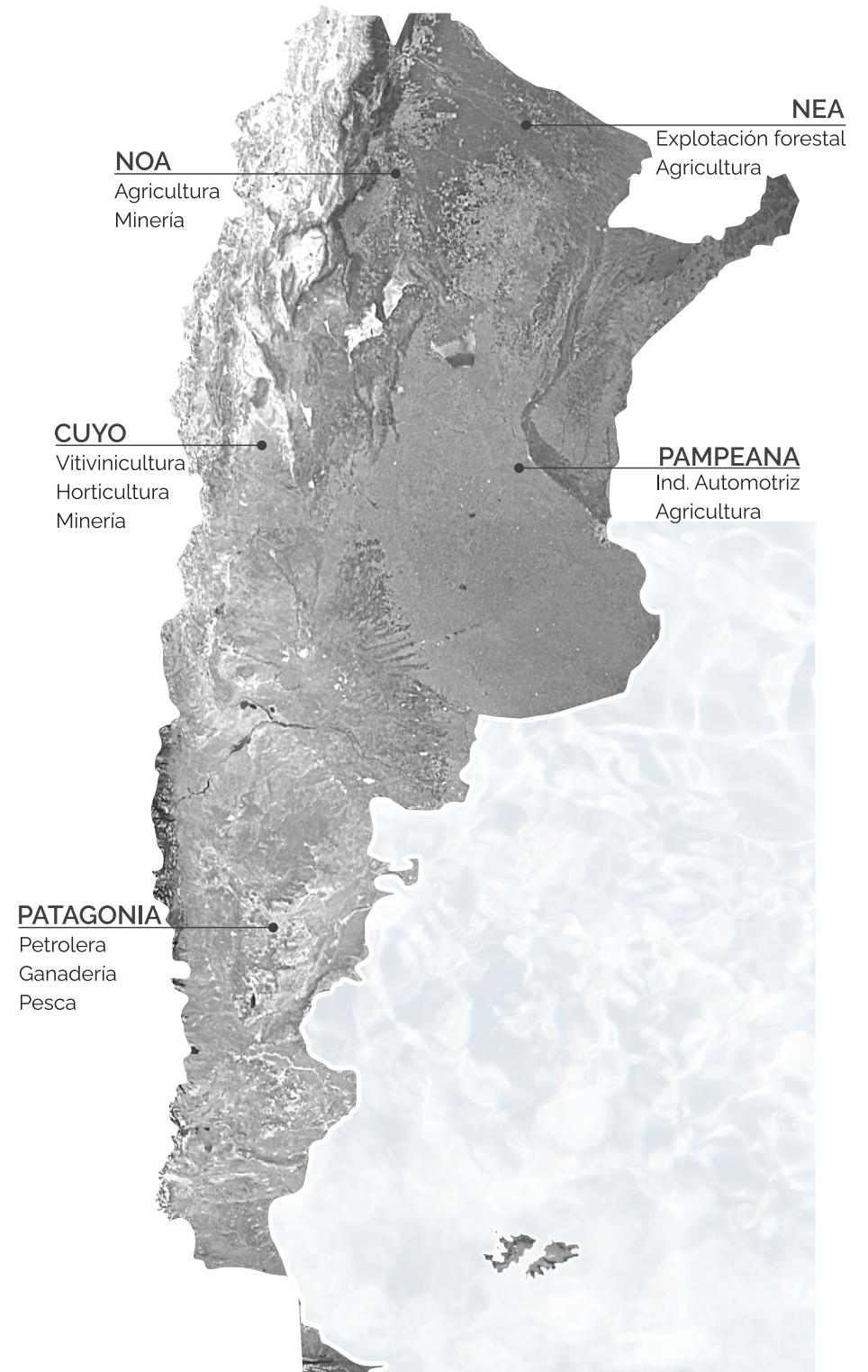
Tucumán



Lules

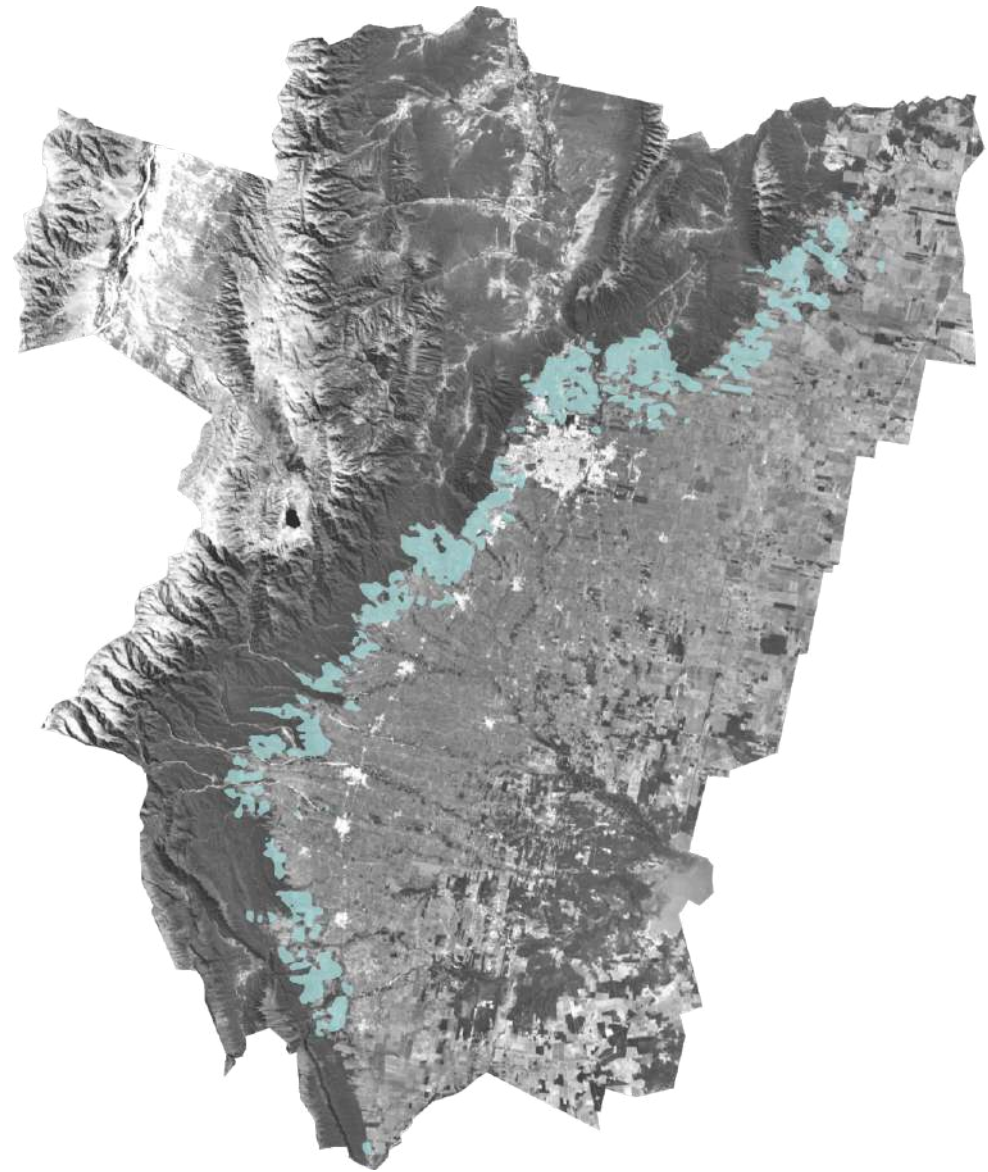
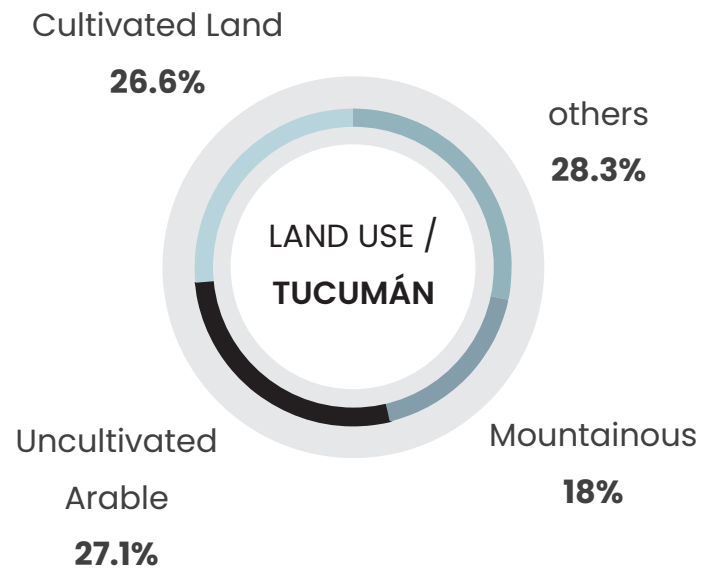
■ THE SOIL IN ARGENTINA

An analysis of predominant regional activities reveals that a major share of the national economy relies heavily on land interventions. Whether through extractive or productive practices, these activities trigger the progressive degradation of our terrestrial ecosystems.



■ THE SOIL IN TUCUMAN

In Tucumán, agricultural expansion into the mountain foothills creates a forced synergy between two incompatible dynamics: intensive land exploitation and the preservation of the lower *Yungas* (subtropical mountain forests).



■ SUELO CULTIVADO

■ TERRITORIAL CRISIS: SOIL DEGRADATION & ENVIRONMENTAL IMPACT

Intensive agricultural land use has triggered a severe ecological crisis.

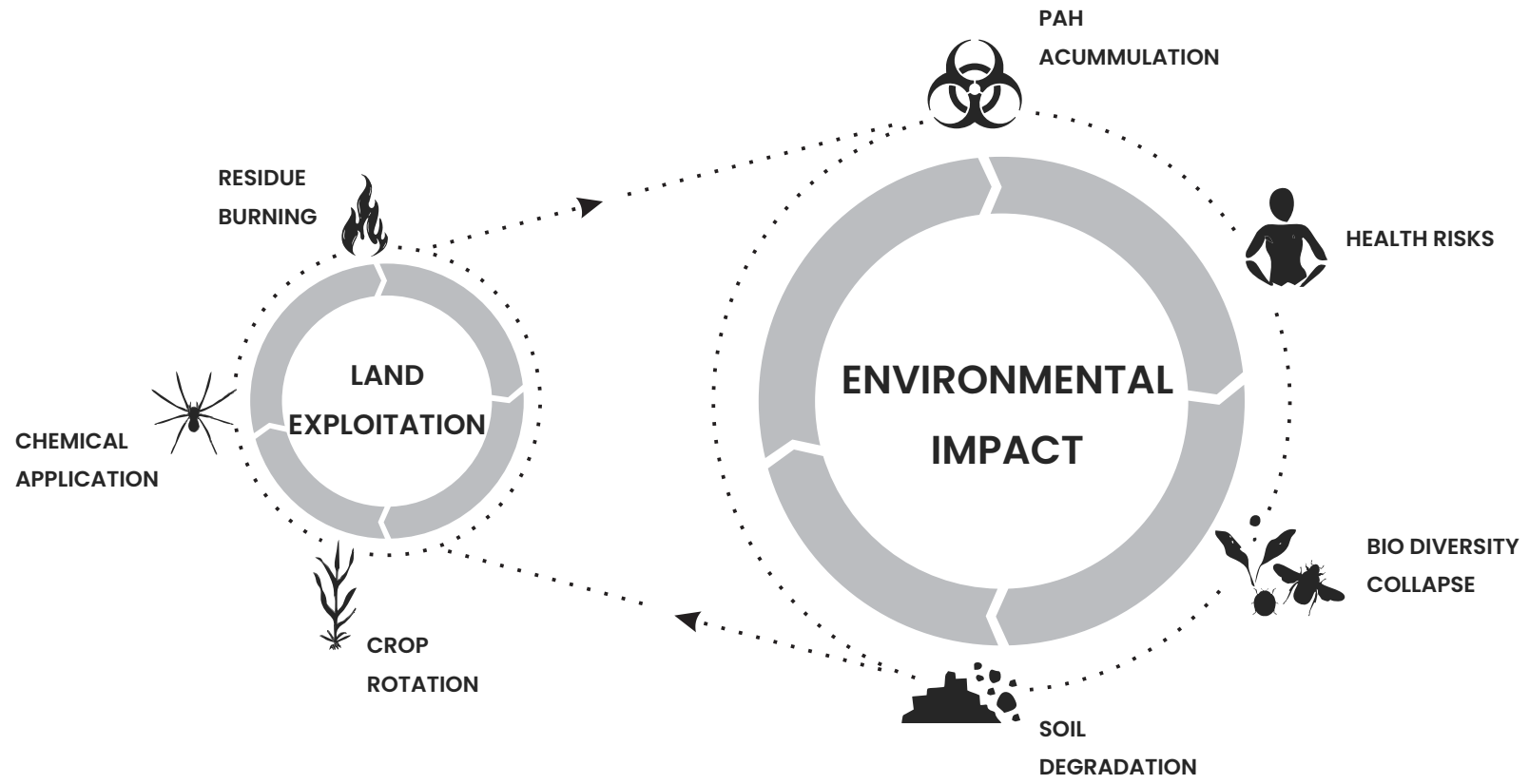
DIRECT CONSEQUENCES

-PAH Accumulation: Crop burning releases Polycyclic Aromatic Hydrocarbons (PAHs), highly toxic organic pollutants that accumulate in the environment due to incomplete combustion.

-Public Health Risks: Toxic bioaccumulation poses severe health threats to both agricultural workers and nearby urban populations.

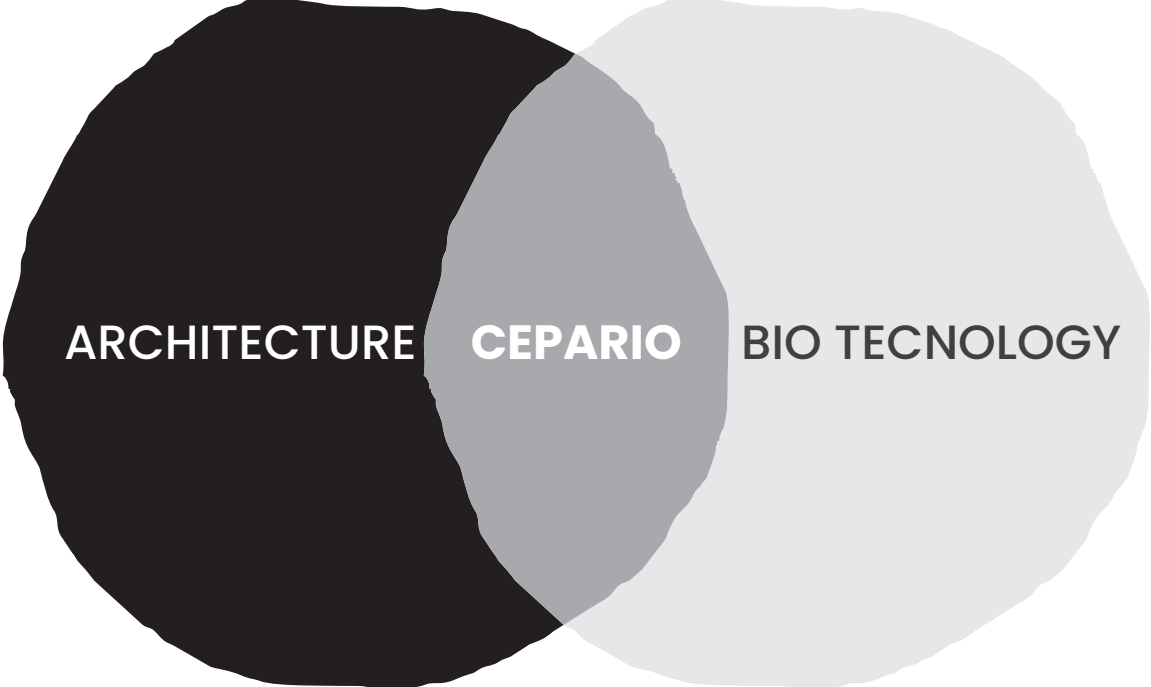
-Biodiversity Collapse: The ongoing chemical and thermal stress leads to a massive loss of local flora and fauna species.

-Soil Degradation: Ultimately, the soil loses its structure, vital nutrients, and water-retention capacity, resulting in complete sterility.



An aerial photograph of a river winding through a dense, green forest. In the upper middle part of the image, a large, light-colored, rectangular structure, possibly a dam or a large building, is visible. The river flows from the top right towards the bottom left. The lighting is soft, suggesting a hazy or overcast day.

