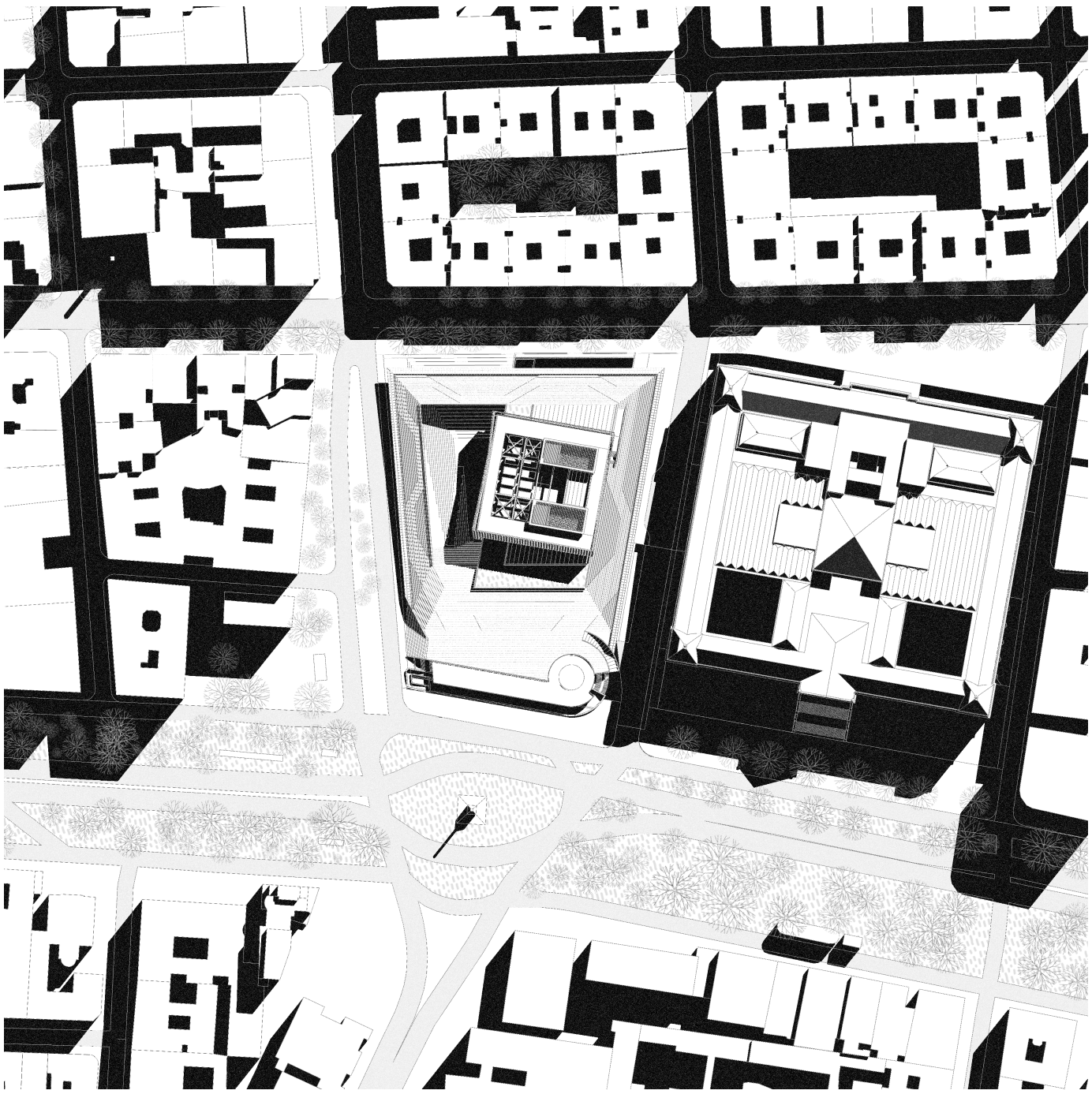


Beyond the Black Box:

Cultivating Knowledge Commons from Madrid's Digital Shadows

Beyond the Black Box proposes a radical transformation of how citizens interact with digital infrastructure and cultural archives through architectural intervention at Madrid's Plaza de Colón. This project addresses a critical democratic crisis: while data centers consume enormous resources (613 MW of power, 665 million liters of water annually) and cultural archives increasingly train AI systems, both remain invisible and inaccessible to the citizens they serve.

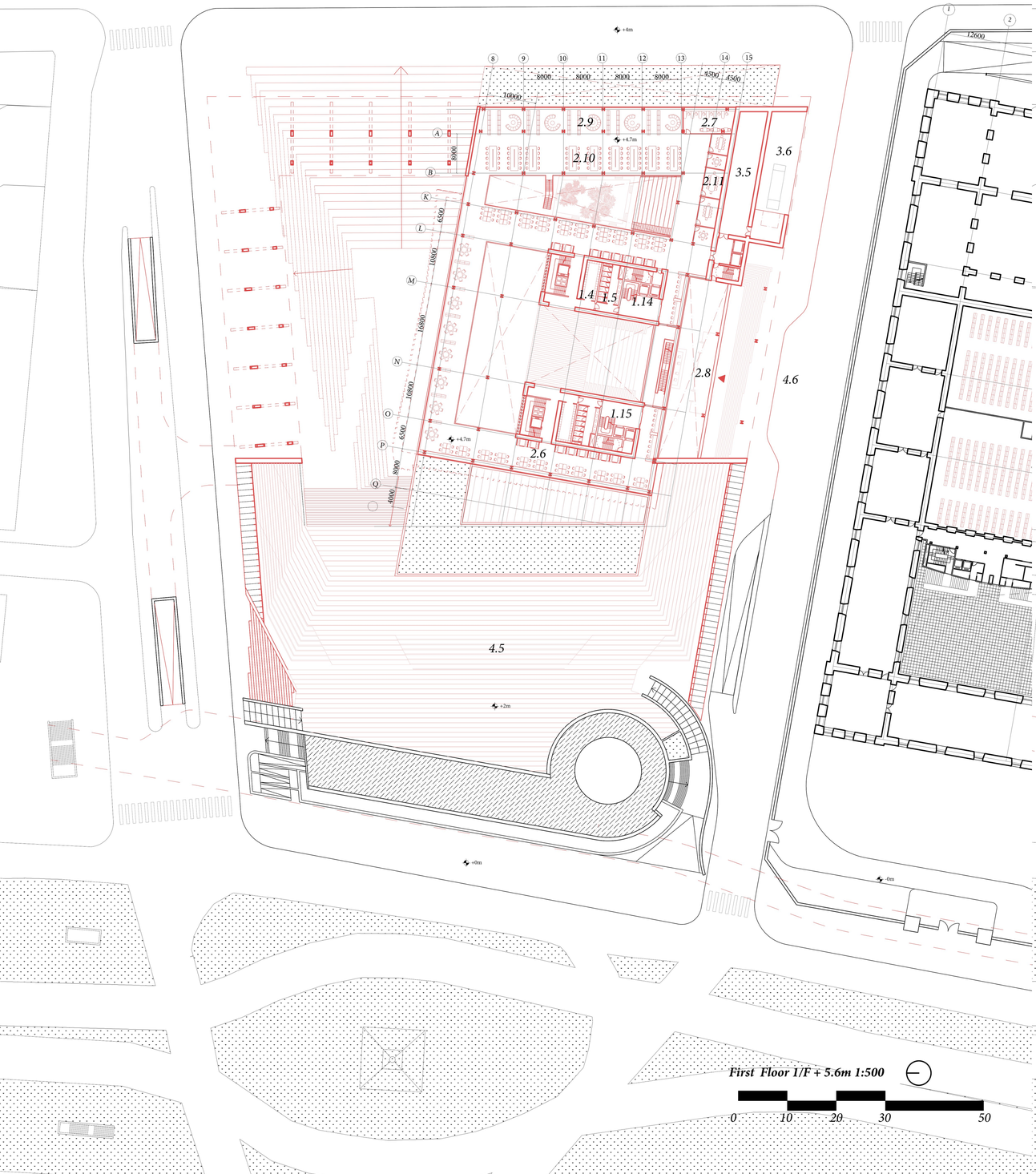
The project confronts three interconnected "black boxes" that undermine democratic participation in the digital age. I**nfrastructure Invisibility** manifests through data centers hidden 8-12 kilometers from Madrid's center, deliberately separating citizens from the technical systems governing their daily lives. **Archive Digitalization** disrupts traditional memory institutions as physical collections become abstract digital processes, leaving communities without spaces to engage with their evolving digital heritage. **Digital Literacy Gaps** persist due to the absence of civic spaces where citizens can understand algorithmic systems and participate in data collection, organization, and utilization.

Located at **Plaza de Colón**—a site that has evolved from Royal Mint to National Library to public plaza—the intervention creates a new civic typology that makes visible both the physical infrastructure of digital archives and the knowledge they contain. The design employs a **cloud-fog-edge computing framework** that reveals resource flows while integrating technical functions with public programs.

Three programmatic axes converge at a central data center: t**he Digital Infrastructure Axis** features transparent server rooms and exposed cooling systems that transform technical infrastructure into educational features; the **Digital Archive Axis** connects to Spain's National Library through visible digitization labs where citizens witness books becoming digital; and **the Digital Literacy Axis** provides hands-on workshops and AI-integrated study spaces where citizens develop digital capabilities.

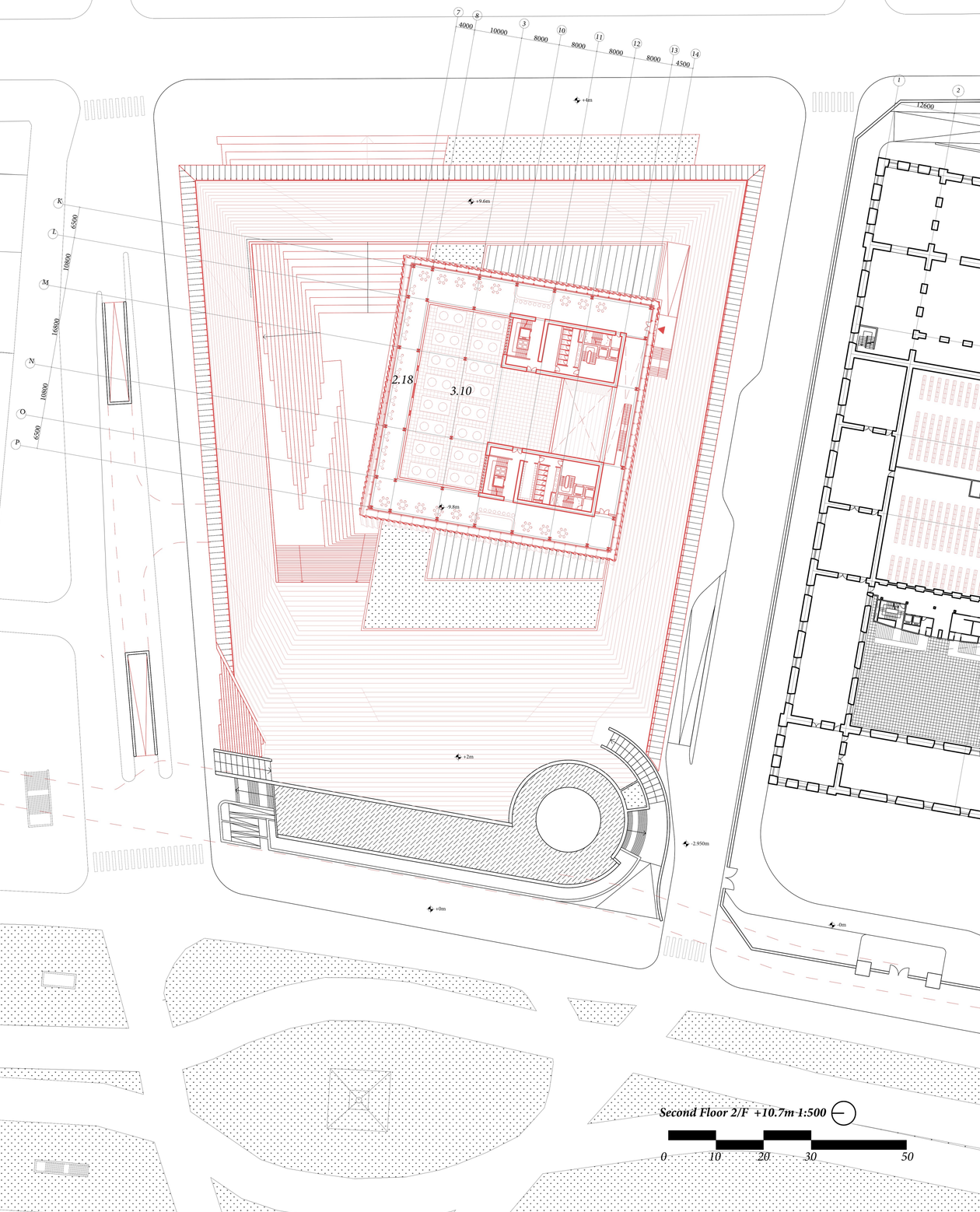
This hybrid architecture materializes the shift from static containers to dynamic circuits in memory practices, establishing a new type of civic institution where cultural heritage is continuously activated through technological engagement and democratic participation. Rather than merely preserving the past, the building actively produces new social memory by enabling citizens to participate in shaping digital archives and infrastructure through transparent interfaces and participatory spaces.