IS IT POSSIBLE TO DESIGN ARCHITECTURE CAPABLE OF HEALING
THE VERY EARTH IT RESTS UPON?

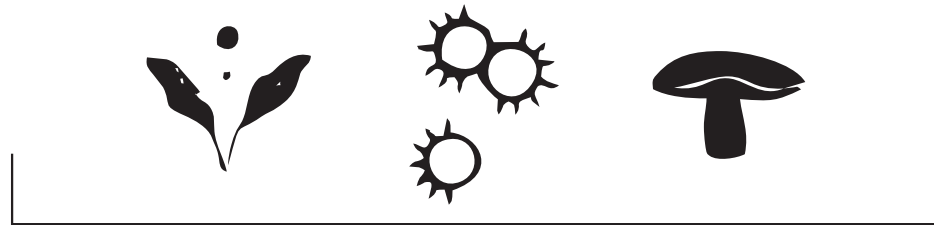


■ THE RESPONSE

Seeking answers forced us to rethink the role of the architect in the face of today's environmental crises.

We understood that our profession can no longer operate in isolation. Architecture must blend with other disciplines to become an active tool for the ecosystem.

Here, architecture merges with Biotechnology, enabling ecological remediation through tangible strategies like bioremediation.



■ THE STRATEGY: SOIL BIOREMEDIATION

A biological treatment that utilizes living organisms to degrade or transform hazardous contaminants.

This process can be deployed through three distinct methods:

Phytoremediation: Utilizing plants.

Bioaugmentation: Utilizing microorganisms.

Mycoremediation: Utilizing *fungi*—the core strategy integrated into our project.



■ MYCOREMEDIATION & THE POWER OF MYCELIUM

Mycoremediation utilizes fungi to degrade or remove hazardous toxins. Due to their resilient nature, selected fungal mycelia tolerate high chemical concentrations and break down complex pollutants—such as PAHs—that are otherwise resistant to standard microbiological systems.

■ CEPARIO: PROGRAM & VISION

A **specialized** facility dedicated to the collection, preservation, research, and reproduction of microorganism strains. In this project, the Cepario operates as a highly specialized **hub** focused exclusively on mycoremediating fungi.

■ BIOREMEDIATION PROCESS: STAGES

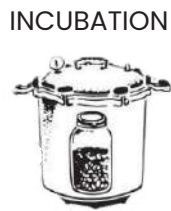
1. FUNGAL
CULTIVATION



SPORE



PETRI DISH



INCUBATION



INOCULUM

cultivated through
a growth medium

2. CONTAMINATED SOIL
PREPARATION



agricultural
soil sample
+
contaminant

3. SOIL INOCULATION WITH
MYCELIUM



the inoculum is
manually added to
the contaminated
soil

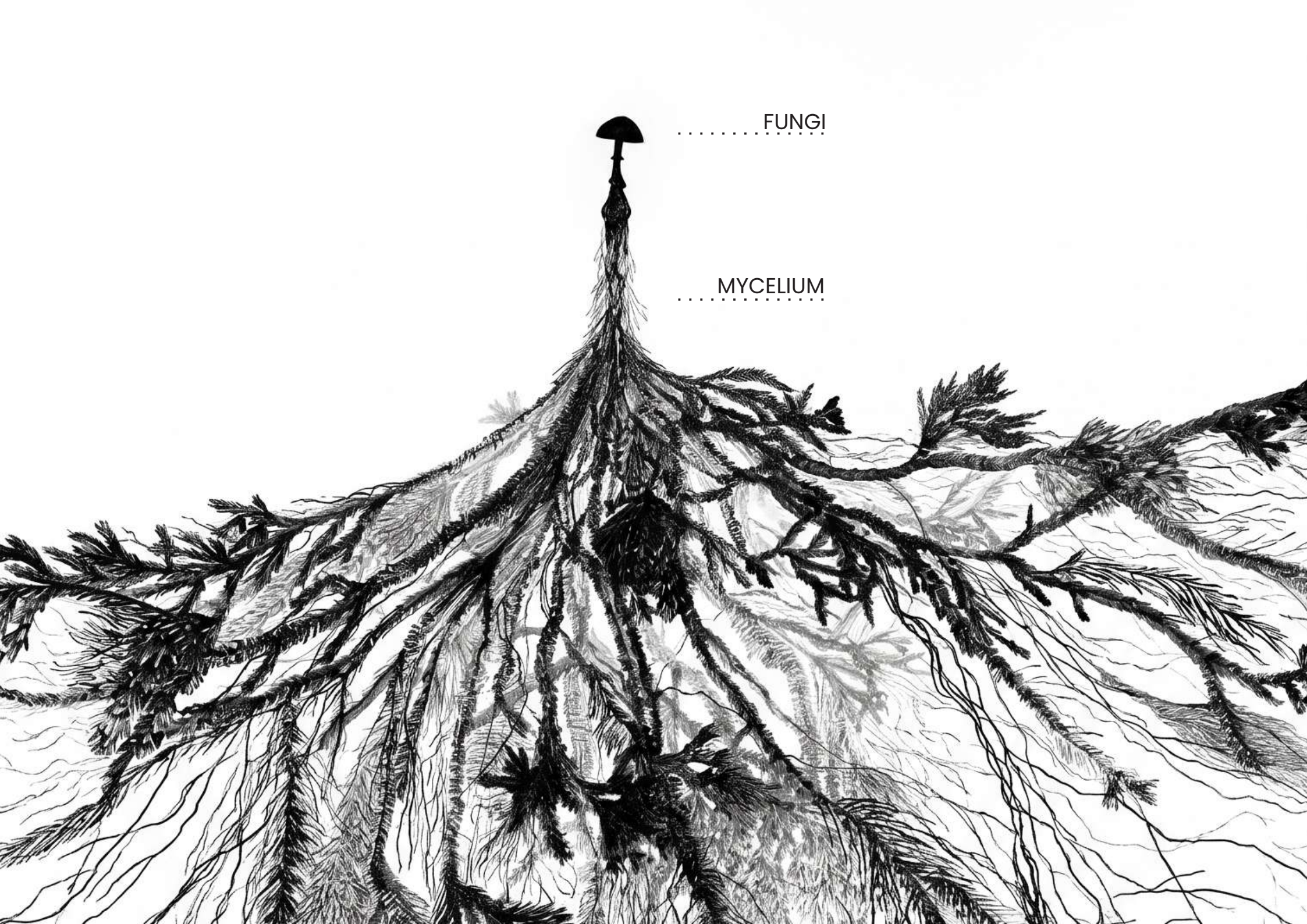


the mycelium expands
through the soil, coming into
direct contact with PAHs

secretes enzymes that
oxidize the contaminant



**PAH
DEGRADATION**



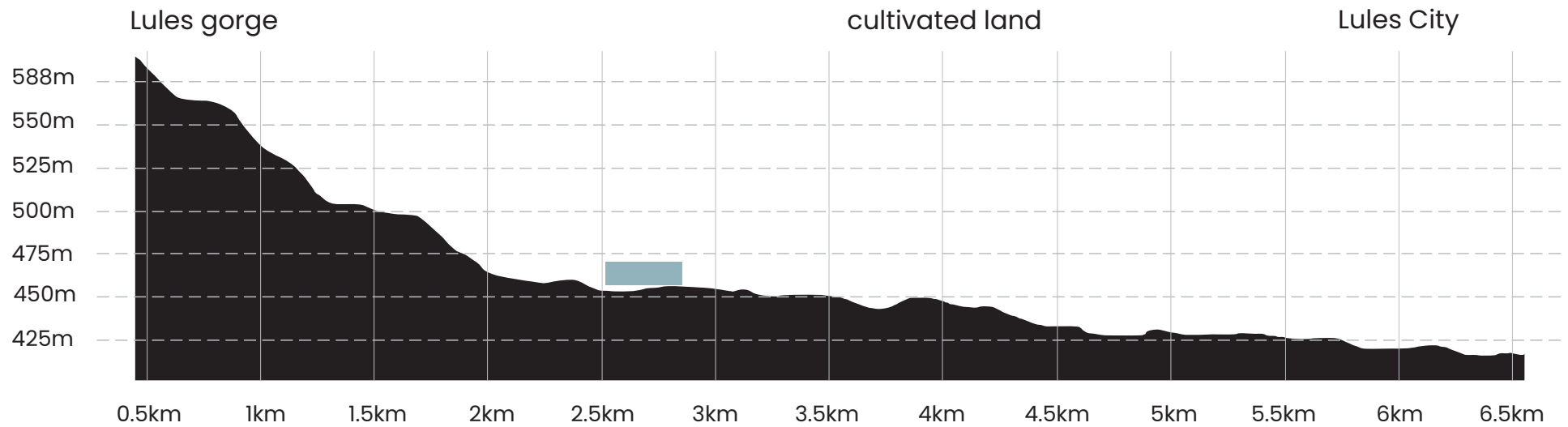
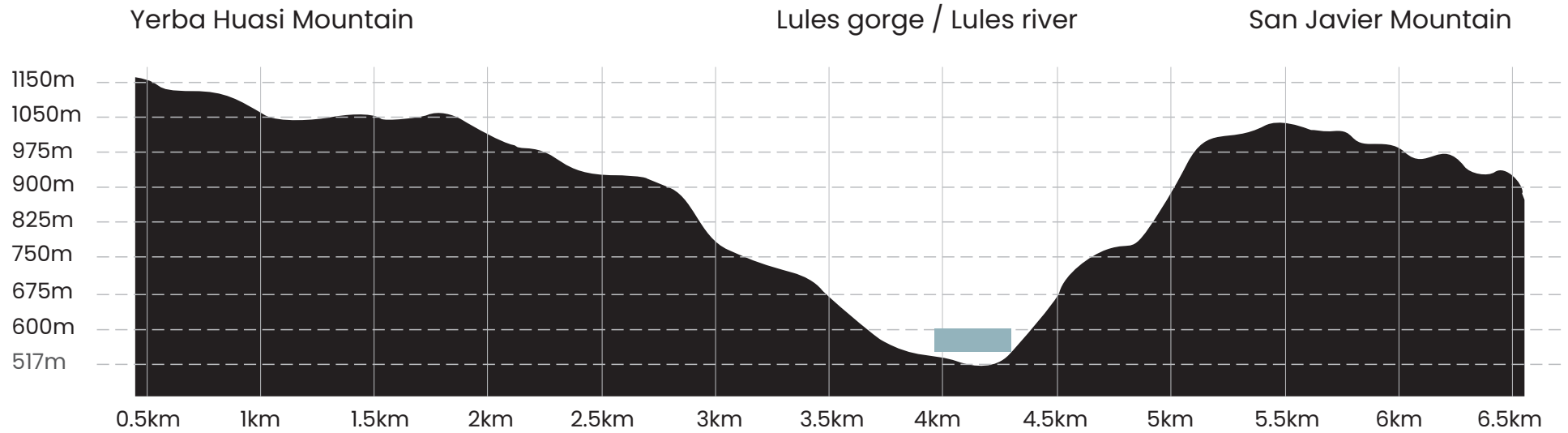
FUNGI

MYCELIUM



The facility is located in Lules, precisely one kilometer inside the gorge, masterfully framed by the *Yerba Huasi* mountain and the *San Javier* mountain range.

■ TOPOGRAPHIC PROFILES & TERRITORIAL CONTEXT





CEPARIO

San Pablo

321

301

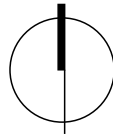
riverside forest

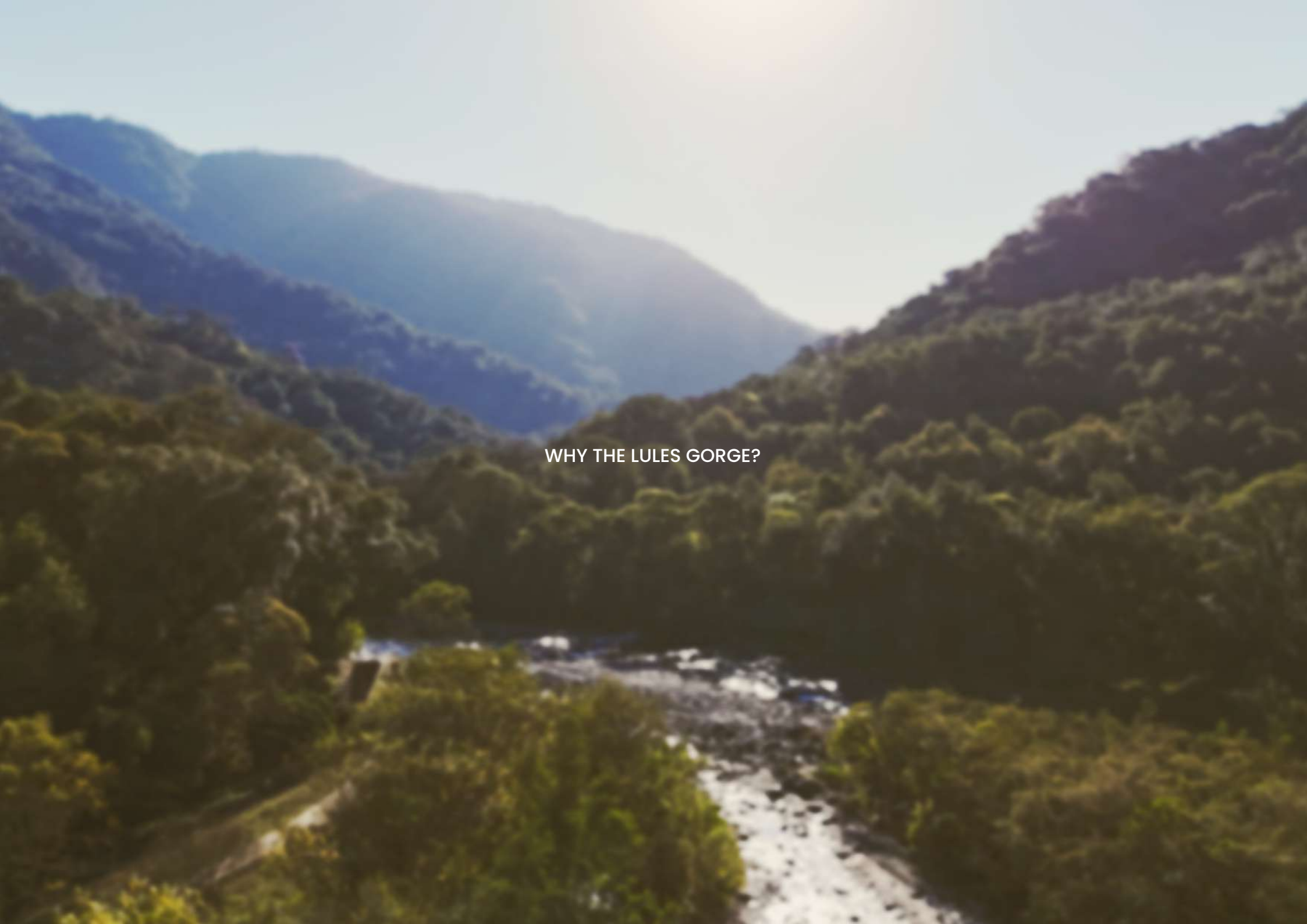
Lules city

321

301

riverside forest

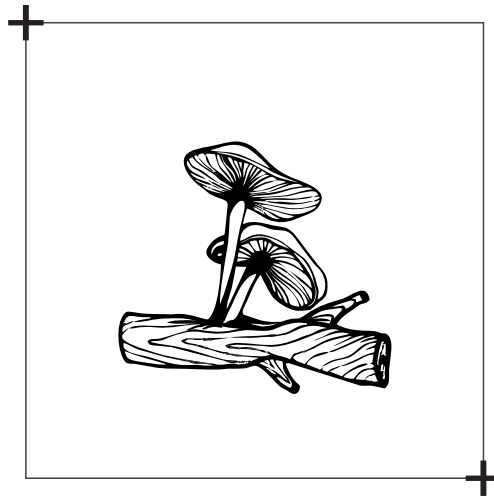


A scenic landscape photograph showing a river flowing through a deep, forested gorge. The river is surrounded by dense green trees and vegetation. In the background, there are rolling hills and mountains under a clear sky. The text "WHY THE LULES GORGE?" is overlaid in the center of the image.

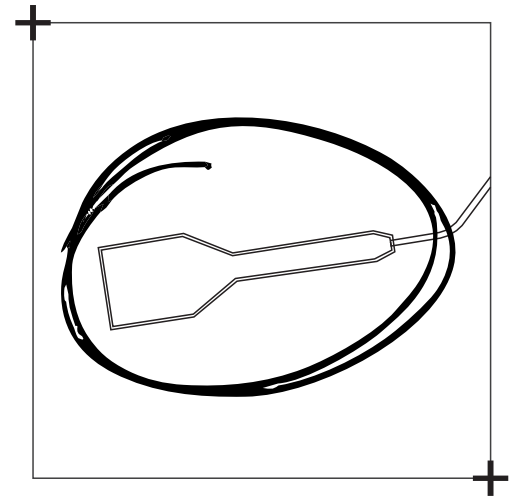
WHY THE LULES GORGE?



**STRATEGIC
LOCATION**



**BIOCLIMATIC
CONDITIONS**



**INFRASTRUCTURAL
INTEGRATION**



STRATEGIC LOCATION

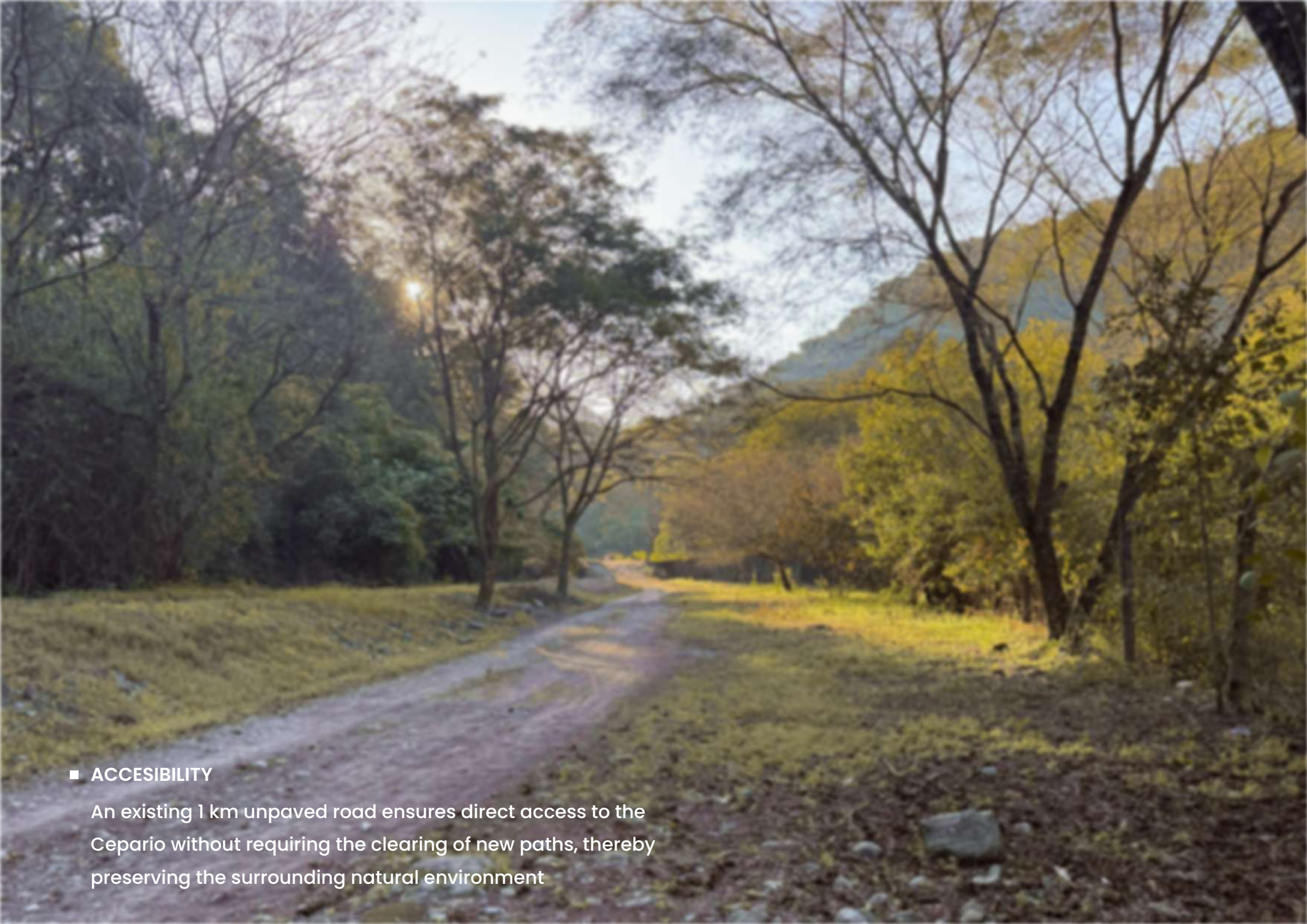
Proximity to intensive agricultural zones, optimizing both the sampling of degraded soils and the deployment of in-situ bioremediation solutions.

BIOCLIMATIC CONDITIONS

A unique microclimate that naturally favors the collection, monitoring, and propagation of diverse fungal species.

INFRASTRUCTURAL INTEGRATION

A direct connection to the existing irrigation reservoir, transforming the site into a support center for the local agricultural sector.



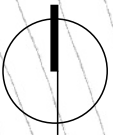
■ **ACCESSIBILITY**

An existing 1 km unpaved road ensures direct access to the Cepario without requiring the clearing of new paths, thereby preserving the surrounding natural environment

■ **WATER INFRASTRUCTURE: IRRIGATION RESERVOIR**

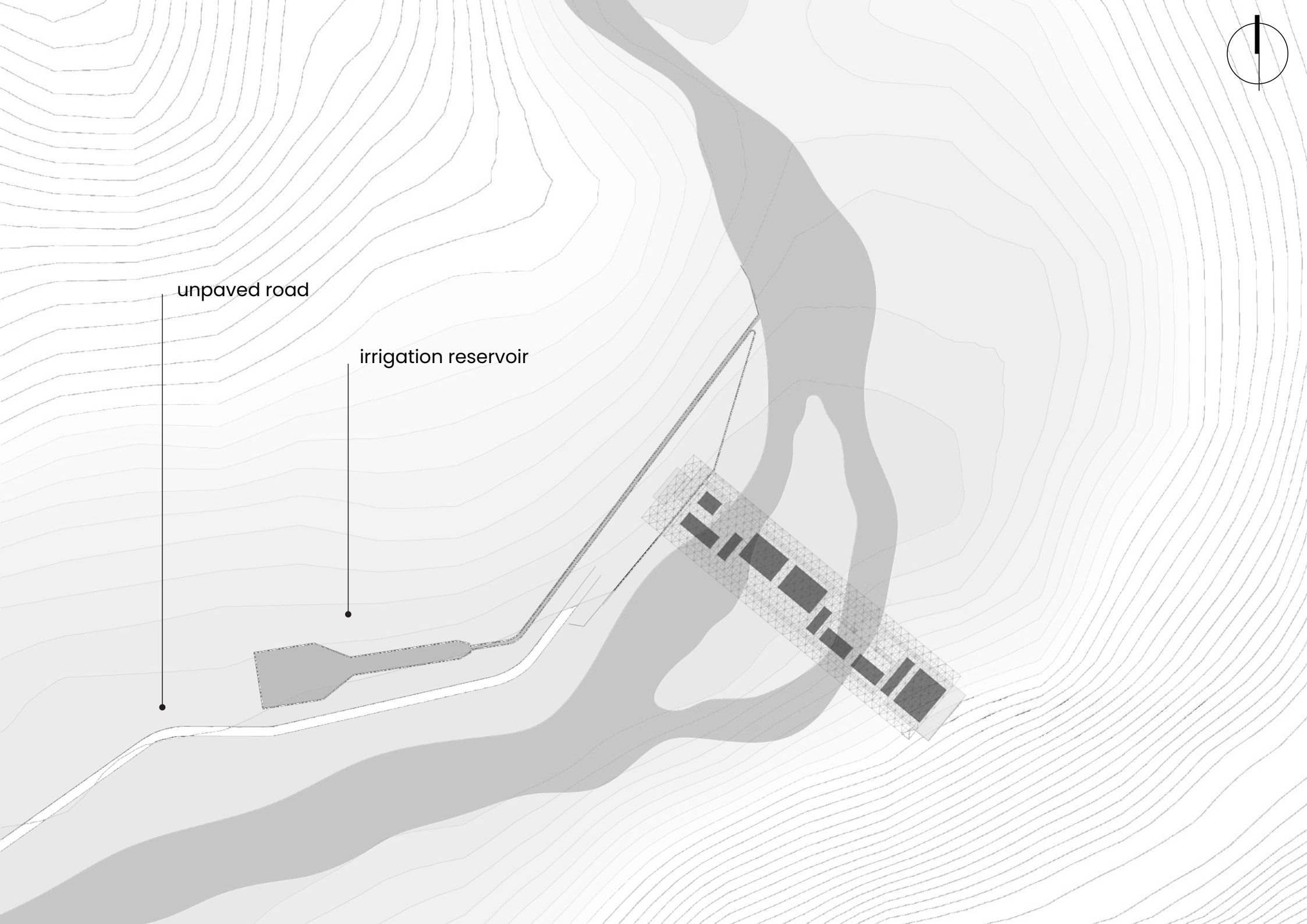
A state-built water infrastructure that drives a gravity-fed, pressurized irrigation network, efficiently supplying the surrounding agricultural fields.





unpaved road

irrigation reservoir





Looking through the gorge towards the city, this image summarizes our intervention. The project functions as a **lightweight**, permeable **bridge** that touches the ground at only two points, leaving the natural ecosystem completely intact. The river and vegetation continue their course underneath a building that hovers over the landscape without altering it.

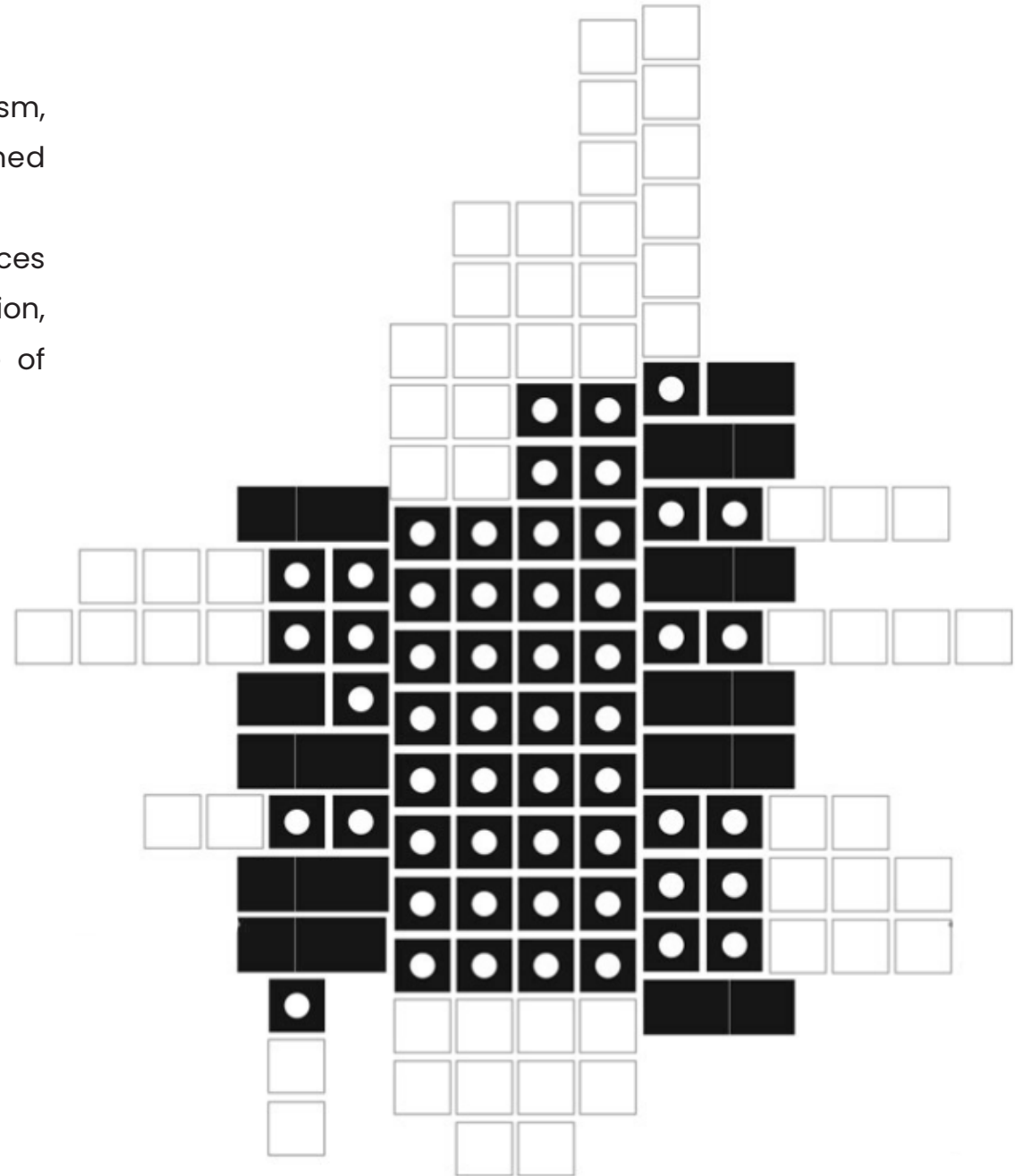
■ THE STRUCTURAL SYSTEM

When designing the project's structure, our goal was to develop a **system** capable of **adapting** to diverse scenarios. We envisioned a flexible architecture that allows the *Cepario* to be replicated in the future, seamlessly adjusting to different terrains, shifting requirements, and diverse user needs.

■ THEORETICAL FOUNDATION: JAPANESE METABOLISM

Our structural system is anchored in Japanese Metabolism, the prominent 20th-century movement that envisioned architecture and cities as living, ever-changing entities.

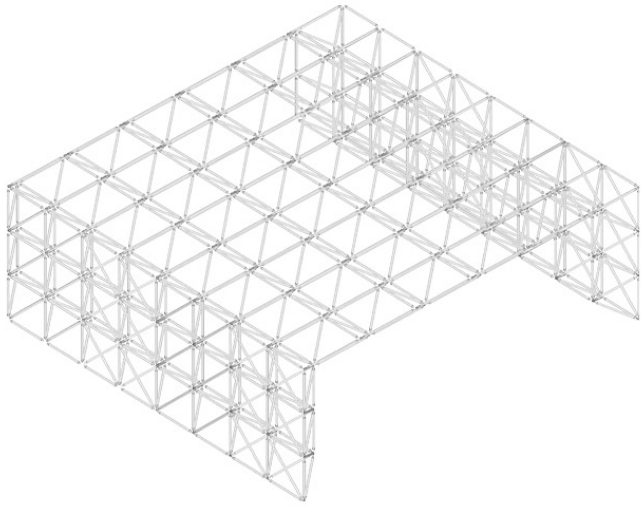
By mirroring organic energy processes, the design embraces cycles of change, constant destruction, and regeneration, conceiving the building as a living organism capable of evolving over time.





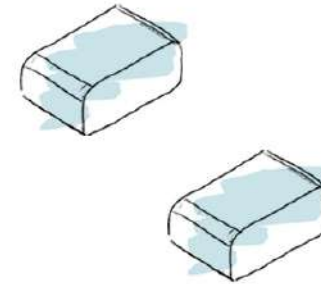
STRUCTURE + CAPSULE

■ THE SYSTEM



THE STRUCTURE

A permanent, high-stability framework designed for modular flexibility. It acts as the primary grid where prefabrication allows the units to be "plugged in", dismantled, and repositioned as needed over time.



THE CAPSULES

The interchangeable, cell-like habitable components. They offer endless geometric configurations, to meet specific user needs. Because each unit is completely independent, they can be replaced or updated without affecting adjacent structures.

"The structural element is conceived as a tree—a **permanent element**—with the housing units as leaves-**temporary elements** - that fall and sprout again according to the needs of the moment. Within this framework, buildings can grow, disappear, and grow again, but the structure remains."