The project demonstrates that architecture can transform traditionally separate systems—hidden data centers and digitizing archives—into integrated civic institutions that serve both knowledge preservation and democratic resilience.



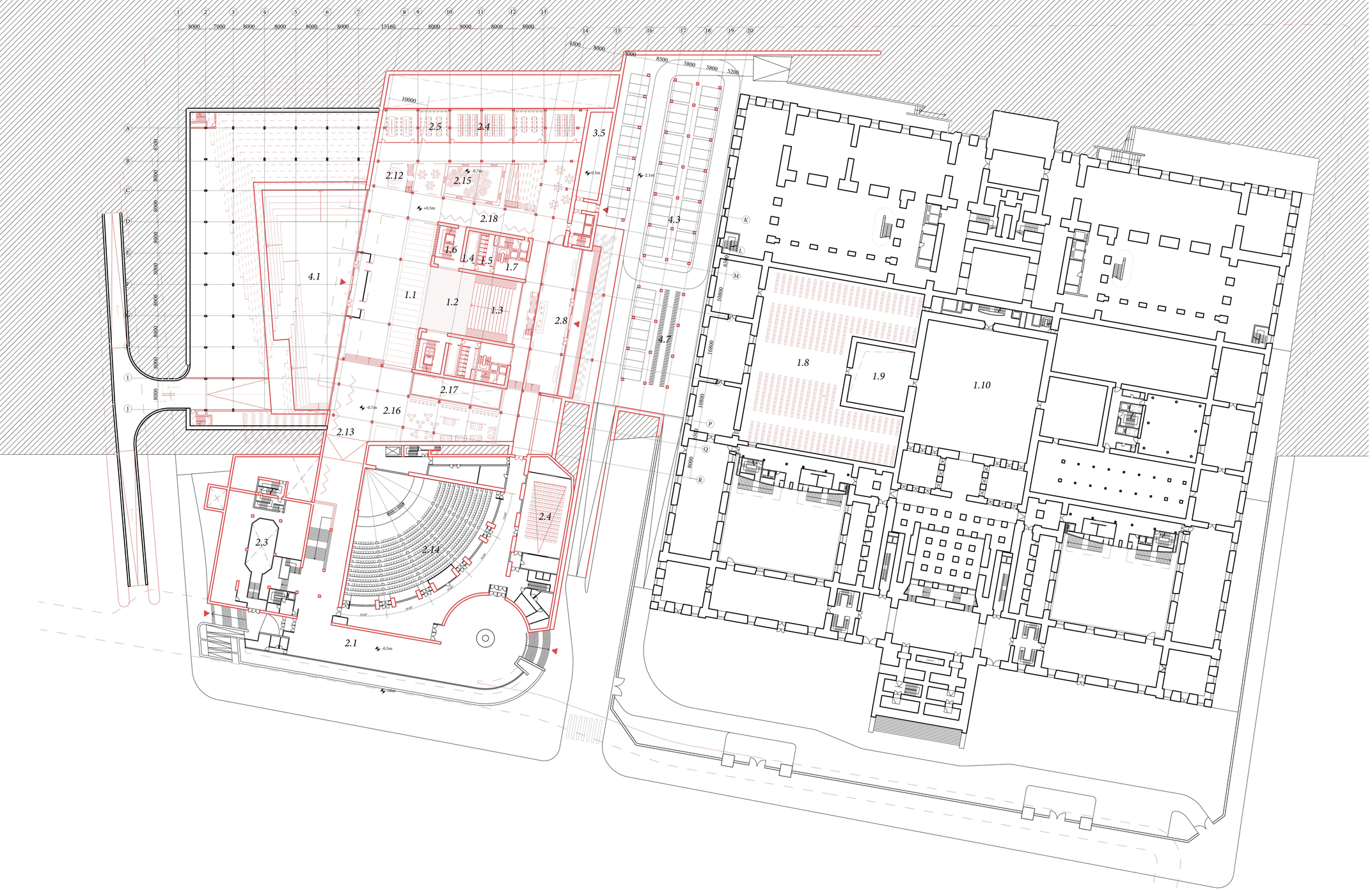
First Floor 1/F + 5.6m 1:500

0 10 20 30 50



Second Floor 2/F +10.7m 1:500

0 10 20 30 50



City Digital Archive

1.1 Infrastructure Viewing Well
1.2 Library Reception
1.3 Speaker Theater
1.4 Clockroom
1.5 Toilet
1.6 Circulation Core
1.7 Staff Office Lobby
1.8 Book Archive
1.9 Archive Consultation Room
1.10 Reading Room
1.11 Close Stack Bookshelf Delivery Room
1.12 Social Memory Gallery
1.13 Community Storytelling Studio
1.14 Digital Heritage Workshop
1.15 Data Processing Office
1.16 Data Archiving Office

Civic Technology Hub & Social Memory Gallery

2.1. Reception
2.2 Digital Infrastructure's Viewing Deck
2.3 Restaurant
2.4 Classrooom
2.5 Computer Lab
2.6 Quiet Working Station
2.7 Educational Curator Office
2.8 Group Visitor Reception
2.9 Library Stack
2.10 Common Working/Reading Area
2.11 Meeting Room
2.12 Information Desk
2.13 Exhibition
2.14 Theatre / Lecture Hall
2.15 Green Atrium
2.16 Cafe
2.17 Information Dashboard Wall
2.18 Rooftop Bar & Teahouse

Transparent Infrastructure Core

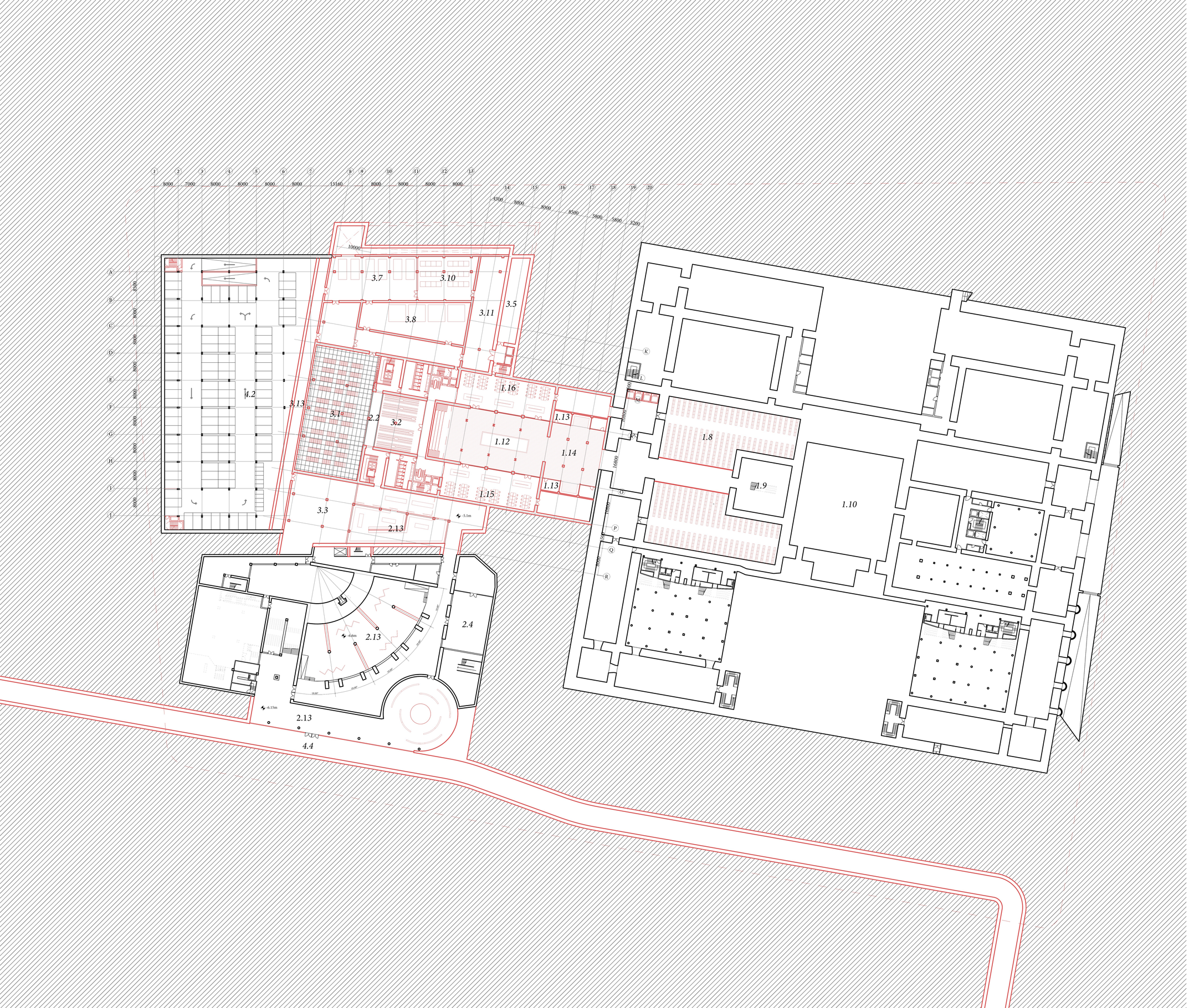
3.1 Supercomputer Room (Hot Data)
3.2 Tape Digital Archive (Cold Data)
3.3 Heat Exchange Room
3.4 Liquid Cooling System
3.5 Service Core
3.6 Loading/Unloading Bay
3.7 Diesal Gernerator Room
3.8 Water Storage Tank & Pump Room
3.9 Transformer Room
3.10 Network Operations Center
3.11 Storage Room
3.12 Cooling Tower
3.13 Service Corridor

OTHER

4.1 Civic Agora Courtyard
4.2 Public Car Parking
4.3 Staff Car Parking
4.4 Pedestrian Tunnel
4.5 Pedestrian Deck
4.6 Visitor Drop Off Area
4.7 Bike Rack