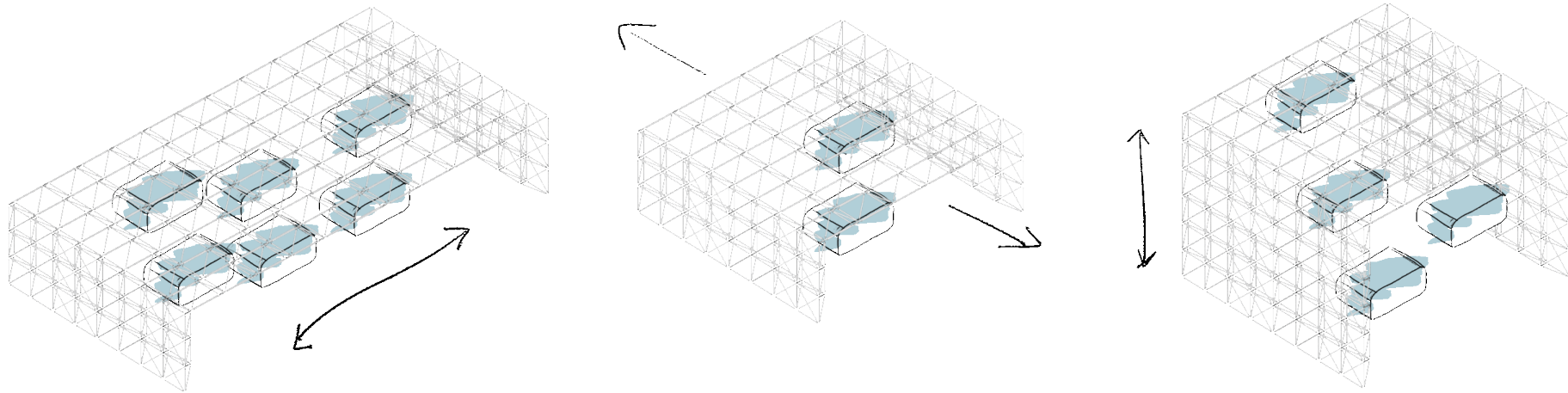
KENZO TANGE

"Two distinct parts, yet necessary to one another. The whole is formed by parts—**the capsules**—and all parts are necessary to understand the whole—**the structure**; neither could be bypassed. The whole mutates every time a part is changed, reconfiguring themselves in a state of constant transformation."

KISHO KUROKAWA

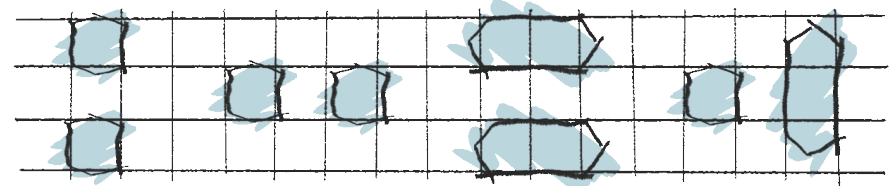
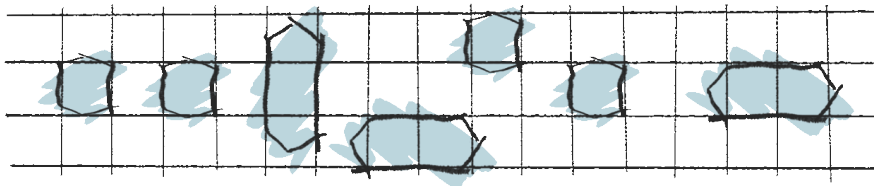
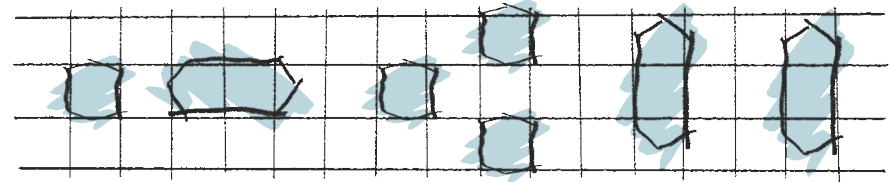
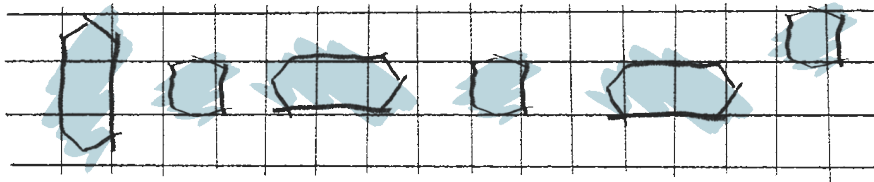
■ THE METABOLIC-BIOLOGICAL CONNECTION

Just as every type of contaminated soil requires a specific bioremediation process, the *Cepario* is architecturally engineered to adapt to any environmental scenario.



■ SYSTEM CAPABILITIES: INFINITE RECONFIGURATION

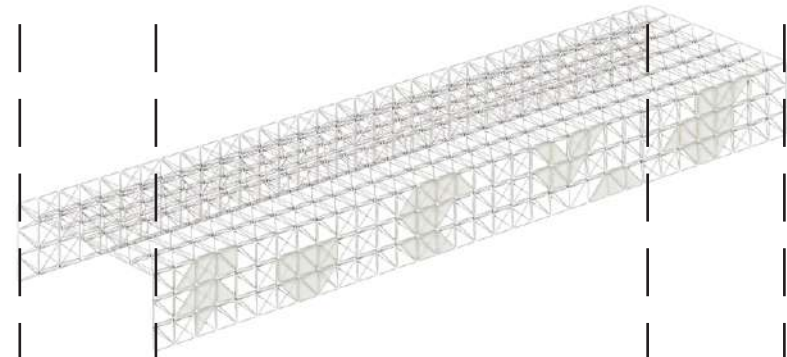
Our system allows infinite spatial reconfigurations, conceiving the building as a living, changing organism capable of continuous growth and environmental adaptation.



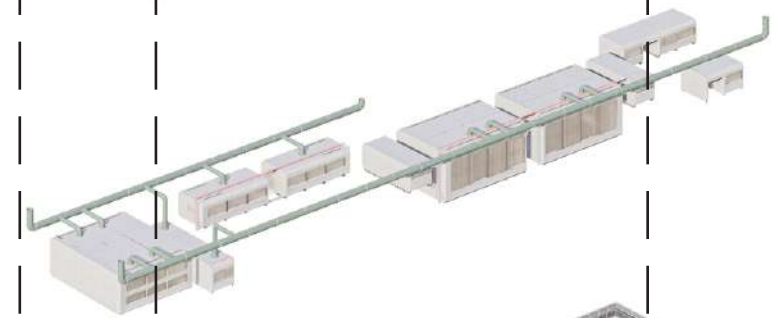
■ STRUCTURAL DISASSEMBLY

Driven by the concept of impermanence, the architecture is engineered to be flexible, detachable, and reassemblable—seamlessly adapting to shifting user needs

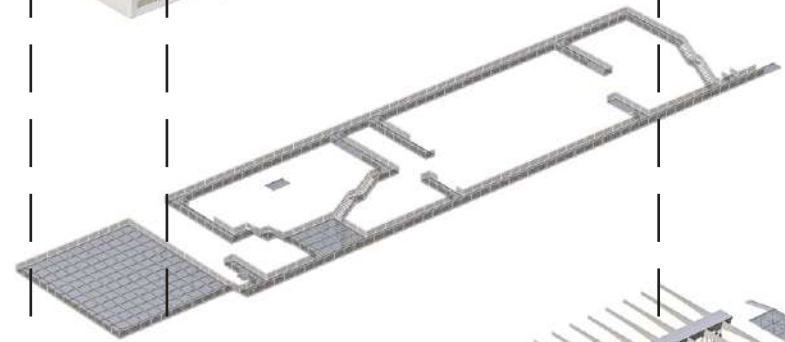
STRUCTURE.



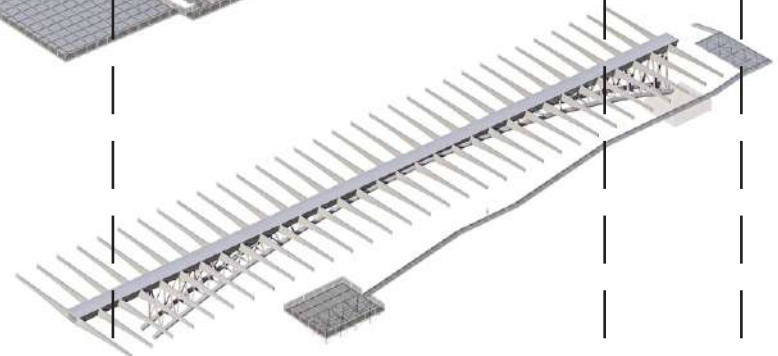
CAPSULES.



WALKWAYS.



ARCH.



■ STRUCTURAL DISASSEMBLY

01- STRUCTURE

The permanent framework of the complex: a three-dimensional space frame formed by structural bars and joints. Structural loads are distributed triaxially across all interconnected elements

02- Capsules

The modular habitable units. Depending on their spatial positioning, they are either suspended from the upper nodes or supported by the lower structural brackets.

03- Walkways

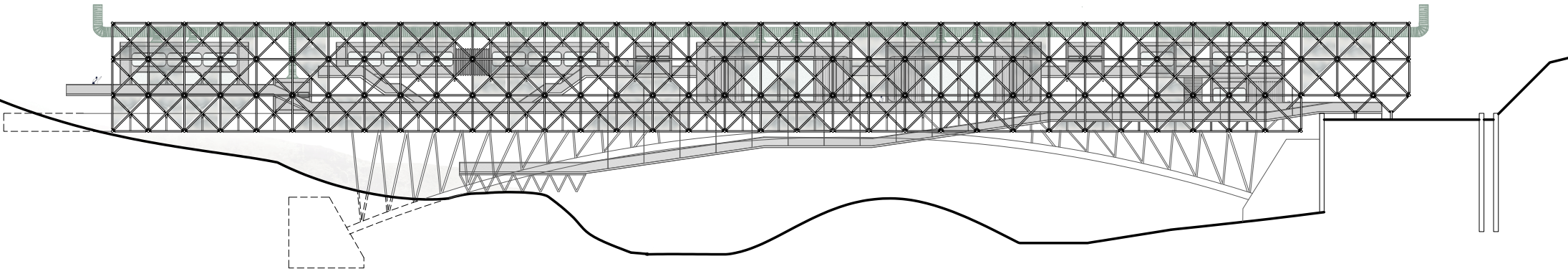
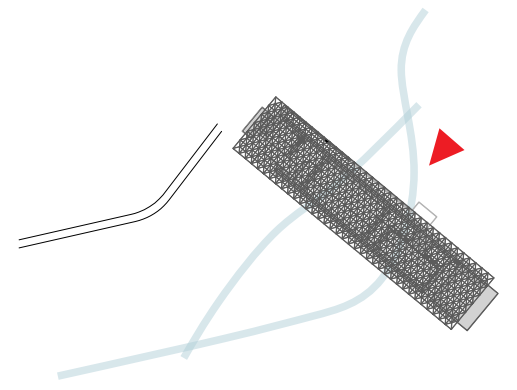
The circulation network that connects the entire complex. These pathways are suspended from the main structure using high-tensile cables.

04- Arch

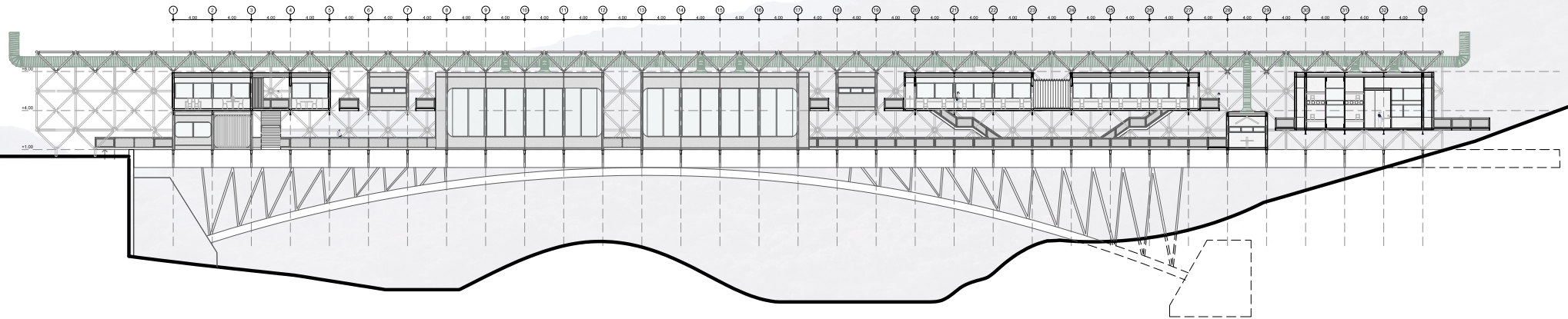
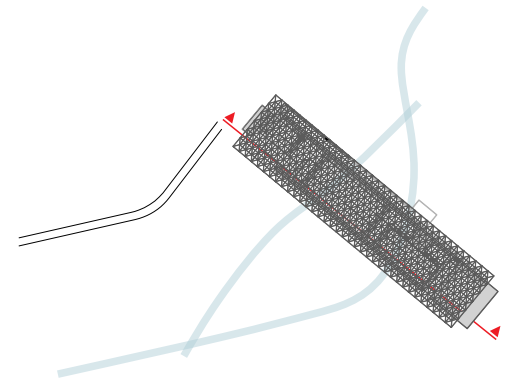
The primary structural spine engineered to transfer the loads of the entire volumetric mass down to the project's only two points of contact with the ground.



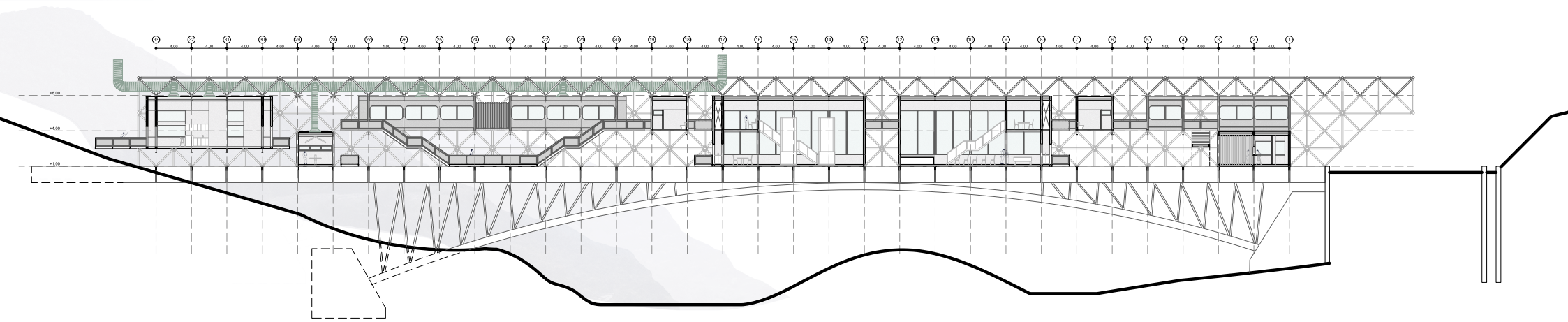
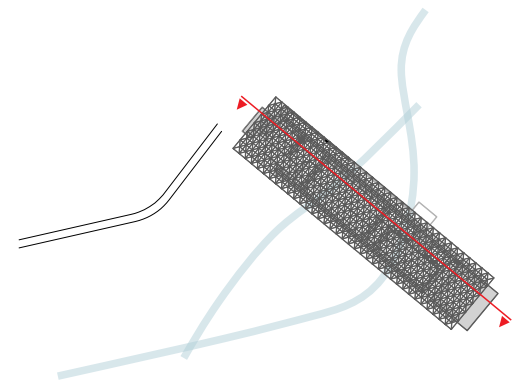
■ MAIN ELEVATION