Ground Floor +1.5m 1:500

0 10 20 30 50



City Digital Archive

1.1 Infrastructure Viewing Well
1.2 Library Reception
1.3 Speaker Theater
1.4 Clockroom
1.5 Toilet
1.6 Circulation Core
1.7 Staff Office Lobby
1.8 Book Archive
1.9 Archive Consultation Room
1.10 Reading Room
1.11 Close Stack Bookshelf Delivery Room
1.12 Social Memory Gallery
1.13 Community Storytelling Studio
1.14 Digital Heritage Workshop
1.15 Data Processing Office
1.16 Data Archiving Office

Civic Technology Hub & Social Memory Gallery

2.1. Reception
2.2 Digital Infrastructure's Viewing Deck
2.3 Restaurant
2.4 Classrooom
2.5 Computer Lab
2.6 Quiet Working Station
2.7 Educational Curator Office
2.8 Group Visitor Reception
2.9 Library Stack
2.10 Common Working/Reading Area
2.11 Meeting Room
2.12 Information Desk
2.13 Exhibition
2.14 Theatre / Lecture Hall
2.15 Green Atrium
2.16 Cafe
2.17 Information Dashboard Wall
2.18 Rooftop Bar & Teahouse

Transparent Infrastructure Core

3.1 Supercomputer Room (Hot Data)
3.2 Tape Digital Archive (Cold Data)
3.3 Heat Exchange Room
3.4 Liquid Cooling System
3.5 Service Core
3.6 Loading/Unloading Bay
3.7 Diesal Gernerator Room
3.8 Water Storage Tank & Pump Room
3.9 Transformer Room
3.10 Network Operations Center
3.11 Storage Room
3.12 Cooling Tower
3.13 Service Corridor

OTHER

4.1 Civic Agora Courtyard
4.2 Public Car Parking
4.3 Staff Car Parking
4.4 Pedestrian Tunnel
4.5 Pedestrian Deck
4.6 Visitor Drop Off Area
4.7 Bike Rack

Basement Level 1 +0.4m 1:500

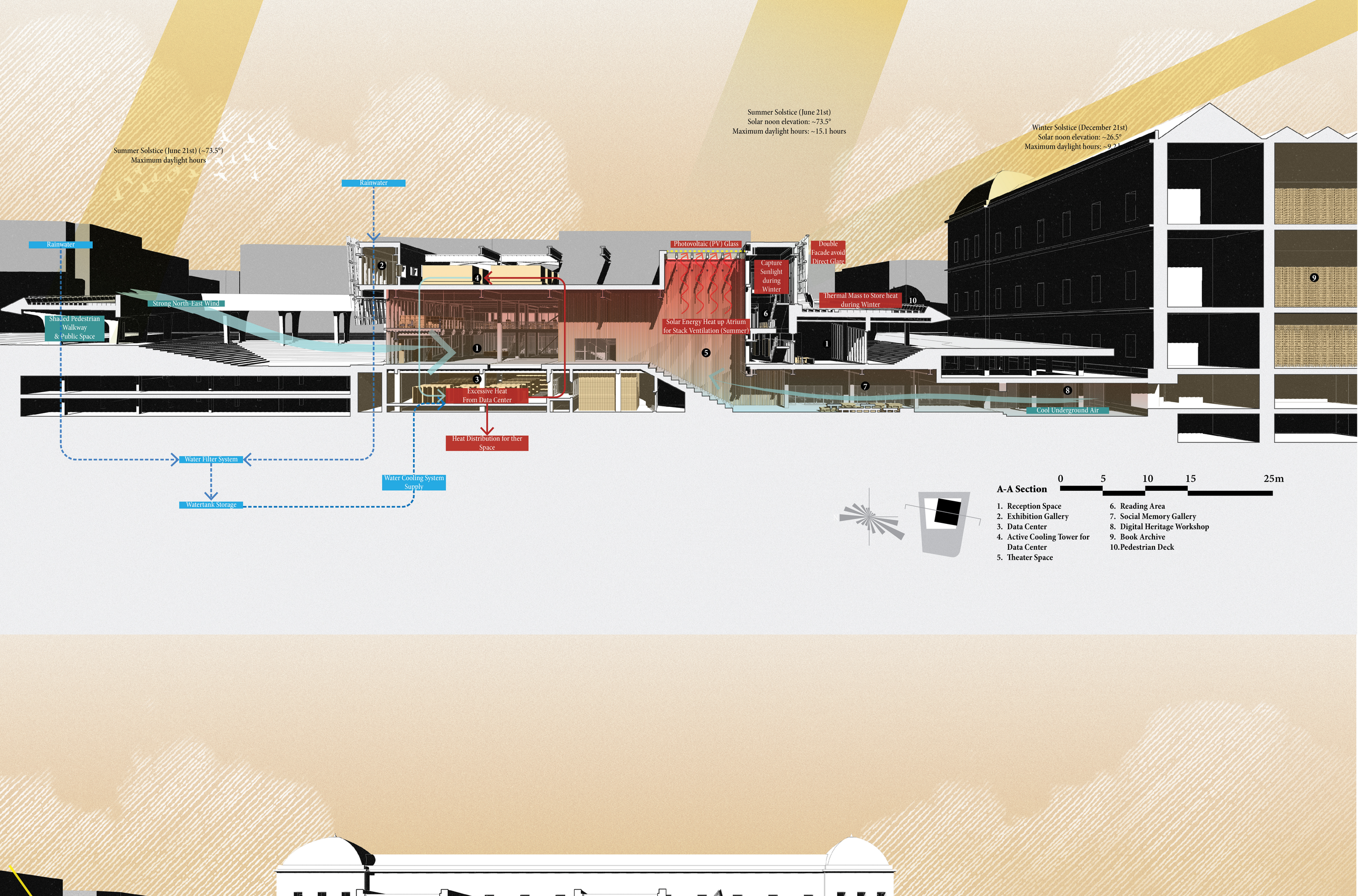
0 10 20 30 50

Summer Solstice (June 21st) (~73.5°)
Maximum daylight hours

Summer Solstice (June 21st)
Solar noon elevation: ~73.5°
Maximum daylight hours: ~15.1 hours

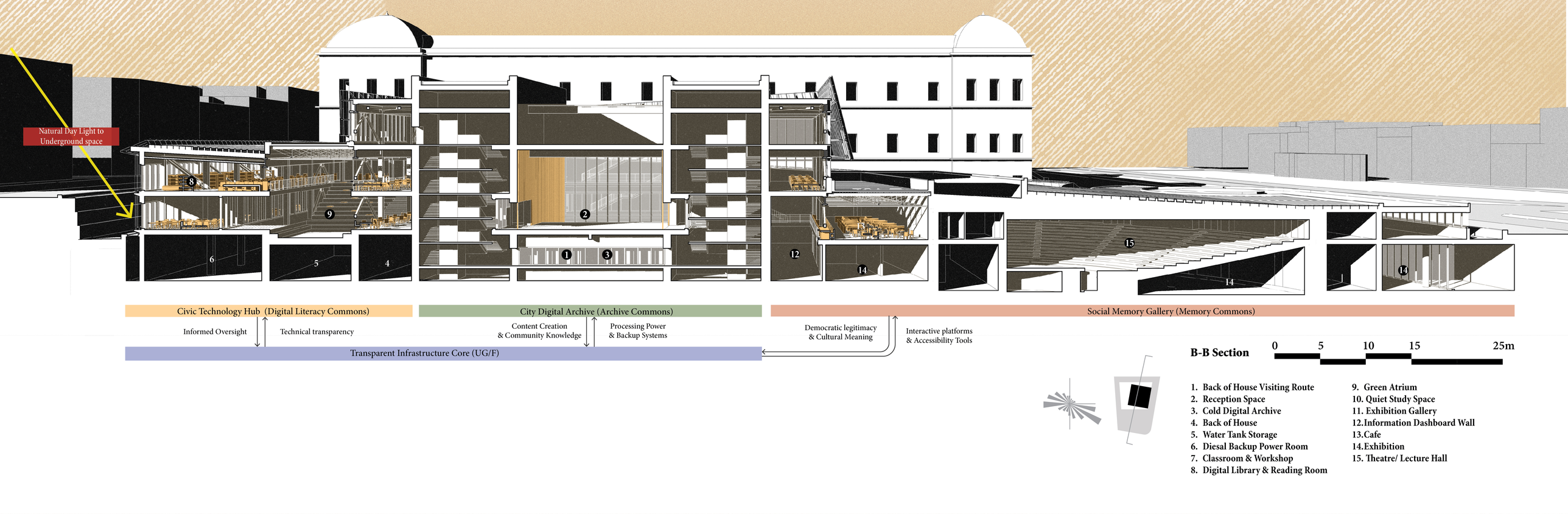
Winter Solstice (December 21st)
Solar noon elevation: ~26.5°
Maximum daylight hours: ~9.2 h

Rainwater
Rainwater
Strong North-East Wind
Shaded Pedestrian Walkway & Public Space
Photovoltaic (PV) Glass
Capture Sunlight during Winter
Double Facade avoid Direct Glare
Thermal Mass to Store heat during Winter
Solar Energy Heat up Atrium for Stack Ventilation (Summer)
Excessive Heat From Data Center
Heat Distribution for ther Space
Water Filter System
Water Cooling System Supply
Watertank Storage
Cool Underground Air



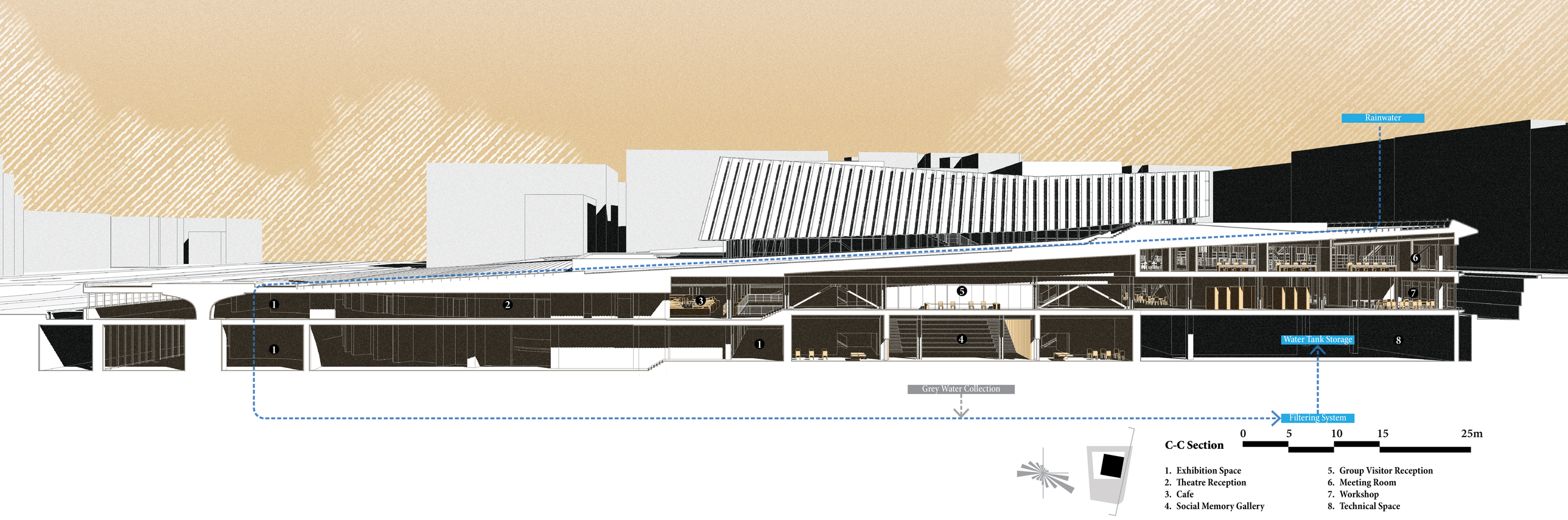
A-A Section 0 5 10 15 25m

1. Reception Space
2. Exhibition Gallery
3. Data Center
4. Active Cooling Tower for Data Center
5. Theater Space
6. Reading Area
7. Social Memory Gallery
8. Digital Heritage Workshop
9. Book Archive
10. Pedestrian Deck



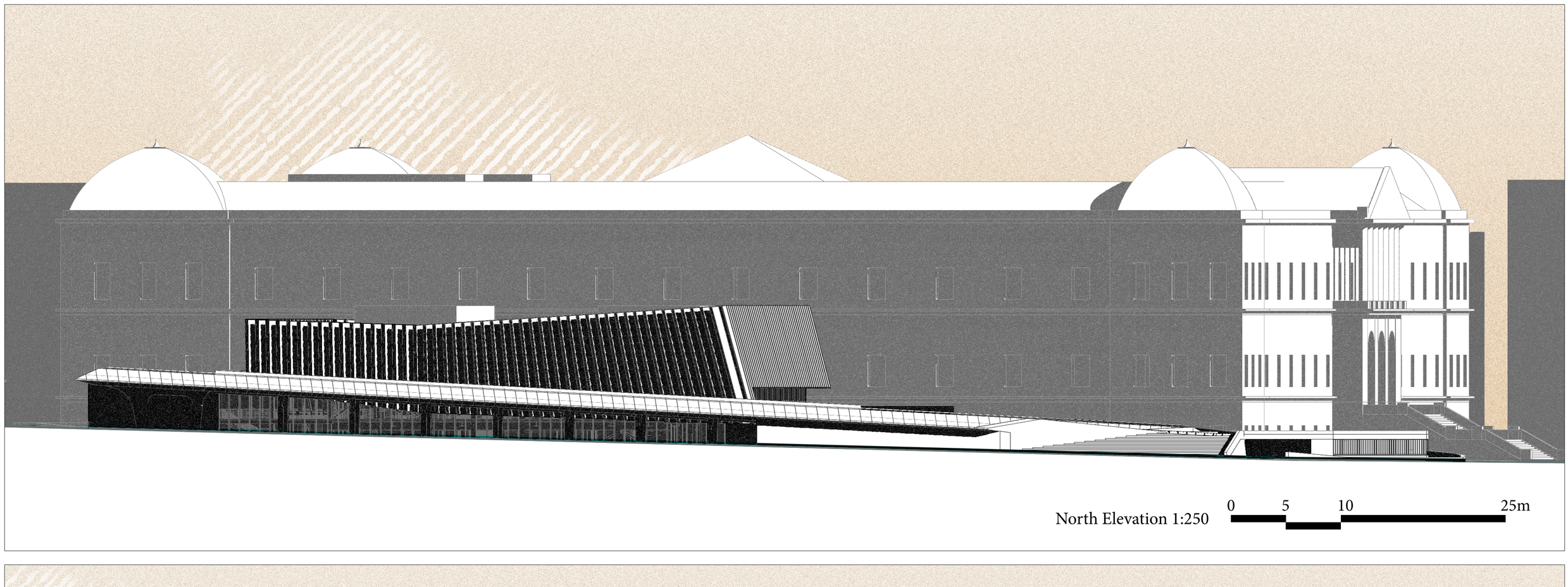
B-B Section 0 5 10 15 25m

1. Back of House Visiting Route
2. Reception Space
3. Cold Digital Archive
4. Back of House
5. Water Tank Storage
6. Diesal Backup Power Room
7. Classroom & Workshop
8. Digital Library & Reading Room
9. Green Atrium
10. Quiet Study Space
11. Exhibition Gallery
12. Information Dashboard Wall
13. Cafe
14. Exhibition
15. Theatre/ Lecture Hall



C-C Section 0 5 10 15 25m

1. Exhibition Space
2. Theatre Reception
3. Cafe
4. Social Memory Gallery
5. Group Visitor Reception
6. Meeting Room
7. Workshop
8. Technical Space