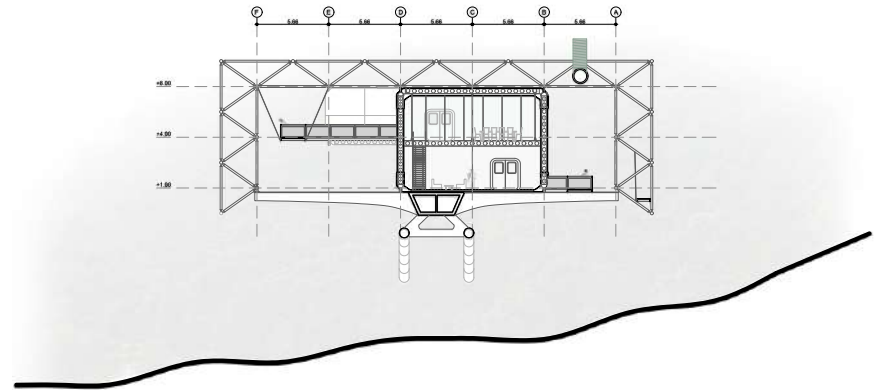
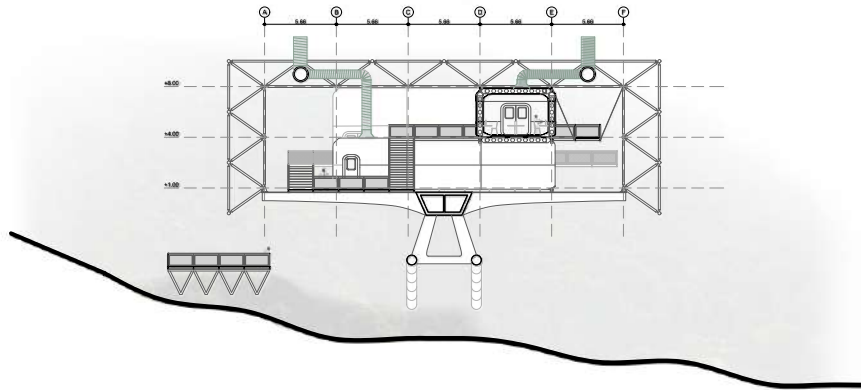
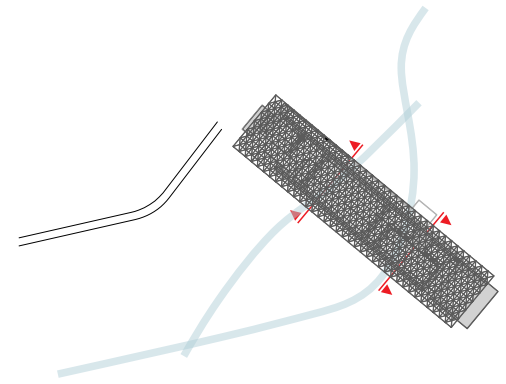
SECTION A



SECTION B



■ SECTION C & D

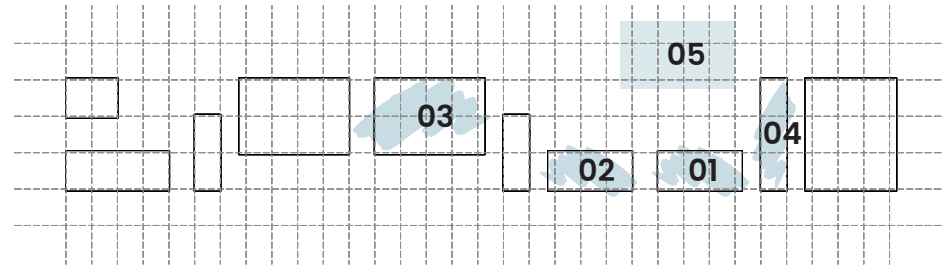




PROGRAM DISTRIBUTION

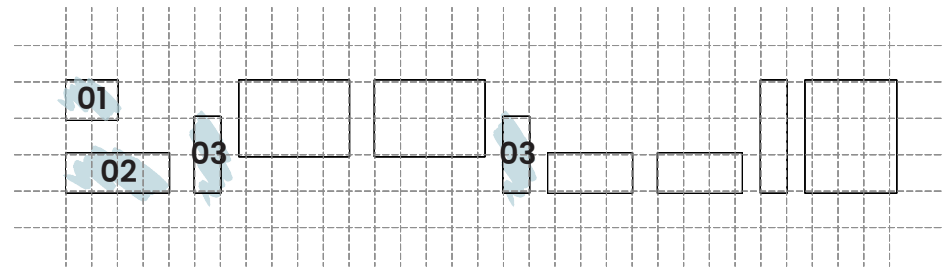
RESEARCH AREA

- 01. Mycology laboratory
- 02. Cultivation laboratory
- 03. Strain bank
- 04. Grow room
- 05. Field testing module



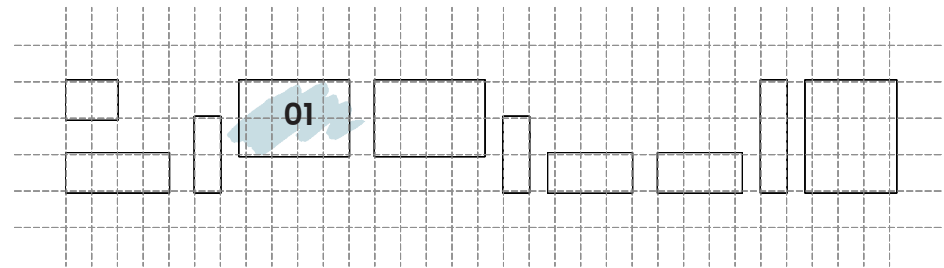
SERVICE ZONES

- 01. Administration
- 02. Offices
- 03. Restrooms + water storage



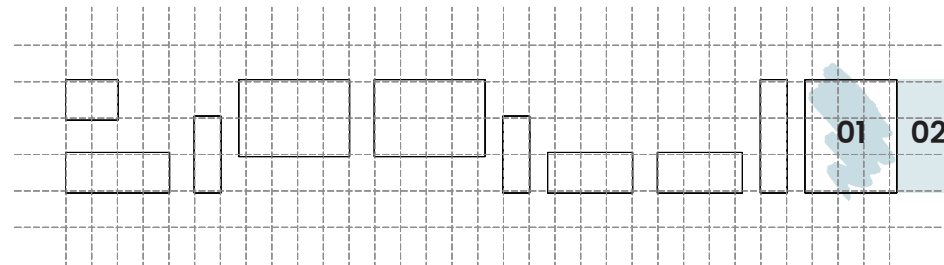
MEETING ZONE

- 01. Exhibition hall + meeting room

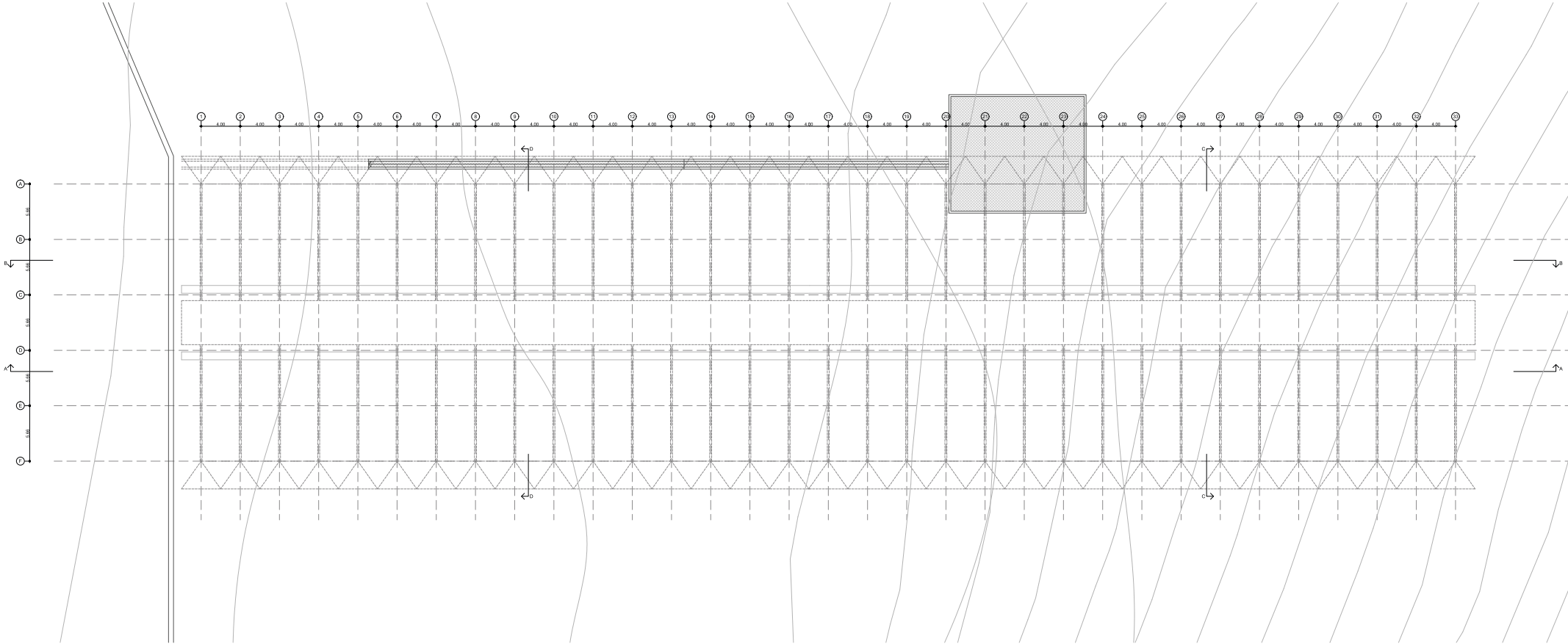


RESIDENTIAL ZONE

- 01. Capsule housing + services
- 02. Recreational area



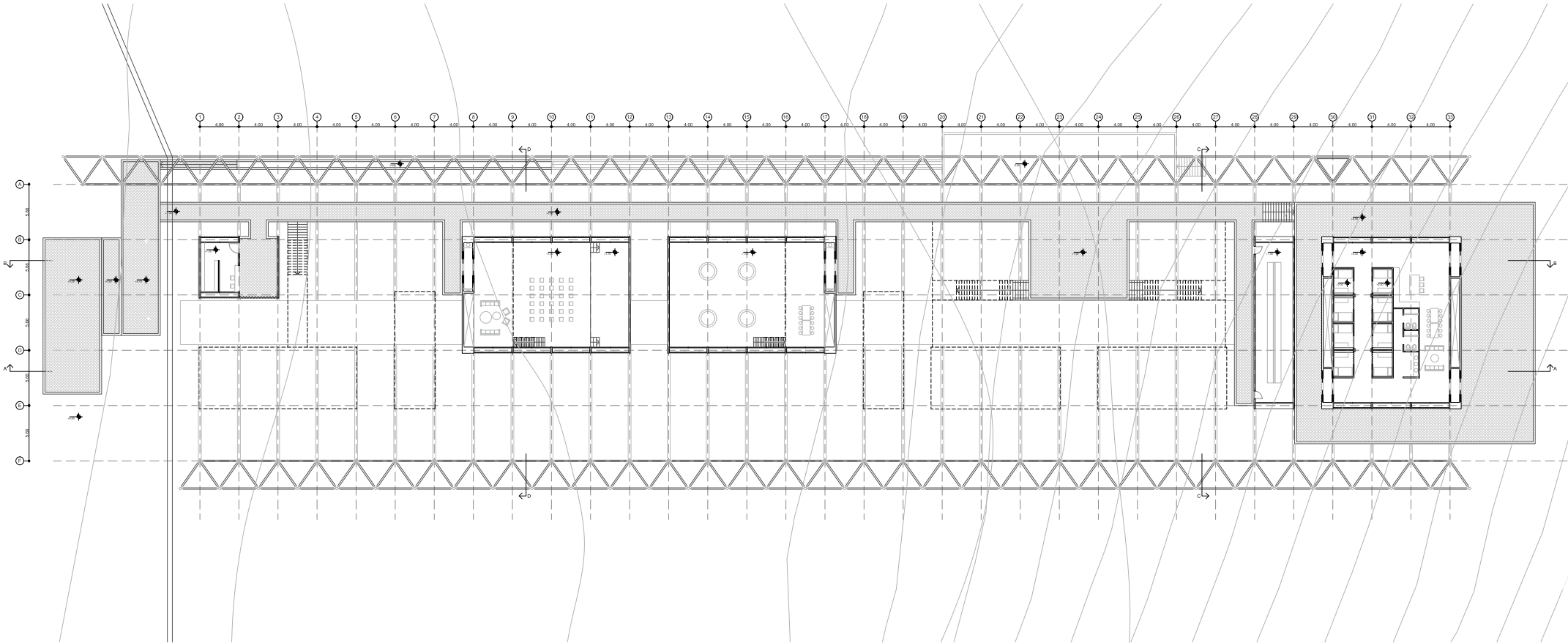
■ GROUND FLOOR PLAN







■ ENTRANCE LEVEL PLAN









001 002

← 007

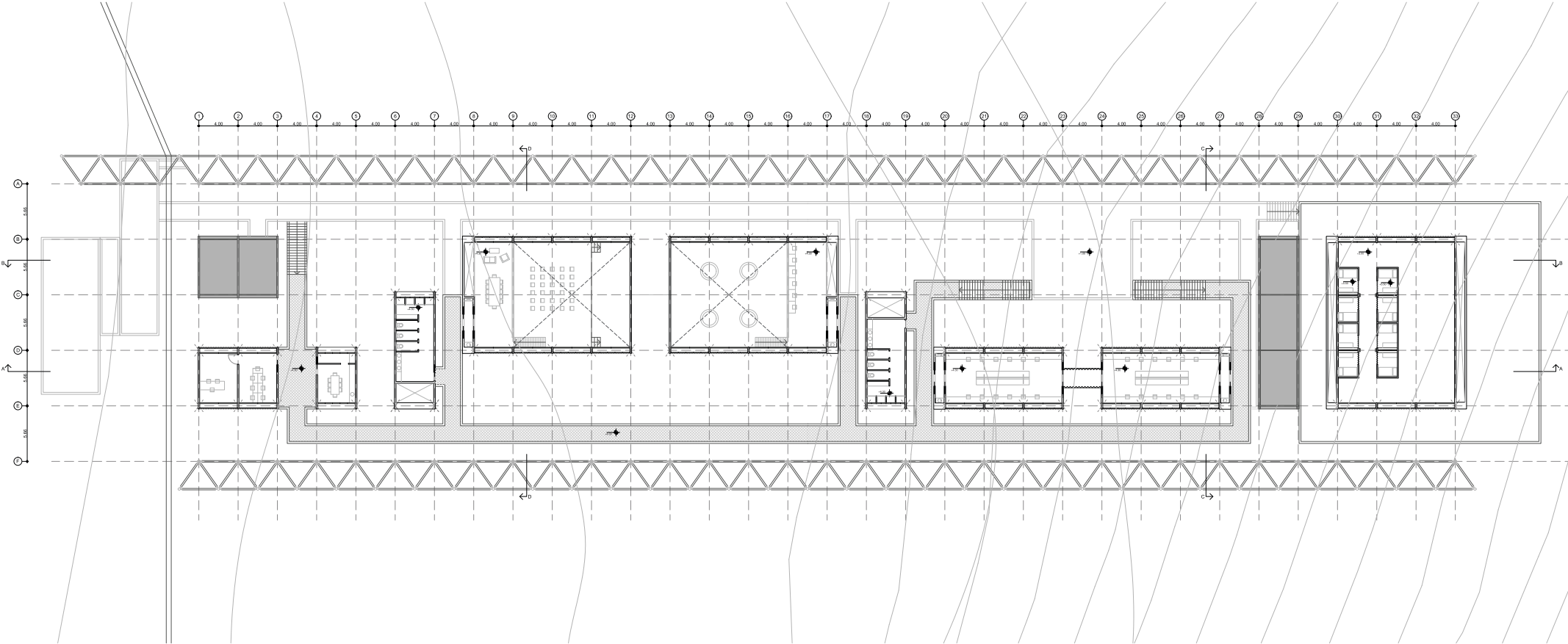
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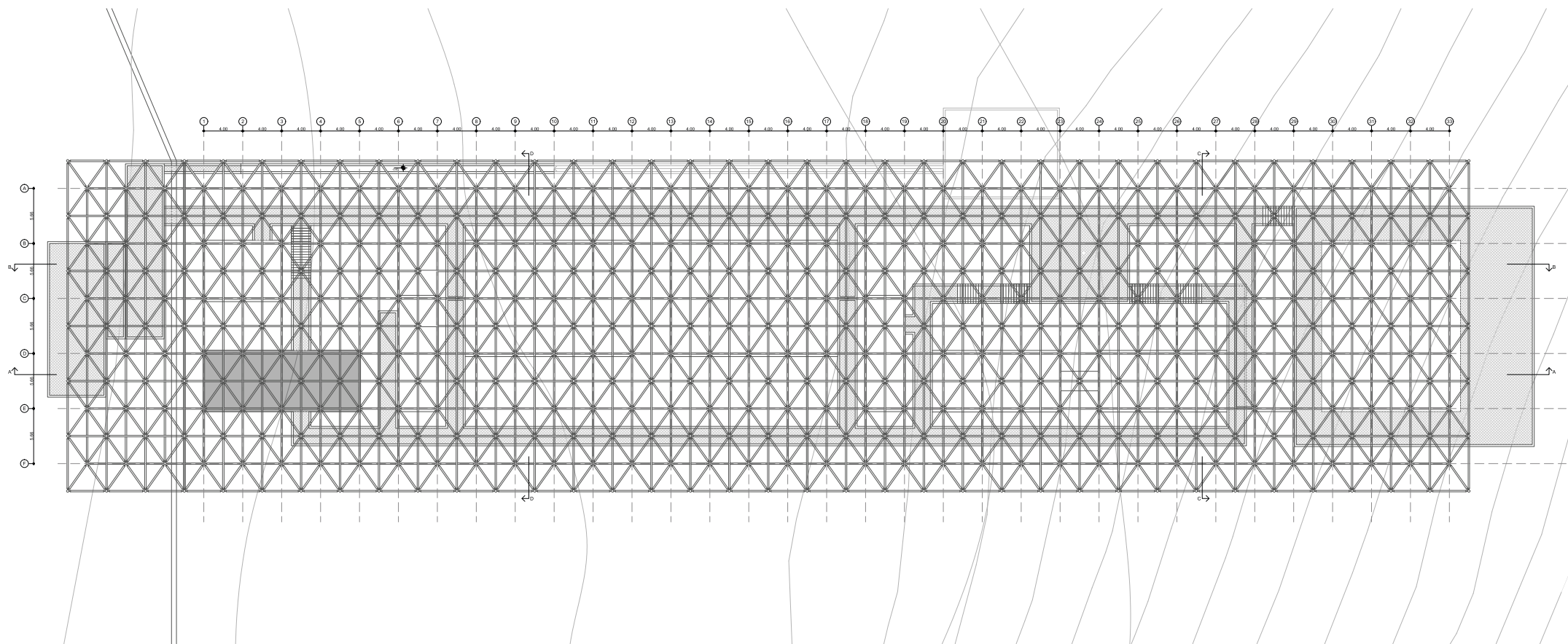
■ UPPER FLOOR PLAN