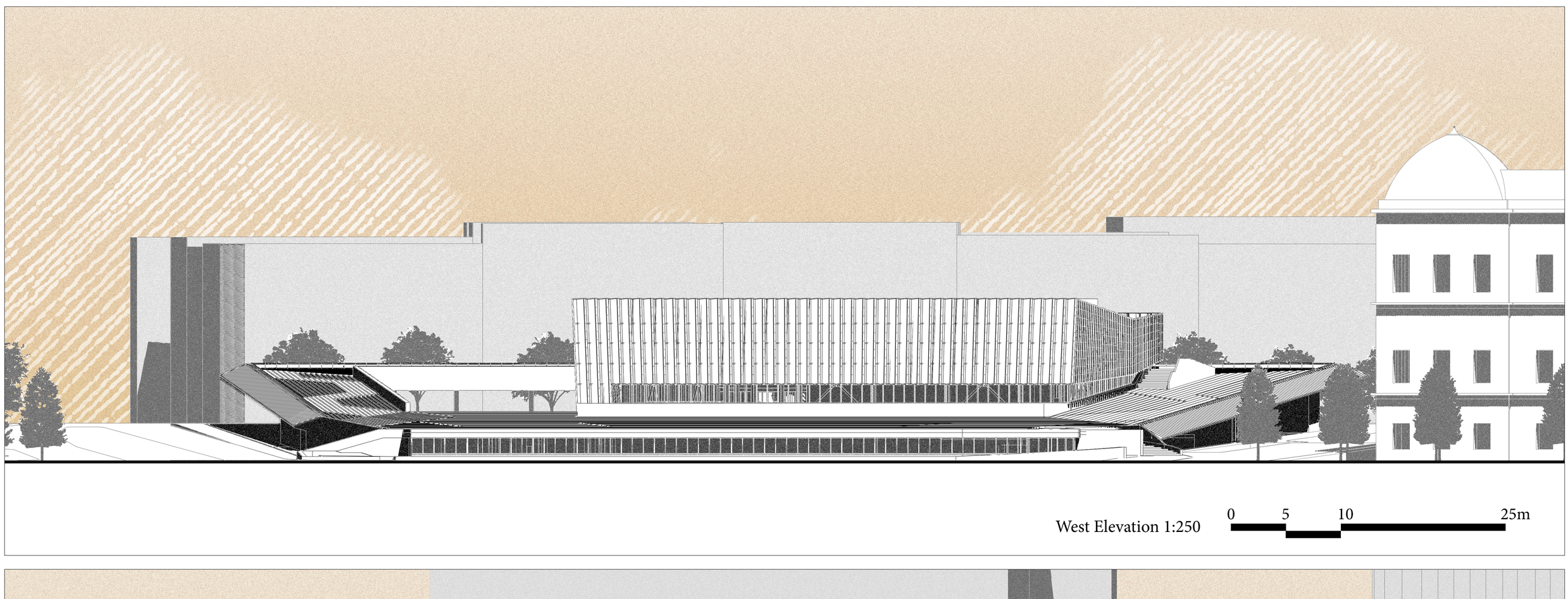
North Elevation 1:250

0 5 10 25m



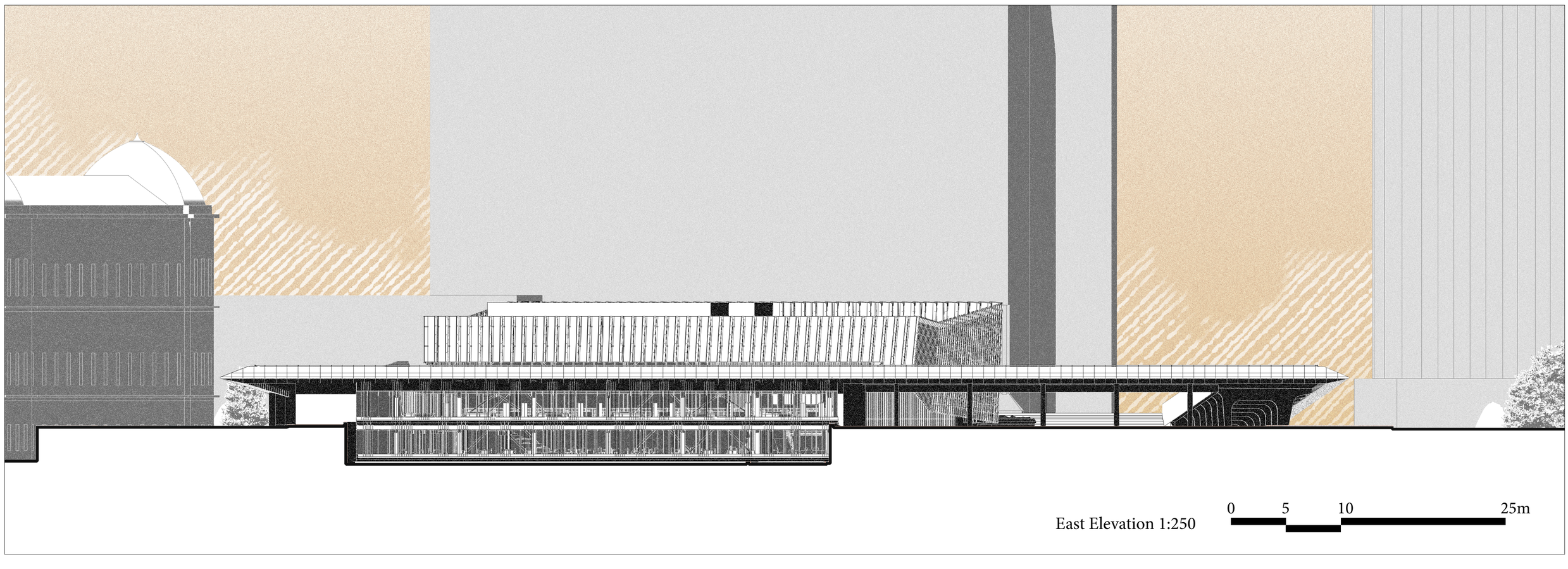
South Elevation 1:250

0 5 10 25m



West Elevation 1:250

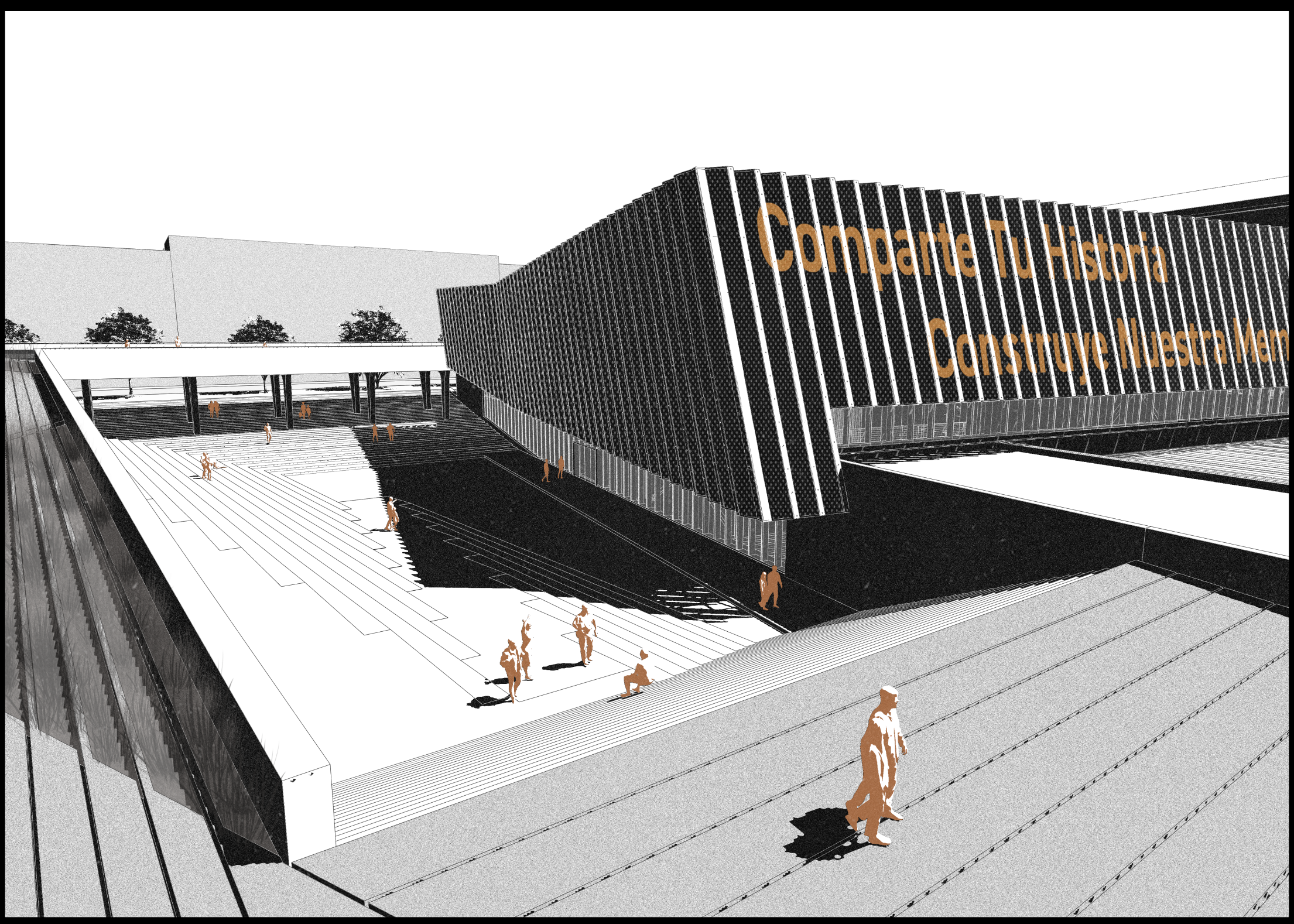
0 5 10 25m

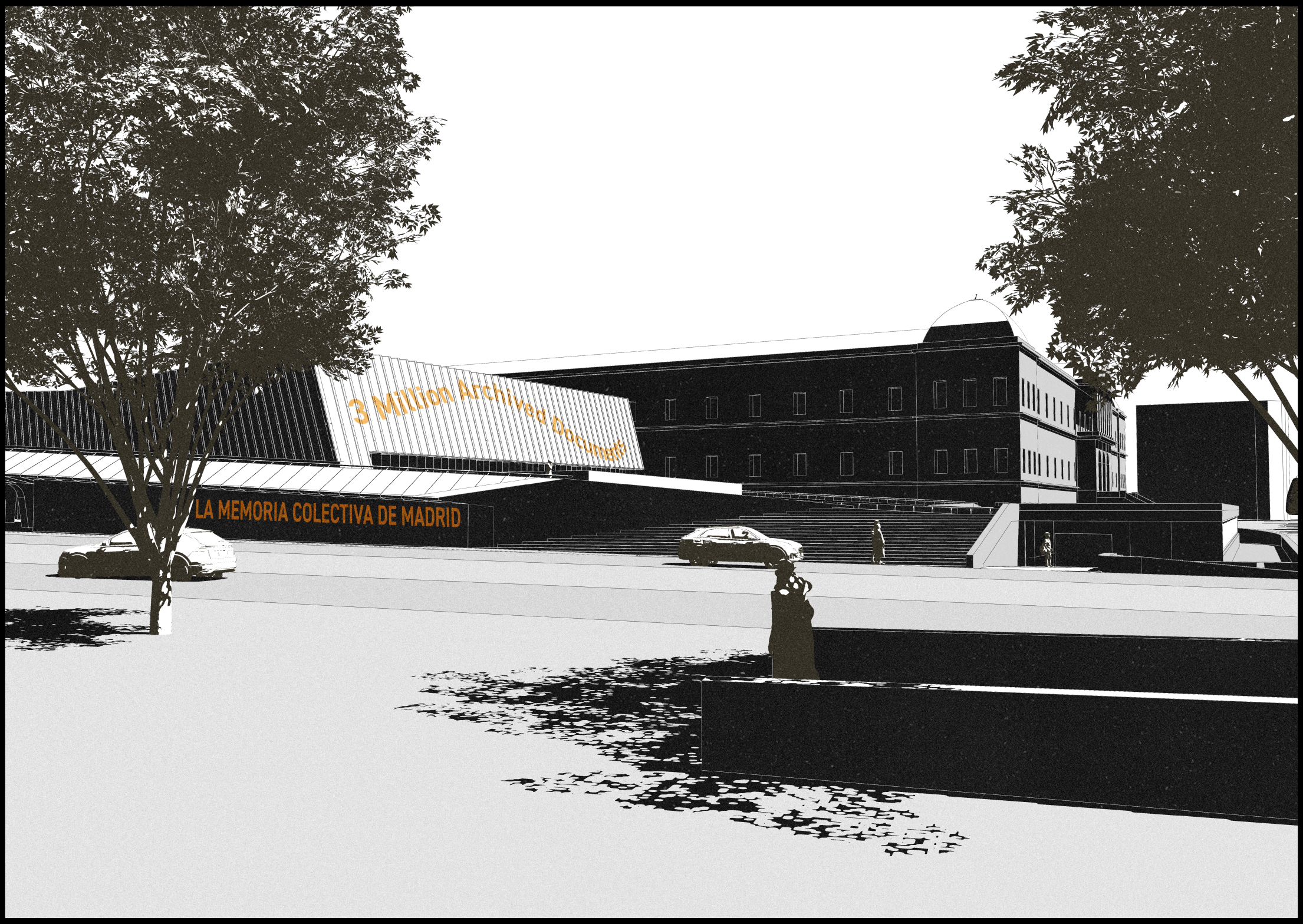


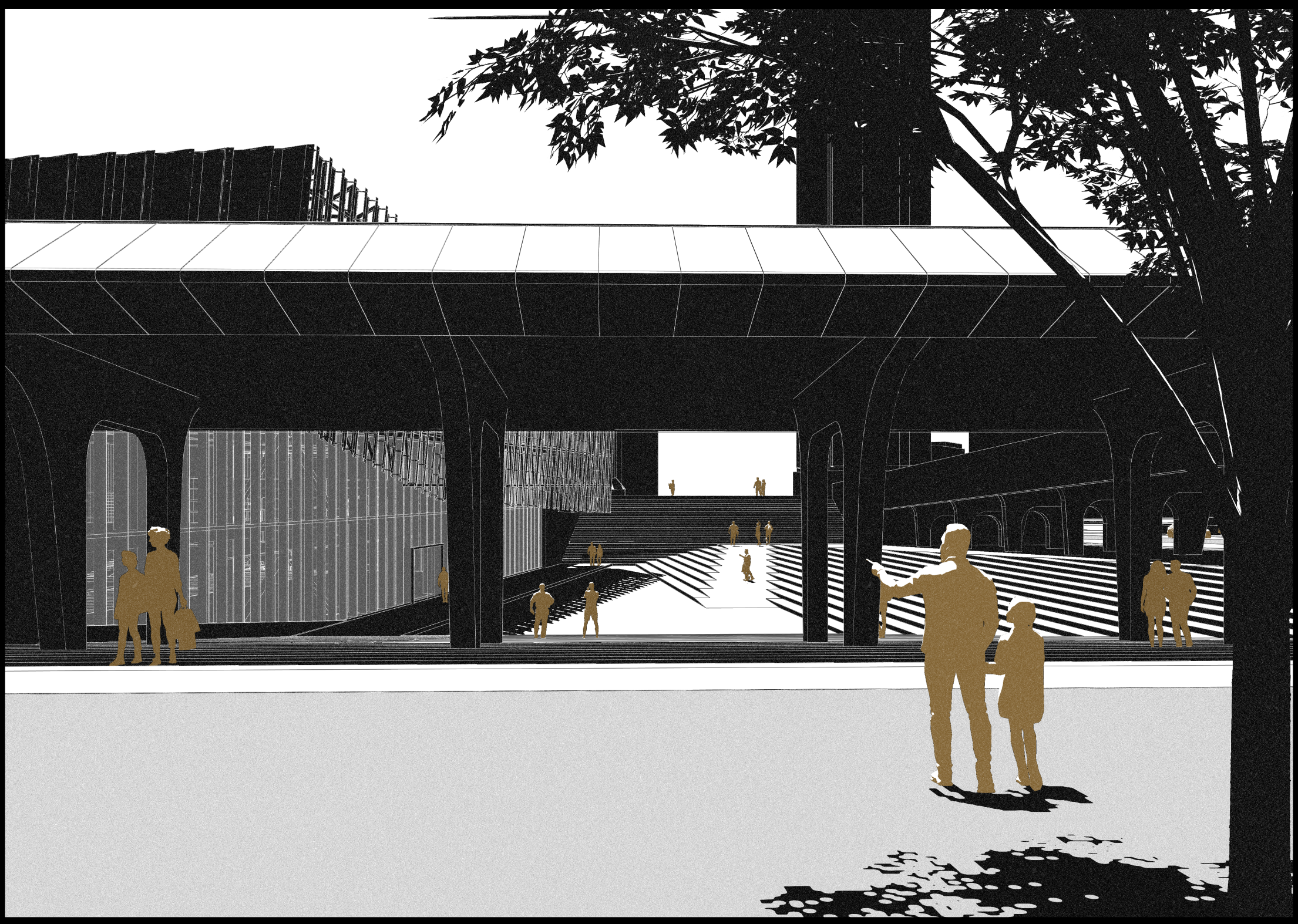
East Elevation 1:250

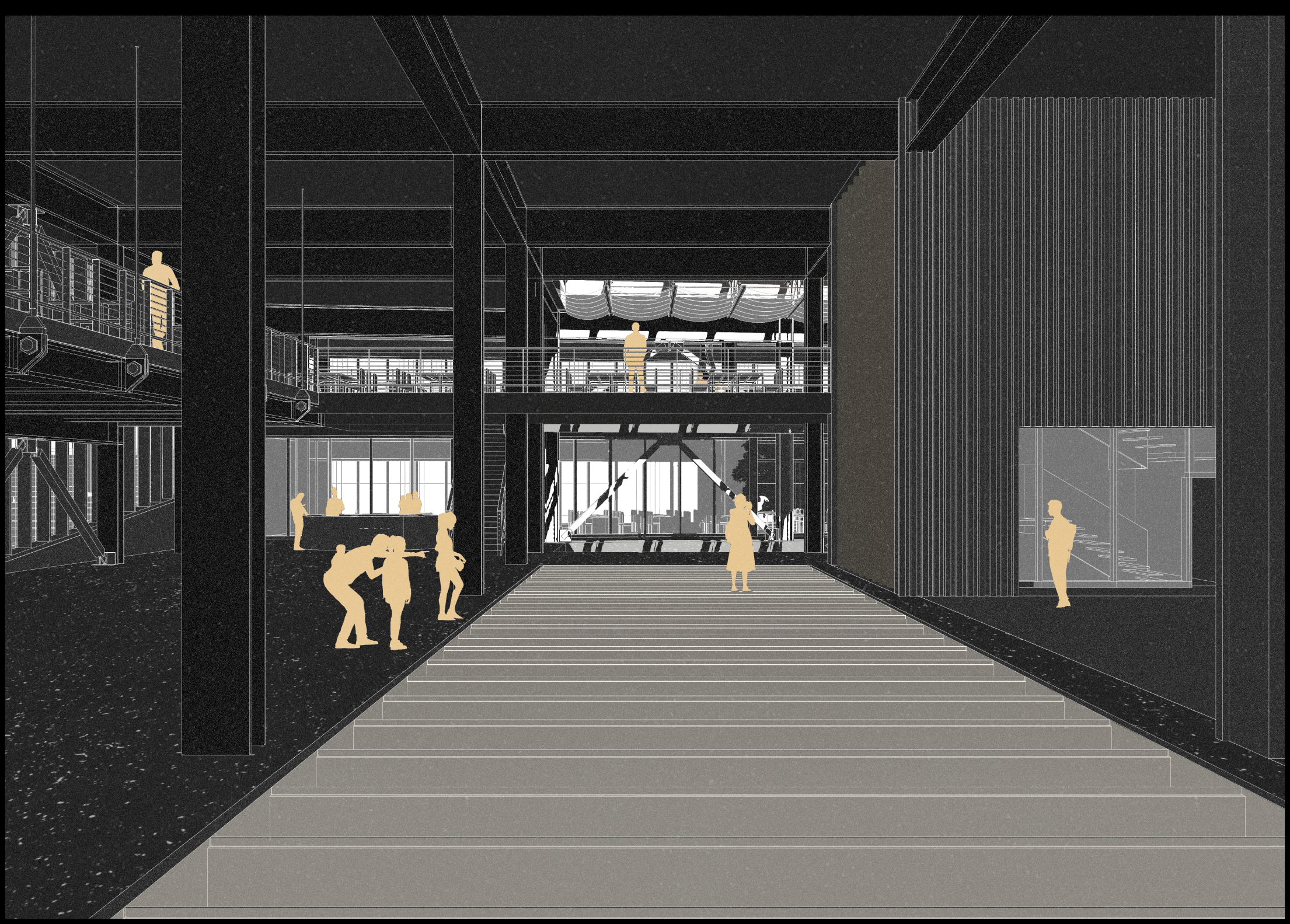
0 5 10 25m

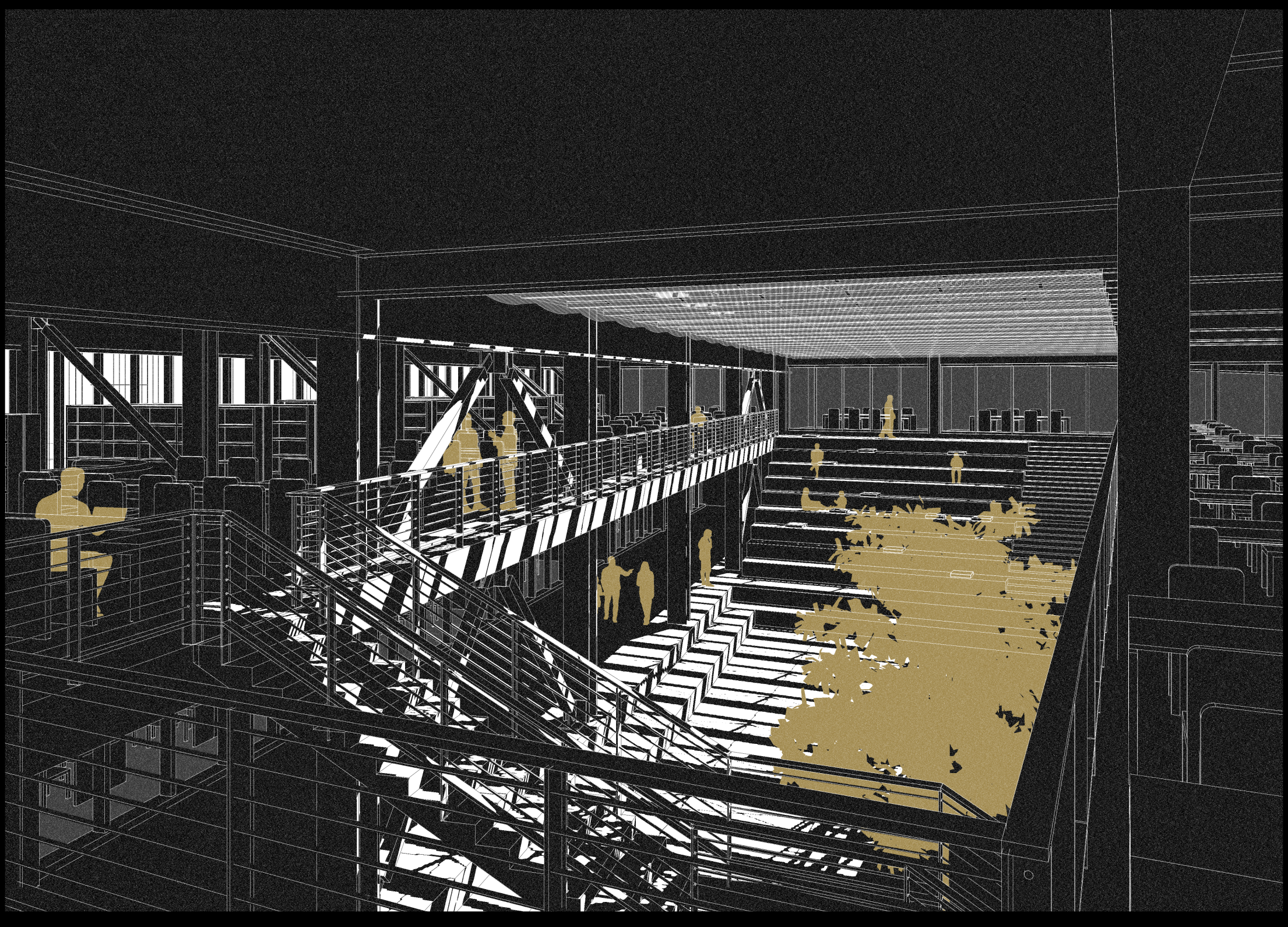

Tu Ciudad, Tu Archivo, Tu Memoria


Comparte Tu Historia
Construye Nuestra Mem


3 Million Archived Documents
LA MEMORIA COLECTIVA DE MADRID







"María from Malasaña just added her family recipes to the archive."

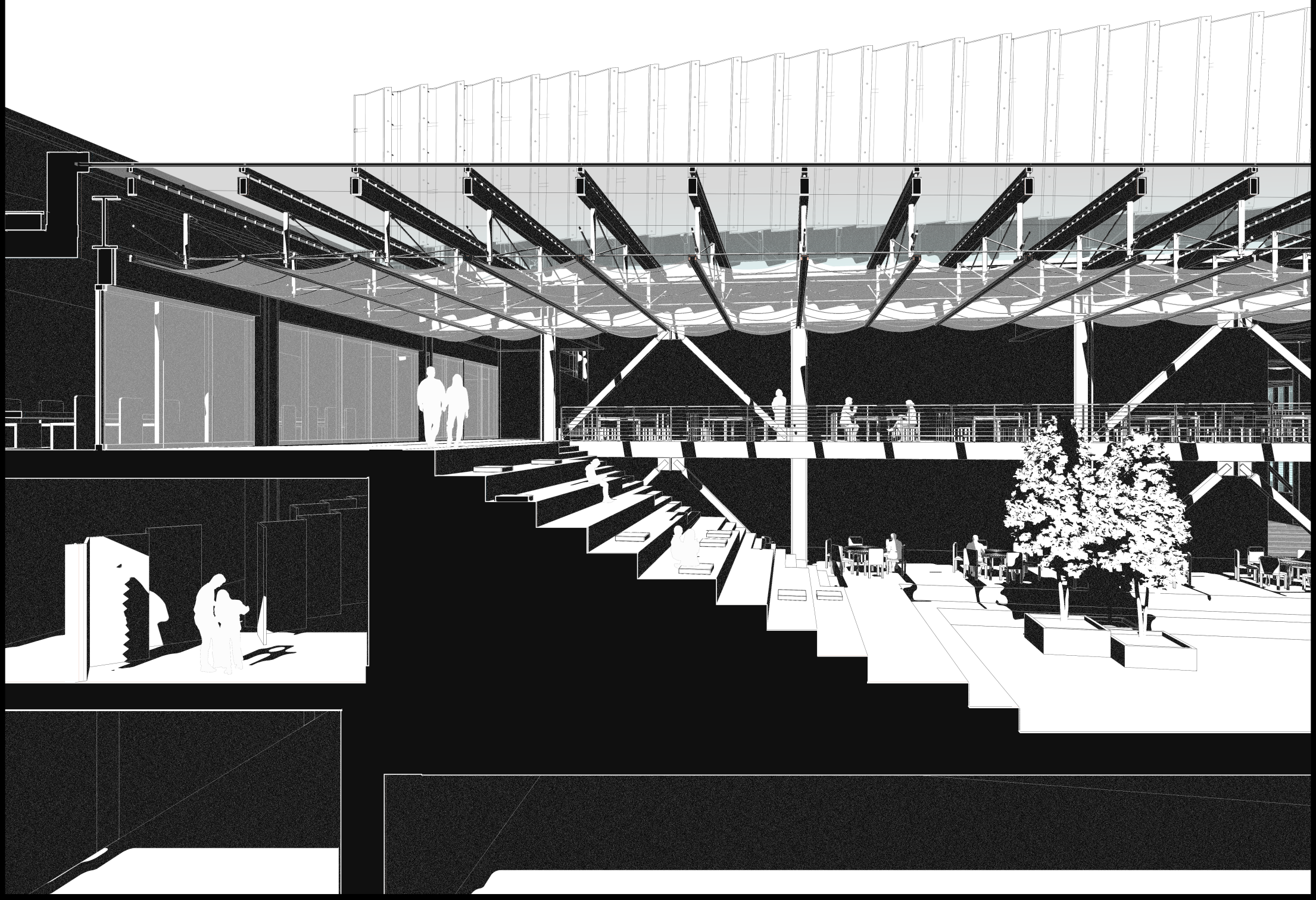
"Carlos, retired librarian, is digitizing neighborhood photos from the 80s."