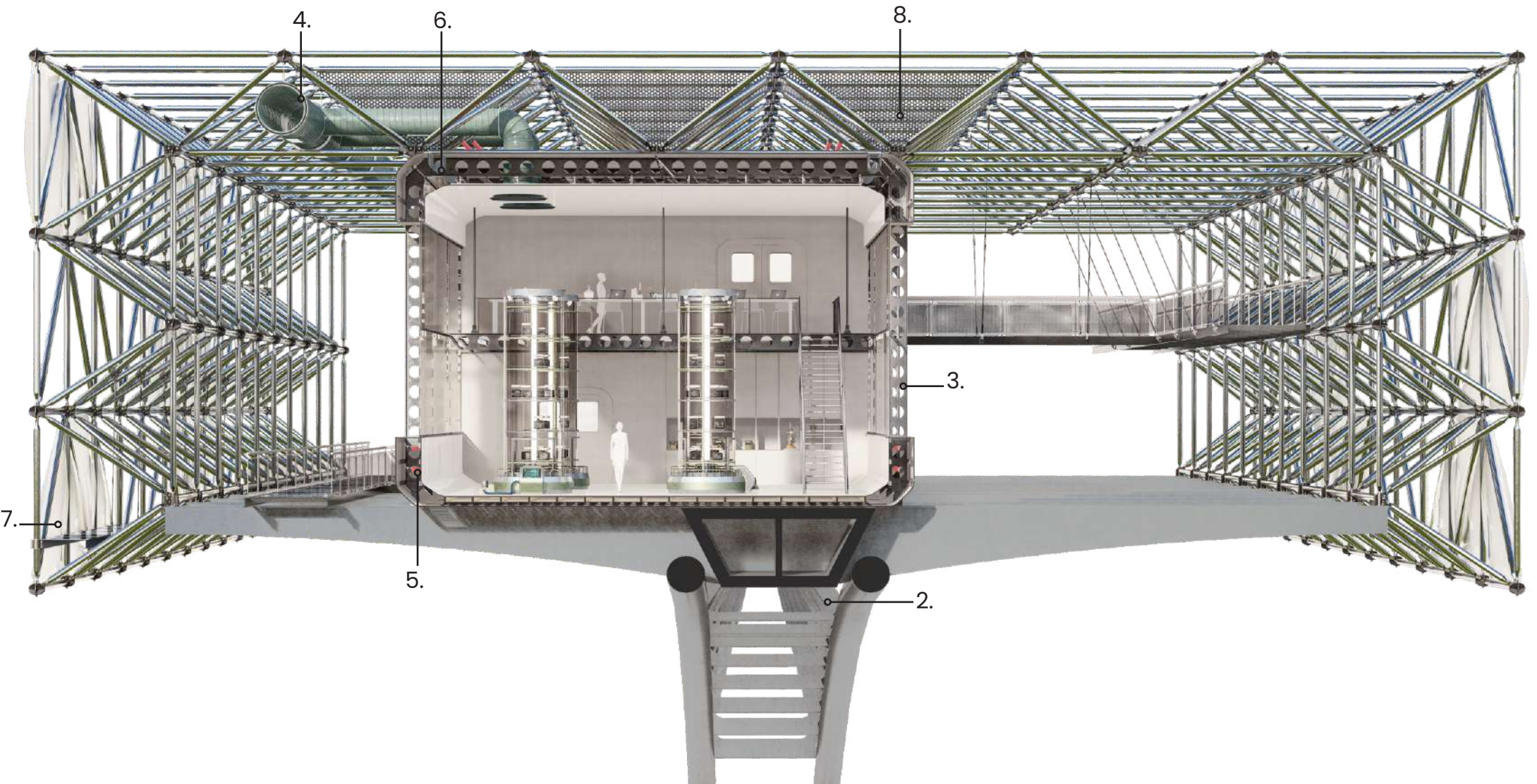


■ ROOF PLAN





■ PERSPECTIVE SECTION: BUILDING SERVICES & SYSTEMS



1. ASSEMBLY SYSTEM

2. LOAD-BEARING SYSTEM

3. FRAME SYSTEM

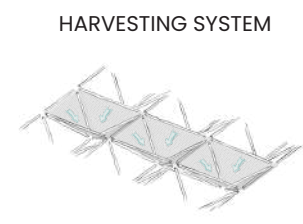
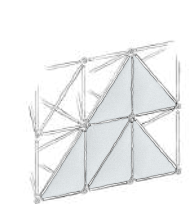
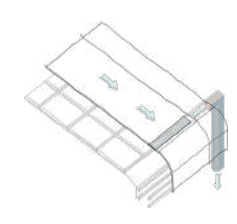
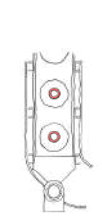
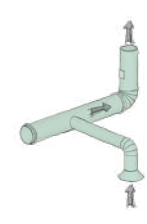
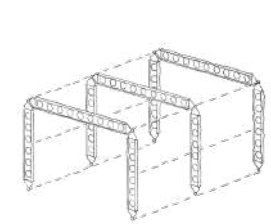
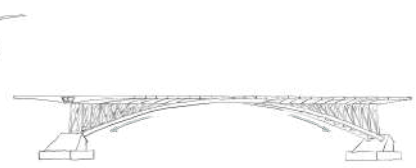
4. HVAC SYSTEM

5. SUPPLY SYSTEM

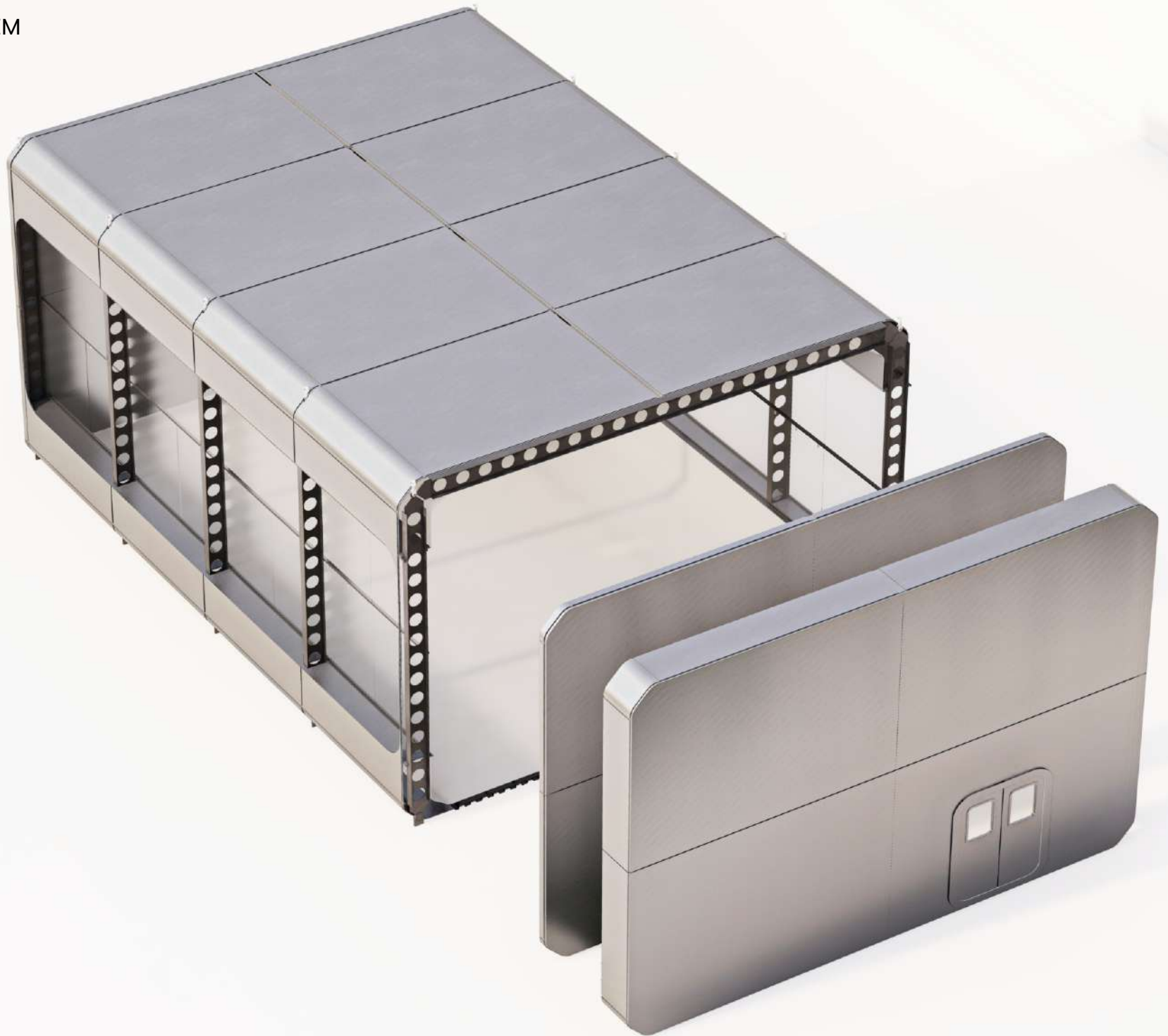
6. DRAINAGE SYSTEM

7. SHIELDING SYSTEM

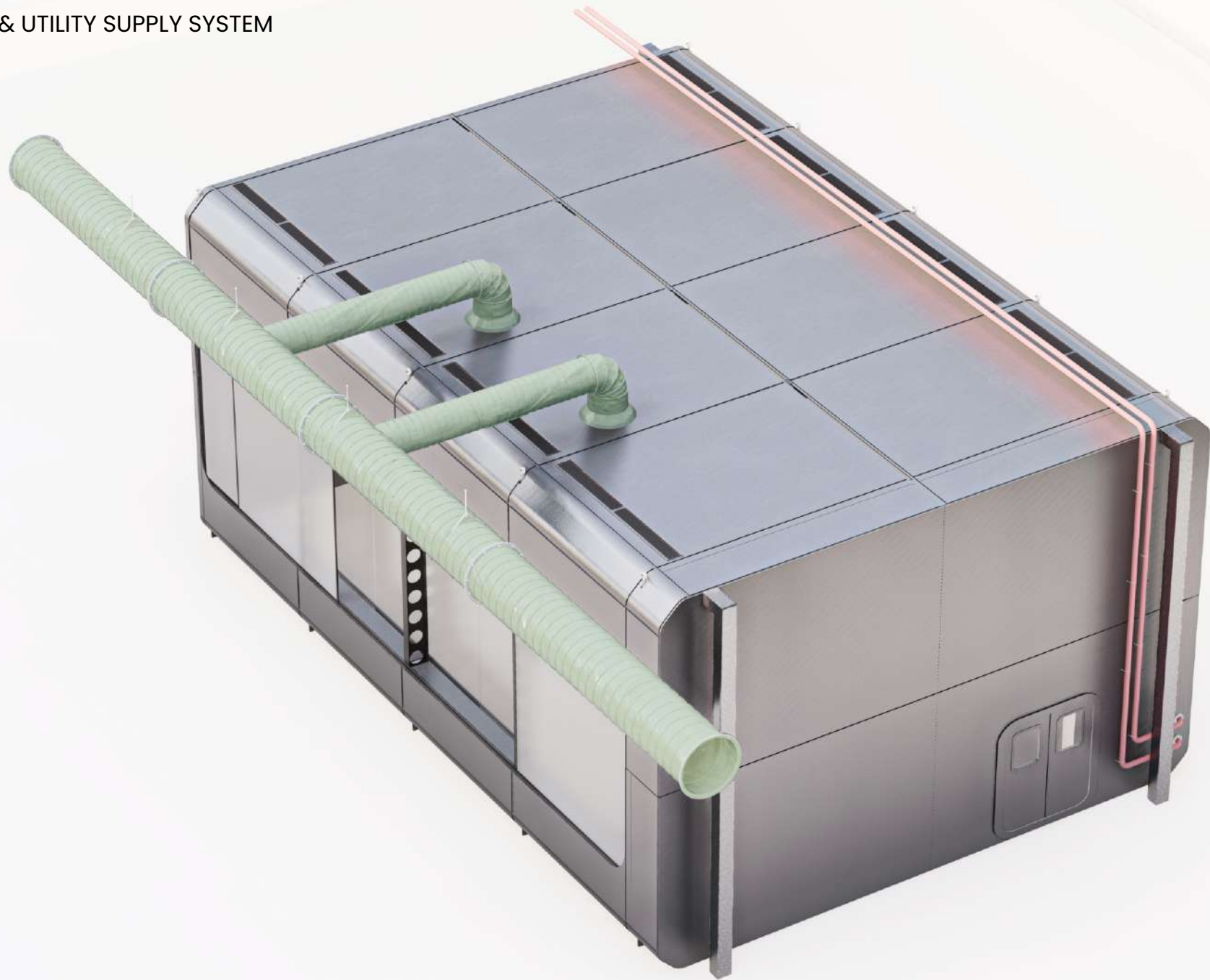
8. WATER & ENERGY HARVESTING SYSTEM



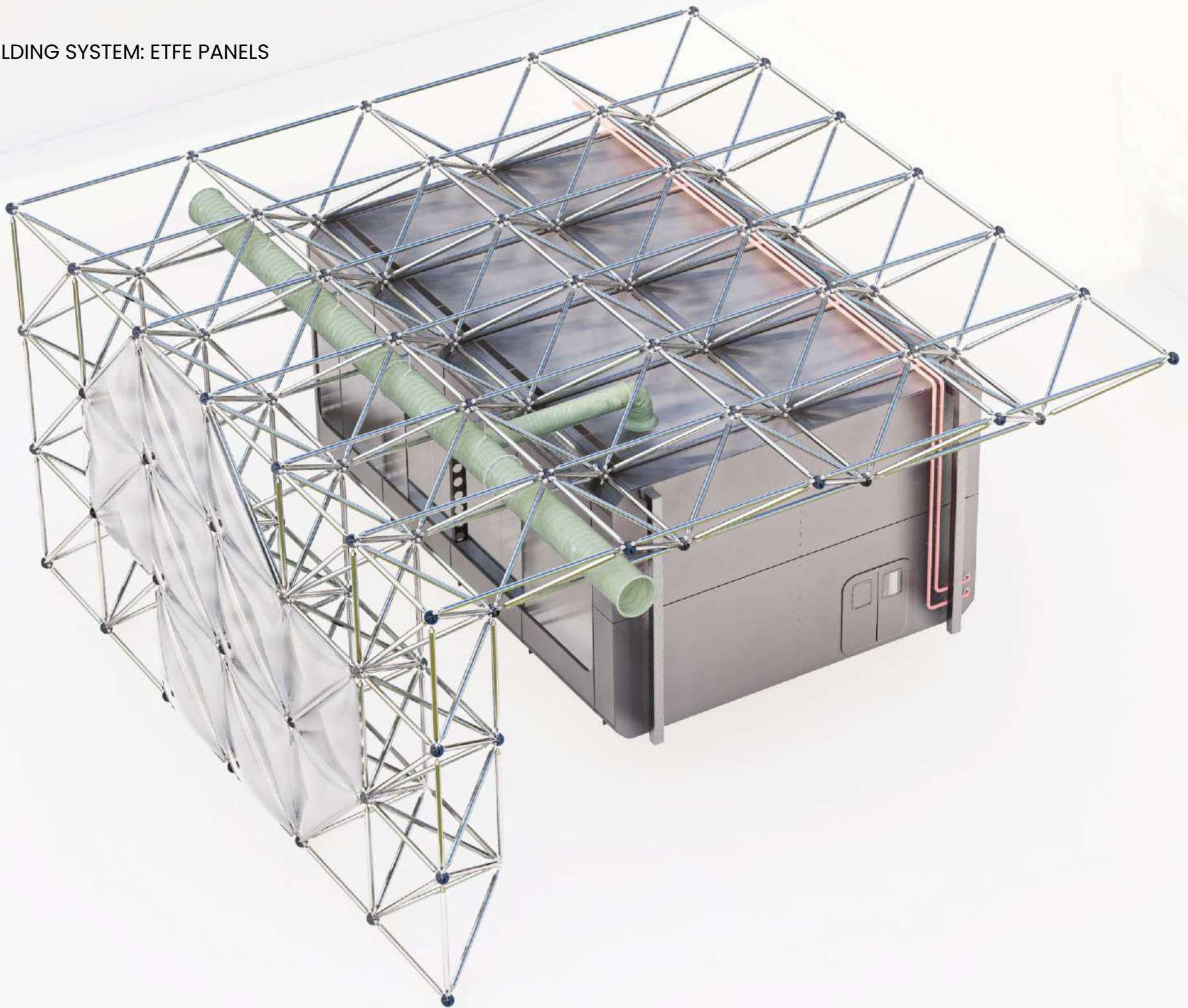
■ FRAME SYSTEM



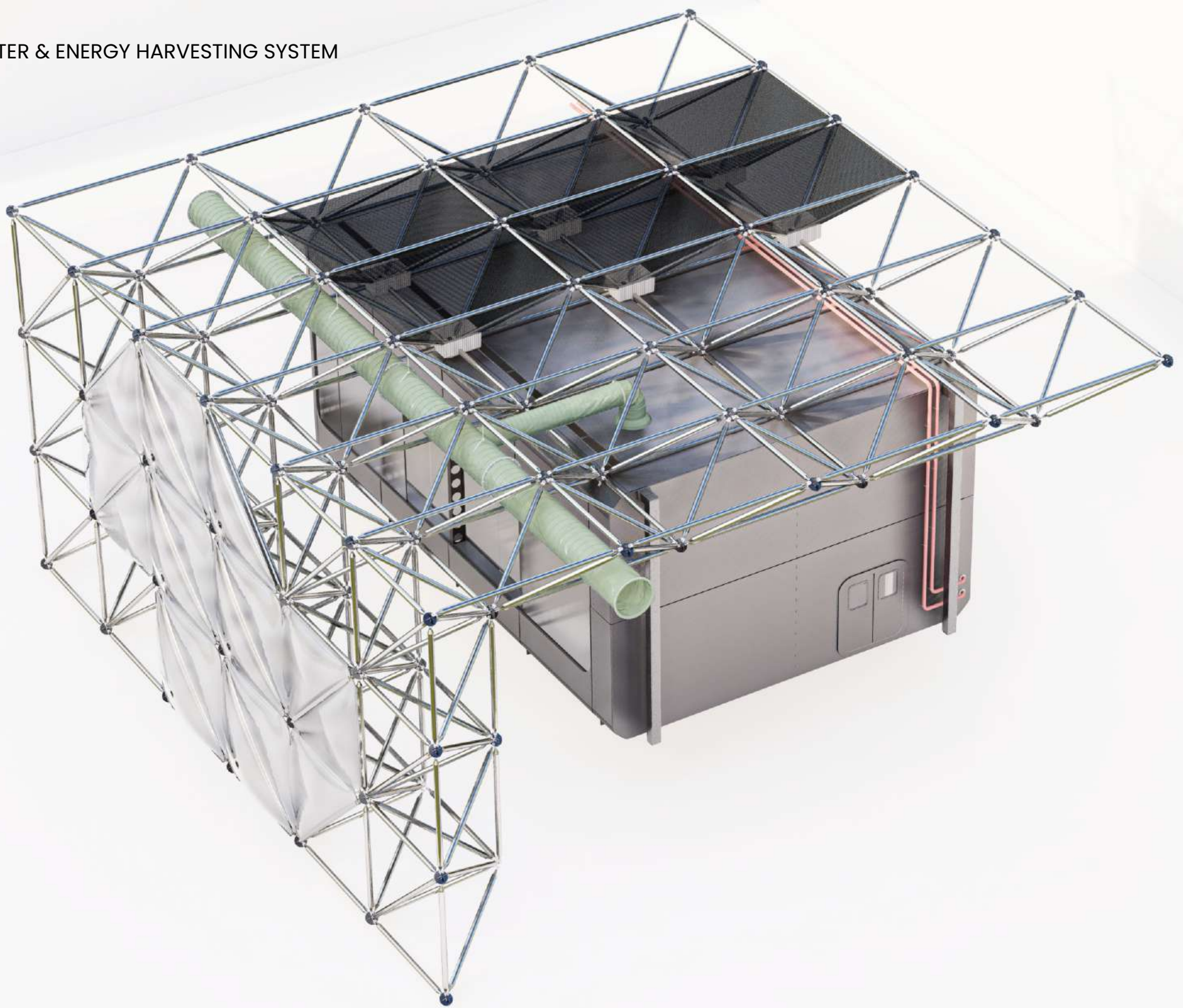
■ HVAC & UTILITY SUPPLY SYSTEM



■ SHIELDING SYSTEM: ETFE PANELS



■ WATER & ENERGY HARVESTING SYSTEM



■ RENEWABLE ENERGY & SELF-SUFFICIENCY

Engineered for full self-sufficiency, the project integrates renewable technologies that leverage natural resources—sun, wind, and rain—while preserving the site's environmental equilibrium. In this way, the architecture operates as a metabolic organism, generating its own power and managing resources through closed-loop systems.



RAINWATER HARVESTING

1- HARVEST:

Inverted umbrellas

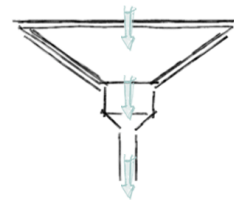
2- TRANSFORM:

Rainwater into portable drinking water and wastewater

3- STORAGE:

Water cisterns

4- DISTRIBUTE



SOLAR & RIVER ENERGY

1- HARVEST:

Trough photovoltaic panels or channels directing water flow toward hydro turbines

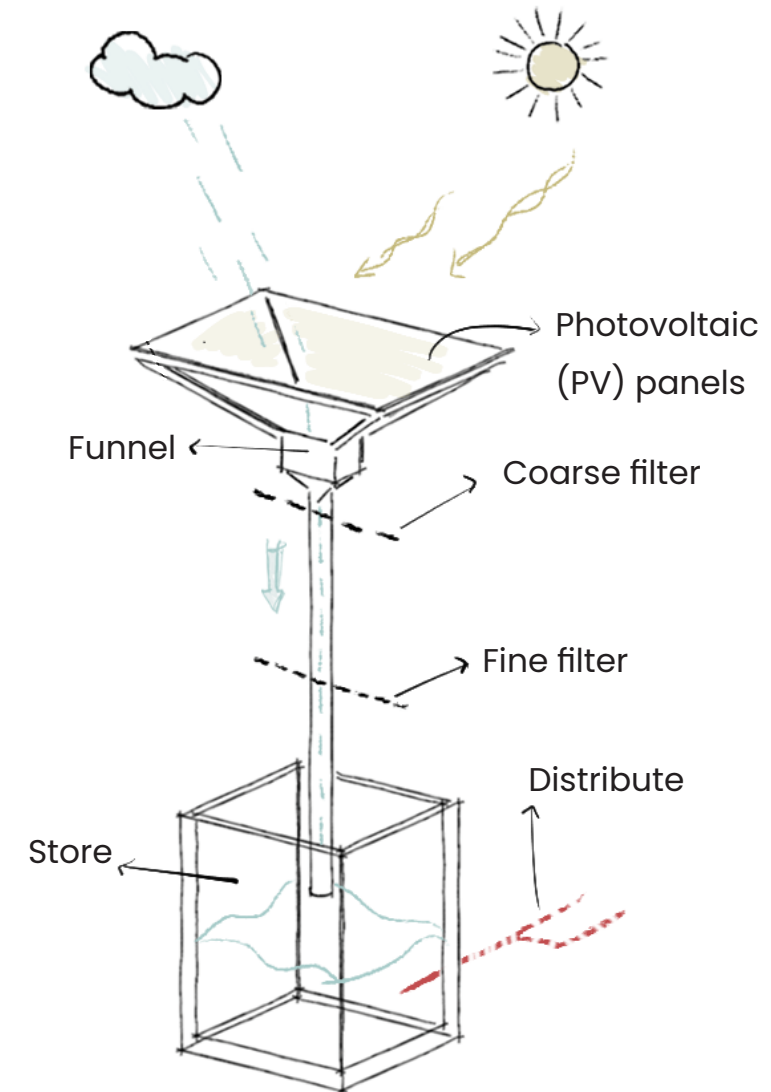
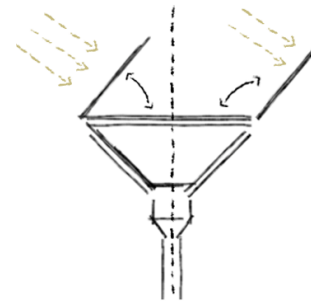
2- TRANSFORM:

Direct current (DC) into alternating current (AC)

3- STORAGE:

Lithium batteries

4- DISTRIBUTE



■ SUSTAINABILITY METRICS & CALCULATIONS

WATER BALANCE

- Local Resource: 1.50 m/year (annual rainfall)
- Catchment Area: 280 m² (Runoff coefficient: 0.9)
- Required Inverted Umbrellas: 13 units = 1,040 L/day (average collection)
- Umbrella Location: Roof level, positioned over wet cores and capsule technical spaces (Cepario and Community modules).
- Non-Potable Demand: 1,100 L/day (toilets + cleaning)
- Greywater Replenishment: 1,050 L/day
- Modular Storage: 15 m³ (approx. 12-day autonomy) / integrated within wet cores.

13 INVERTED UMBRELLAS = 100%
WATER SELF-SUFFICIENCY

ENERGY BALANCE

- Estimated Production: 126 kWh/day = 46 MWh/year
- Design Demand: 120 kWh/day
- Storage Capacity: LiFePO₄ batteries = 252 kWh (usable capacity)
- Battery Location: Technical spaces within capsules.
- Required Batteries: 23 units
- Power Electronics: 3x20 kW hybrid inverters
- Backup Generator: 80 kVA (for emergency backup during extended zero-UV periods)

23 LITHIUM BATTERIES = 100%
ENERGY SELF-SUFFICIENCY



■ ADVANTAGES OF STEEL USE

PREFABRICATION & MODULARITY

Modular components manufactured industrially and quickly assembled on-site for maximum precision

STRENGTH-TO-WEIGHT RATIO

Enables a highly lightweight structure capable of supporting massive loads over the gorge.

SPEED OF CONSTRUCTION

Dry-assembly method drastically accelerates execution times through rapid on-site installation.

DURABILITY & SUSTAINABILITY

Highly resilient against diverse environmental conditions, which extends the building's lifecycle, and is 100% infinitely recyclable.

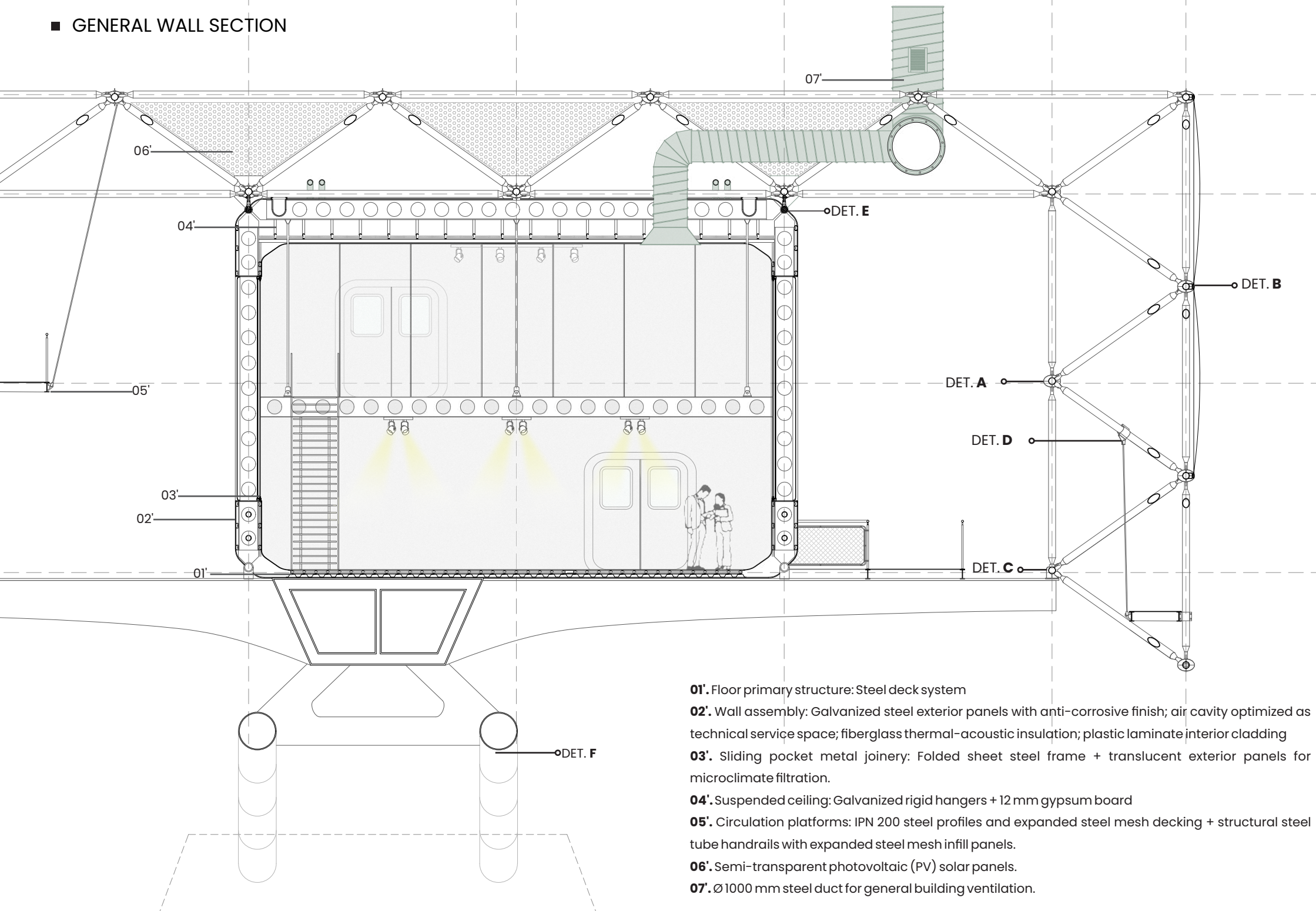


"It is not merely a system of mass production. It is also about introducing qualitative changes into construction processes: creating a selective **system** of component combinations that offers **flexibility**, variety, and ease in the replacement of parts."

KISHO KUROKAWA



■ GENERAL WALL SECTION



01'. Floor primary structure: Steel deck system

02'. Wall assembly: Galvanized steel exterior panels with anti-corrosive finish; air cavity optimized as technical service space; fiberglass thermal-acoustic insulation; plastic laminate interior cladding

03'. Sliding pocket metal joinery: Folded sheet steel frame + translucent exterior panels for microclimate filtration.