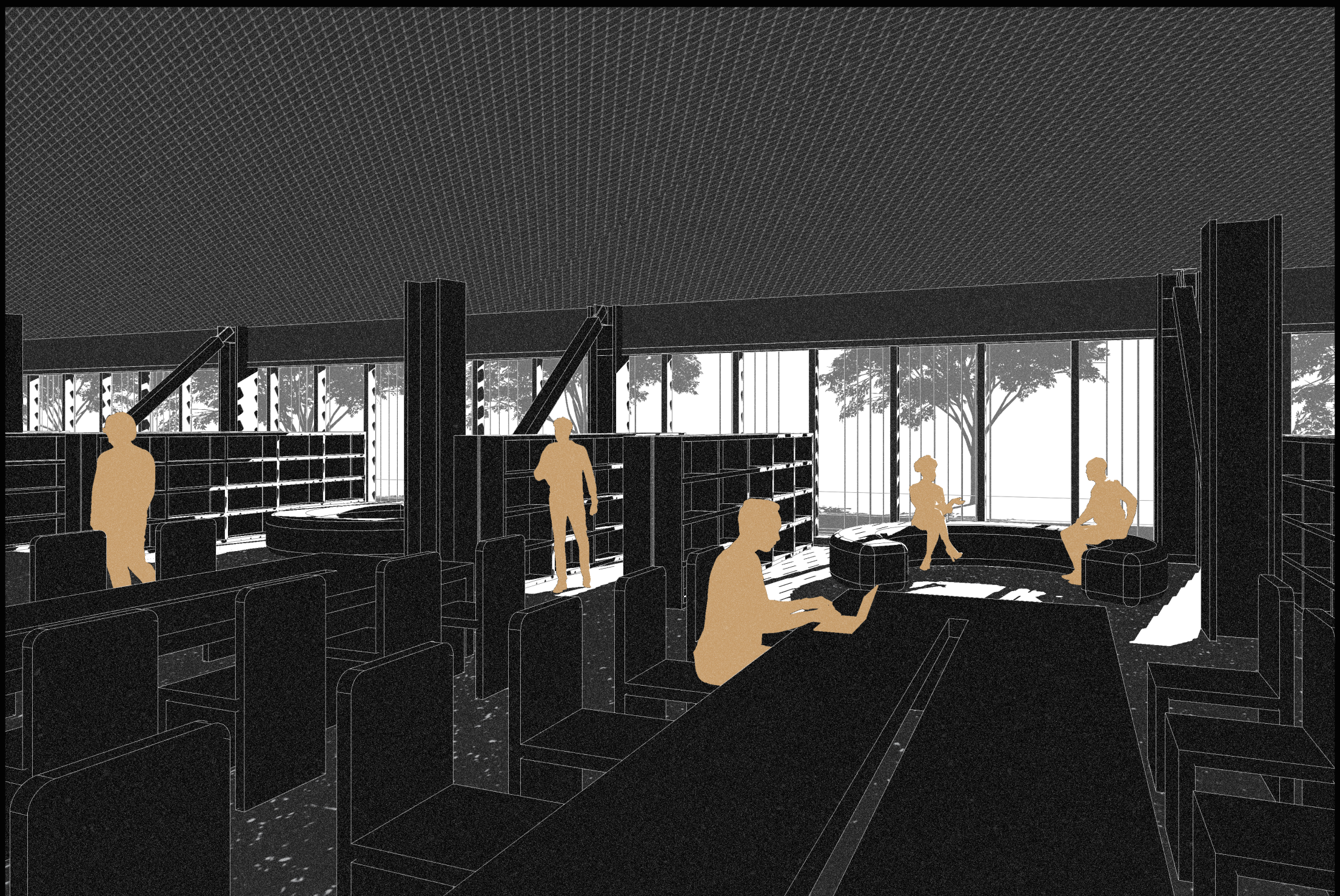
"Students from IES Ramiro uploaded interviews with their grandparents."

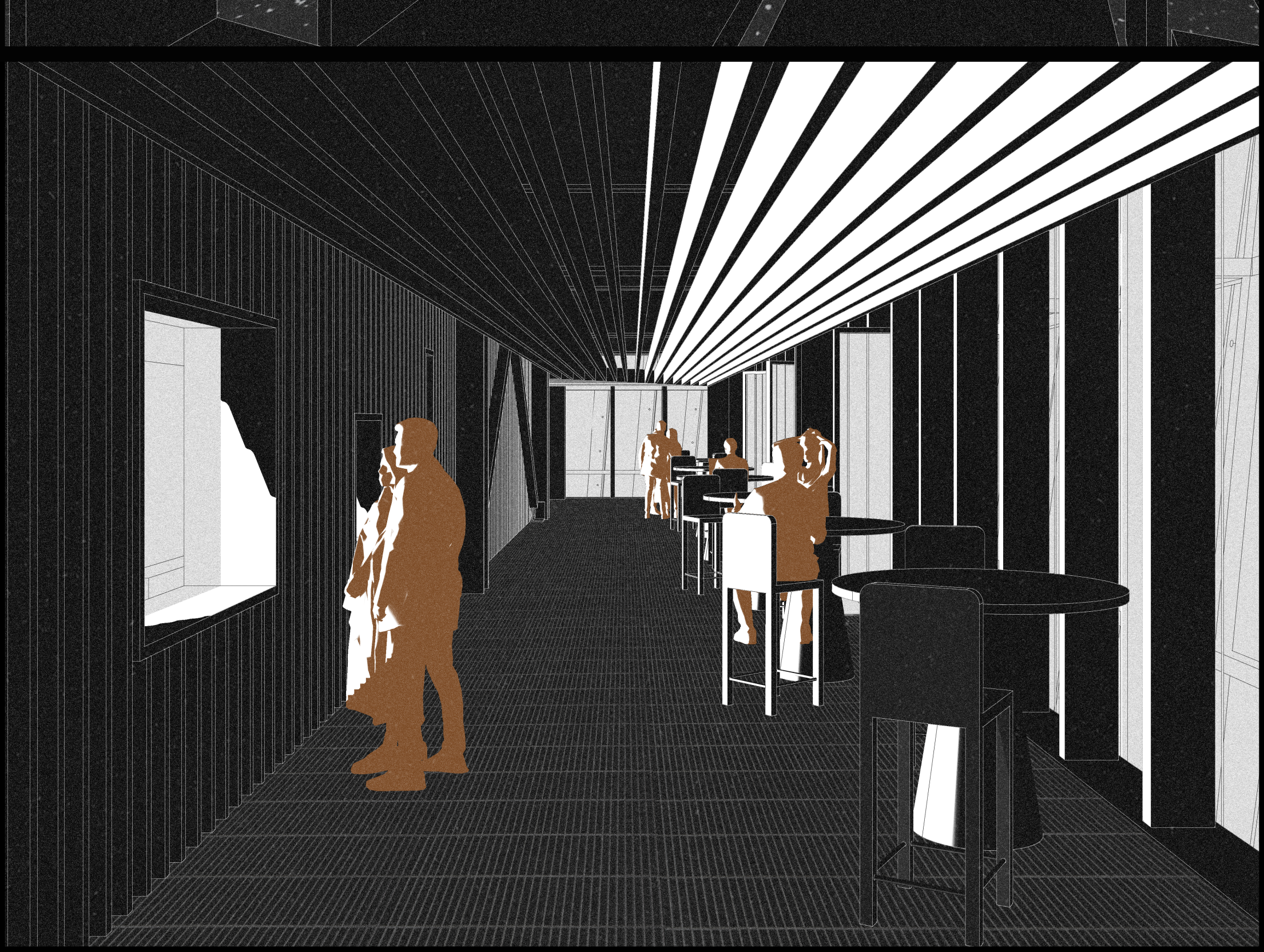
LABORATORIO DE DIGITALIZACIÓN

APORTA TUS CONOCIMIENTOS!