04'. Suspended ceiling: Galvanized rigid hangers + 12 mm gypsum board

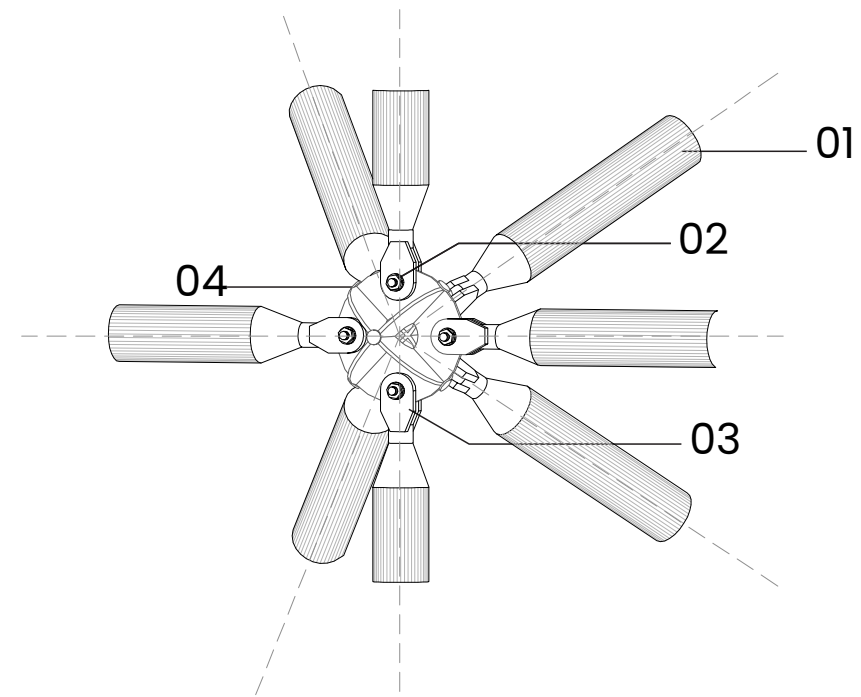
05'. Circulation platforms: IPN 200 steel profiles and expanded steel mesh decking + structural steel tube handrails with expanded steel mesh infill panels.

06'. Semi-transparent photovoltaic (PV) solar panels.

07'. Ø1000 mm steel duct for general building ventilation.

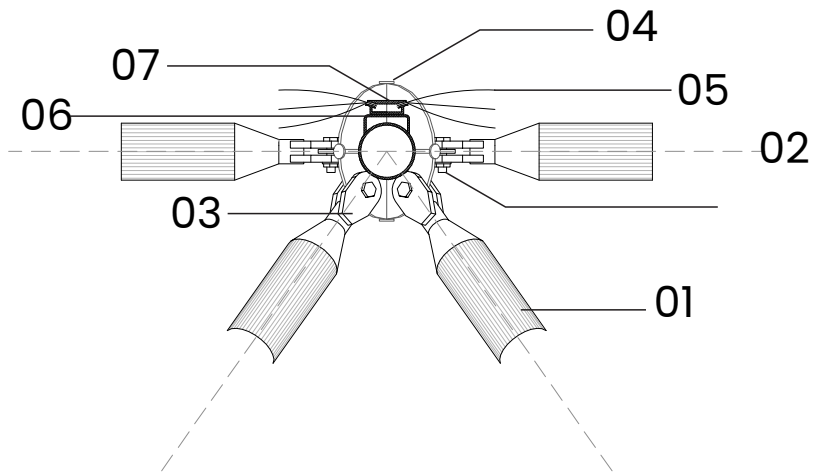
■ CONSTRUCTION DETAILS: TECHNICAL SPECIFICATIONS

01. Ø 150 mm steel pipe, SCHEDULE 40
02. Ø 25 mm structural pin + washer and nut
03. Articulated steel connector arm
04. Ø 300 mm steel node joint, ES FAPYM system
05. Triple-layer pneumatic ETFE cushion system
06. 6 mm extruded aluminum frame
07. Aluminum retaining strip
08. Ø 50 mm threaded rod
09. Steel base plate with stiffeners, t = 12 mm
10. Ø 25 mm anchor bolts
11. Steel bracket, IPN 500 section (h = 500 mm)
12. Steel collar clamp, t = 12 mm
13. Steel connection gusset plate, t = 12 mm
14. Ø 4 mm high-tensile twisted steel cable
15. Steel tension rod
16. Walkway primary structure: IPN 200 section (h = 200 mm)
17. Capsule primary structure: Cellular steel beam (h = 340 mm)
18. Reinforced concrete foundation, H30 mix with Ø15 mm rebar grid
19. Steel base plate secured with heavy-duty anchor bolts
20. Primary structural steel arch: Ø 800 mm tubular steel section



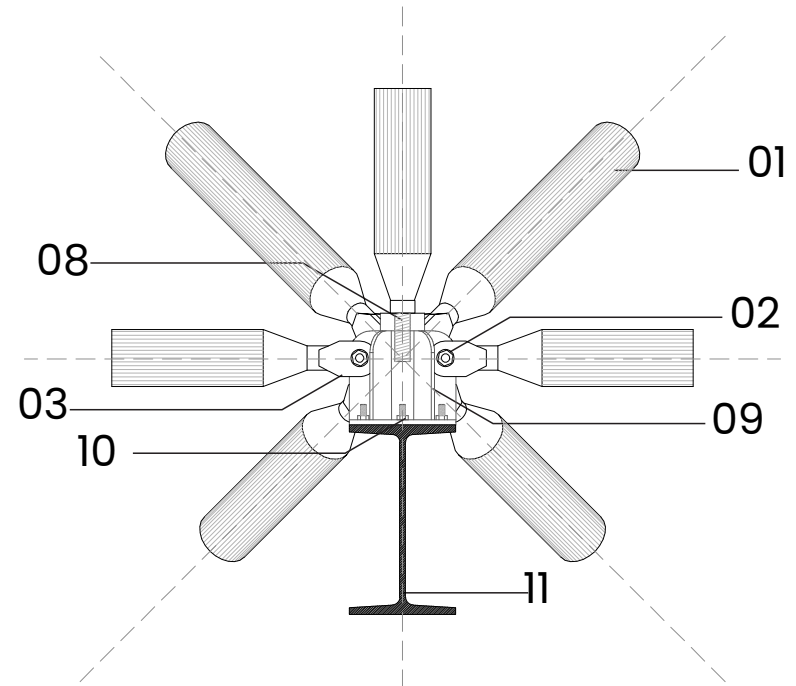
DETAIL TYPE A — Space Frame Node Joint

Articulated pinned connection between tubular sections and the structural nodes of the space frame.



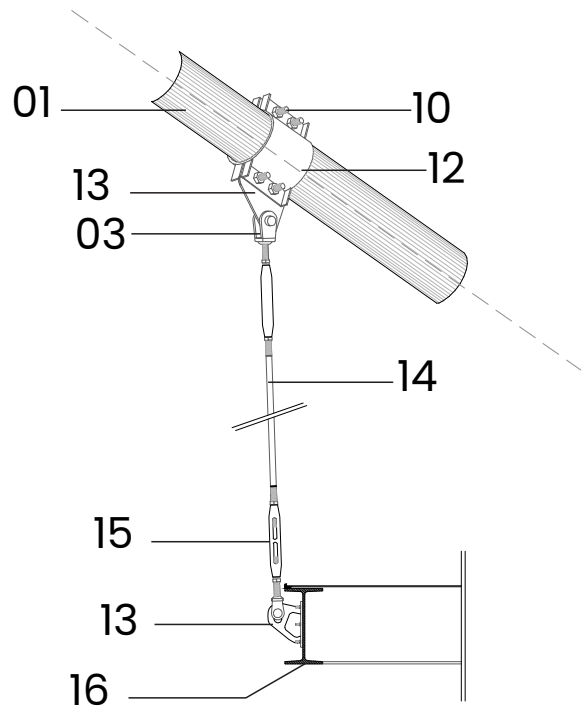
DETAIL TYPE B — Space frame to ETFE joint

Connection between the space frame steel members and the pneumatic ETFE cushion panels.



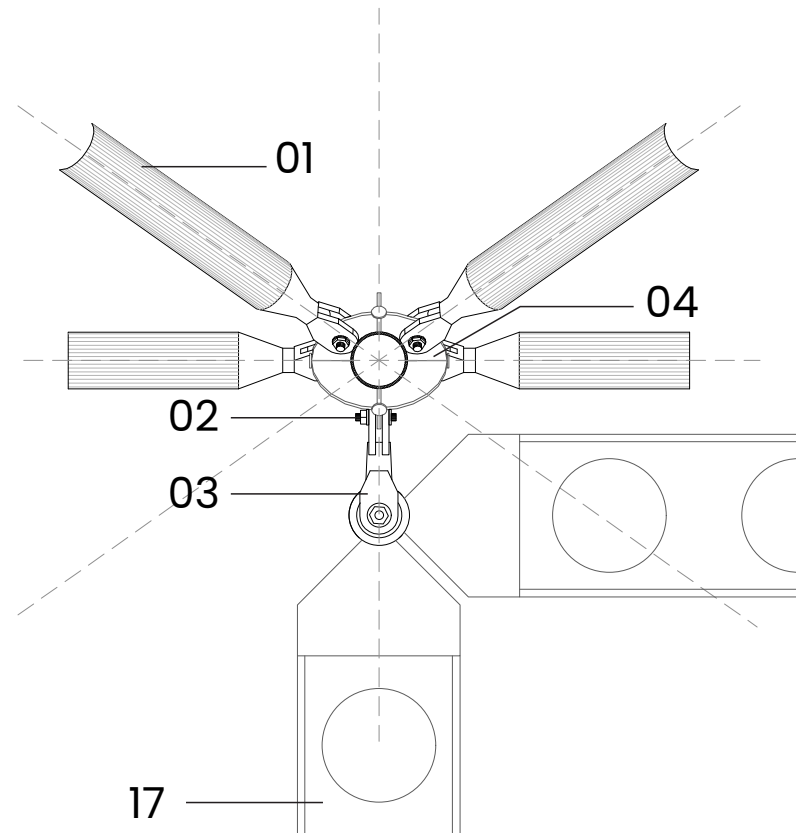
DETAIL TYPE C — Bracket Structural Connection

Structural anchoring and connection of the space frame elements to the secondary steel cantilever brackets.



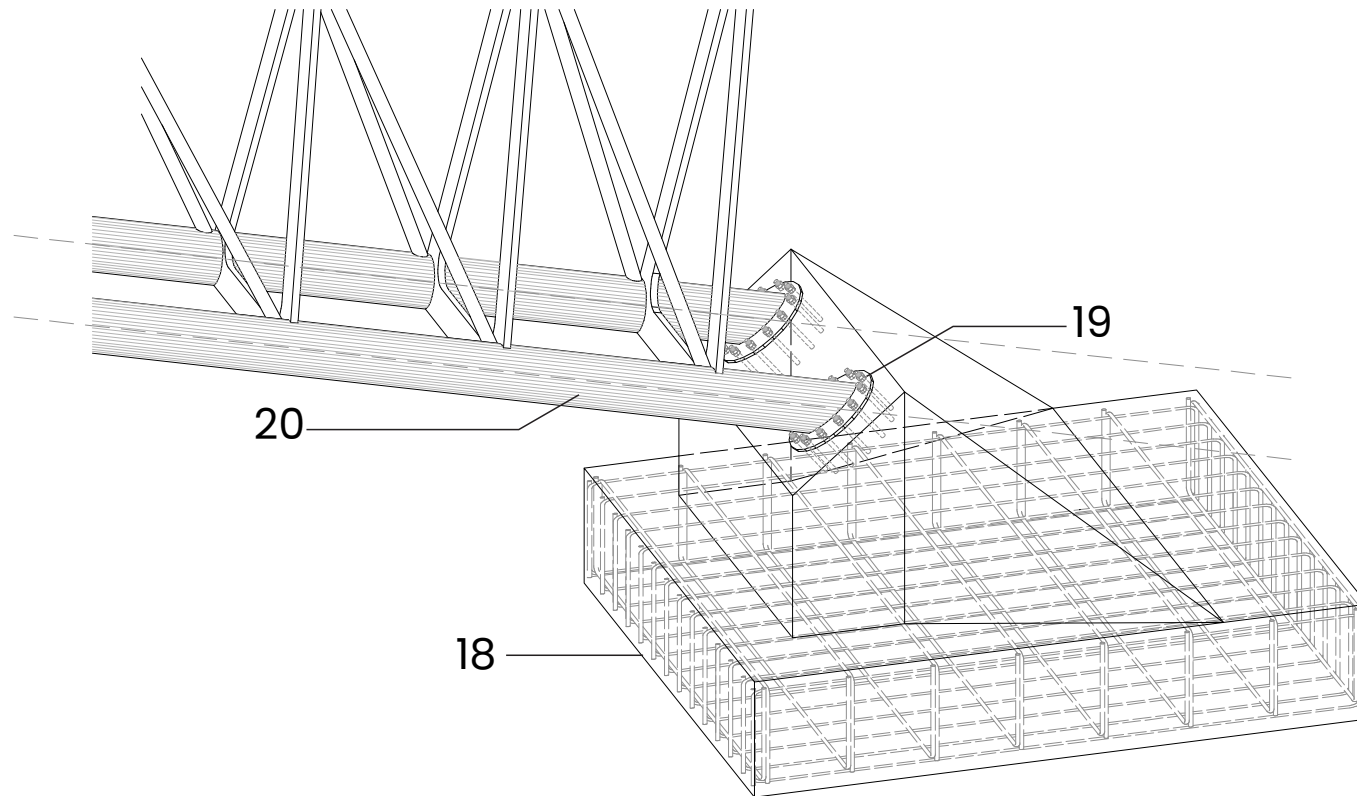
DETAIL TYPE D — Walkway Suspension System

Hanging suspension system for the structural support of the steel walkways.



DETAIL TYPE E — Capsule Structural Interface

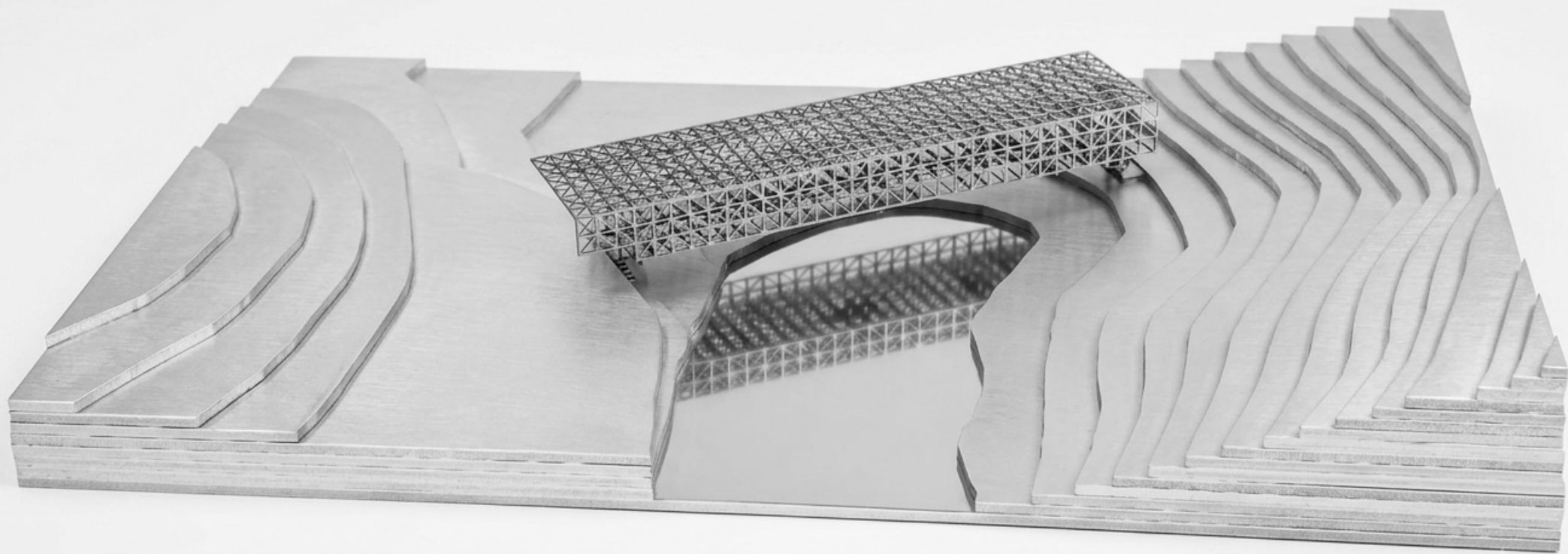
Articulated pinned connection between the capsule's primary frame and the main space frame structure.



DETAIL TYPE F — Foundation System

"Reinforced concrete foundation system designed to anchor the primary load-bearing arch.

■ SCALE MODEL





At nightfall, the architecture blurs into the landscape, leaving the capsules floating above the gorge, while the heart of the project keeps beating in silence.

THANK YOU.