LABORATORIO DE PROCESAMIENTO DE DATOS







ESTADO EN VIVO DE
INFRAESTRUCTURA DIGITAL

PEAK USAGE DETECTED - All systems operating at maximum capacity

ENERGY CONSUMPTION

847kW

Peak: 900kW | Powering: 1,247 homes equivalent

WATER CONSUMPTION

195L/sec

Daily: 16.8M liters | Cooling: 2,340 acres

HEAT RECOVERY

624kW

SERVER UPTIME

94%

CARBON OFFSET

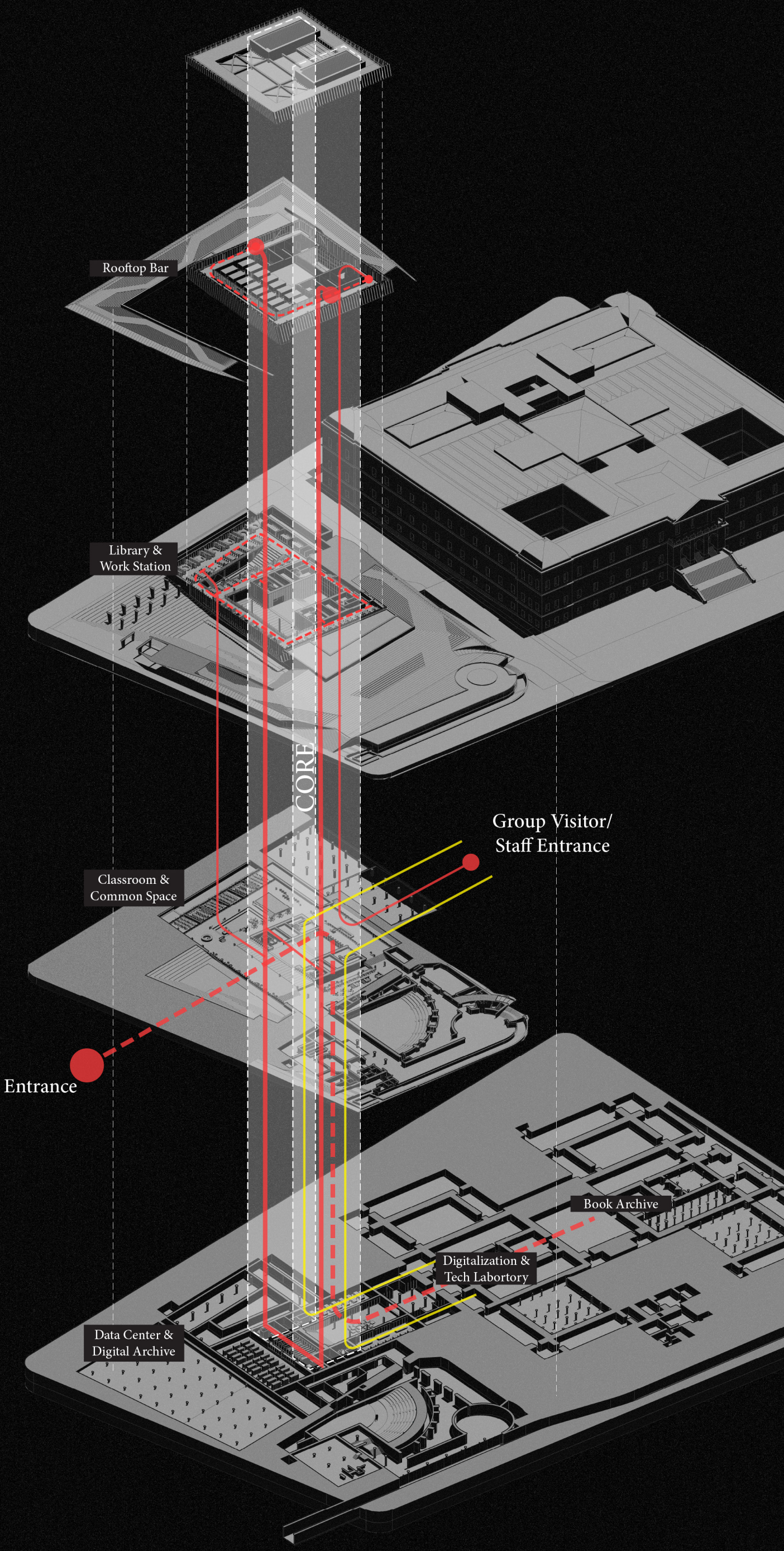
47%

PUE EFFICIENCY

VERTICAL CIRCULATION

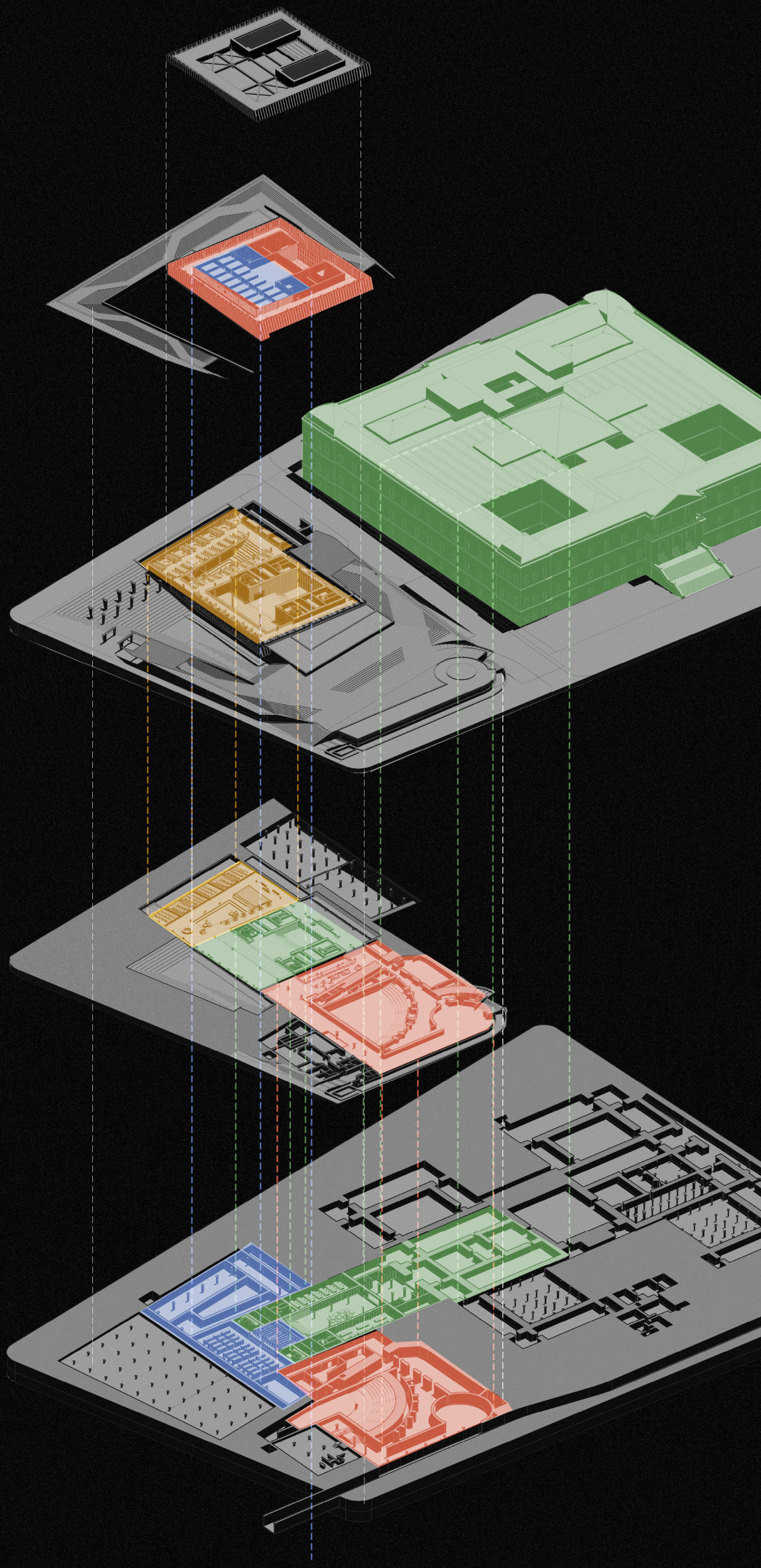
Public Access

Private Access



Program & Zoning

- Transparent Infrastructure Core
- Civic Technology Hub
  (Digital Literacy Commons)
- City Digital Archive
  (Archive Commons)
- Social Memory Gallery
  (Memory Commons)



Civic Technology Hub (Digital Literacy Commons)

Civic Tech Hub + Data Center:

- Glass viewing corridors allowing students to observe server operations during classes
- Real-time infrastructure dashboards integrated into learning stations
- Exposed MEP systems
- Interactive displays showing data flow and energy consumption

- AI-Mediated Knowledge Integration Flow:

Personal Story/Knowledge

↓

AI Training Workshop

↓

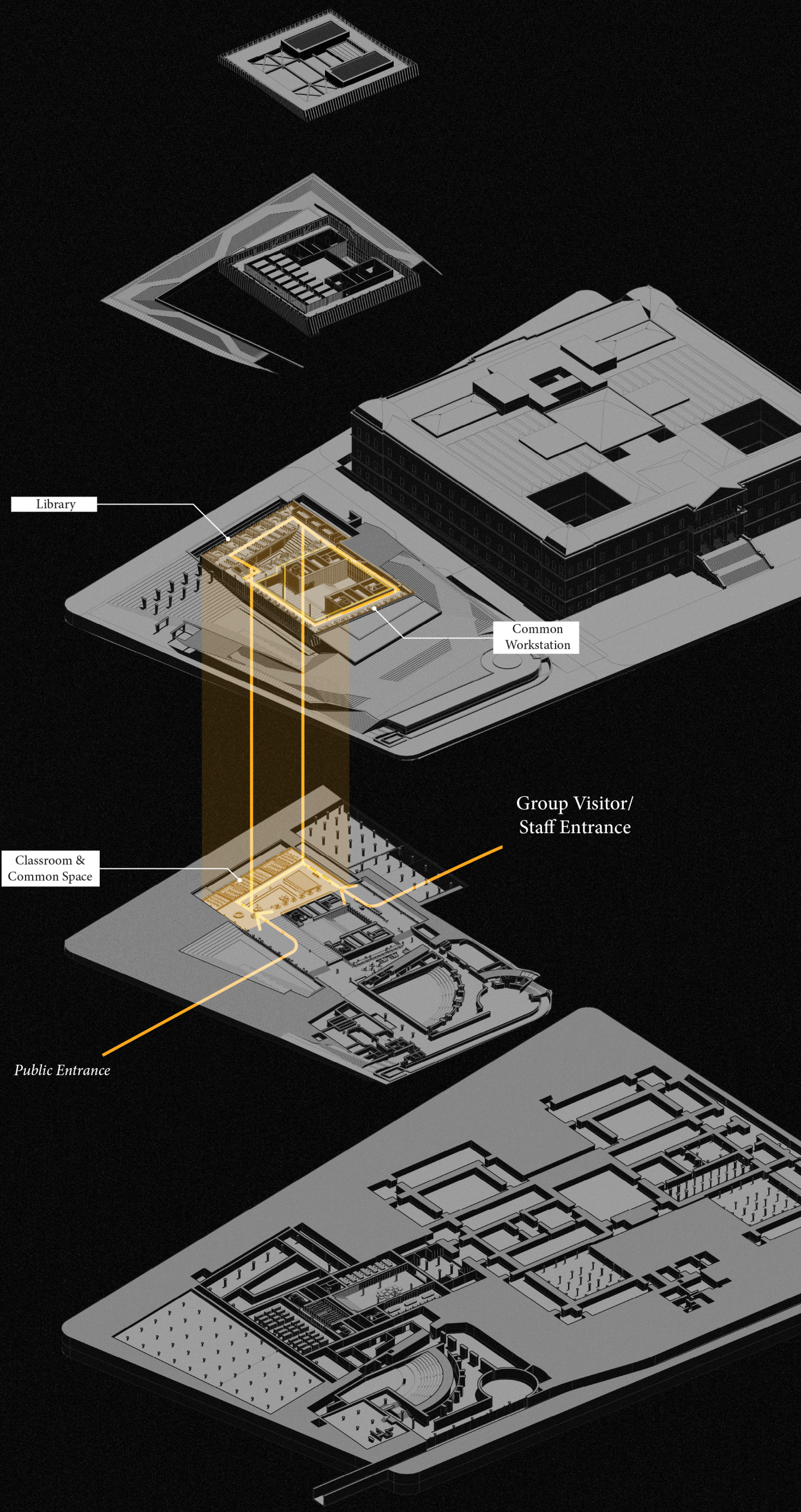
Community Algorithm

↓

Story Connections

↓

Citizen Oversight



City Digital Archive (Archive Commons)

Archive Commons + Transparent Infrastructure Core

- Direct digital pipeline from water cooling to server storage
- Real-time backup systems visible through glass partitions
- Shared cooling systems serving both digitization equipment and servers
- Quality control stations monitoring digital file integrity

Book Digitization → AI Training Flow

Historical document/ Books (Library Archive)

↓

Digital Scanning

↓

Server Storage

↓

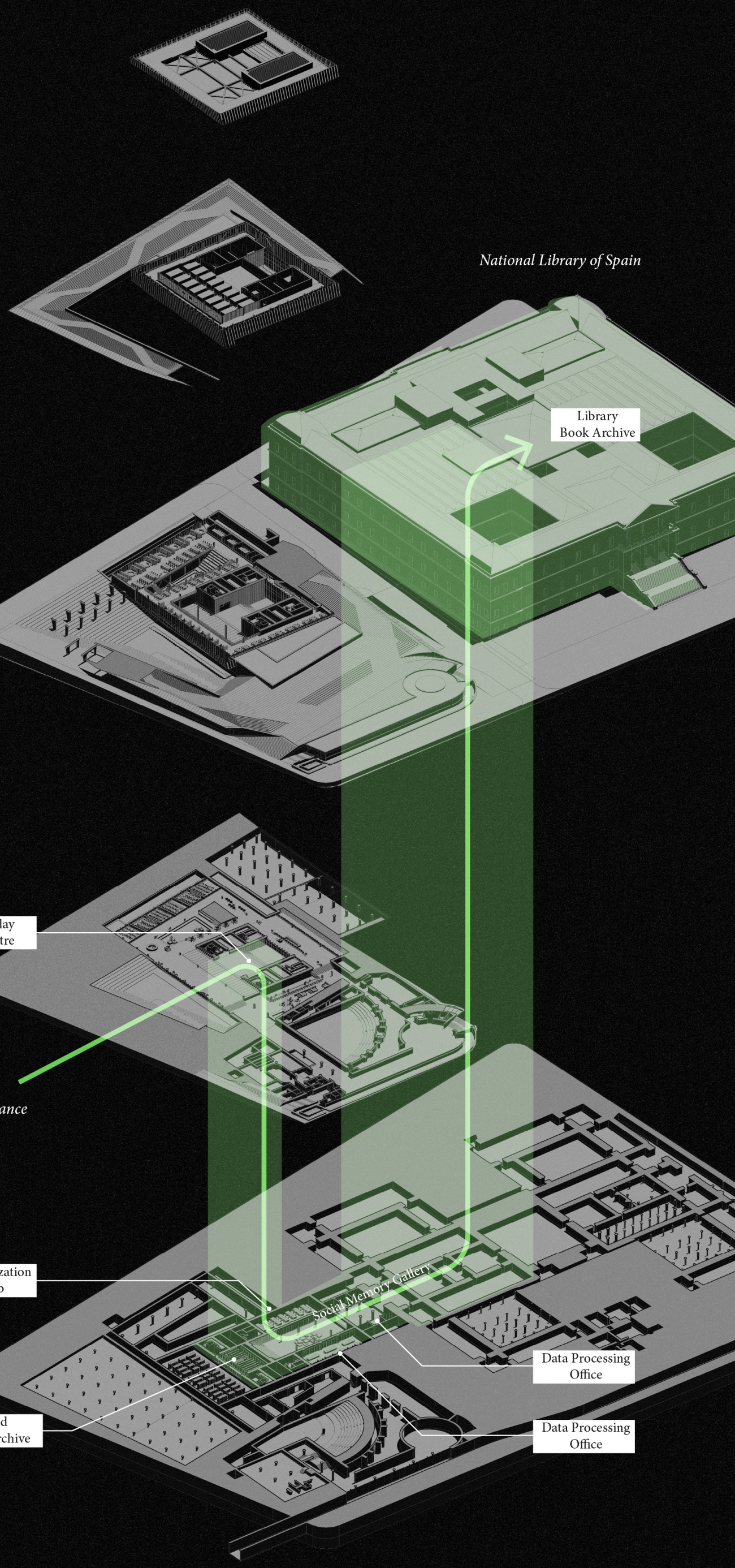
Local AI Model Training

↓

Conversational Search

↓

Citizen Oversight



Social Memory Gallery (Memory Commons)

Social Memory Commons + Archive Commons

- Community story recording stations feeding into archive database
- Collaborative cataloging workspaces where citizens help tag historical materials
- Exhibition prep areas where archived materials become public displays
- Research consultation desks connecting personal stories to historical context

Community Contribution Flow:

Personal Story /Knowledge Contribution

↓

Review & Tag

↓

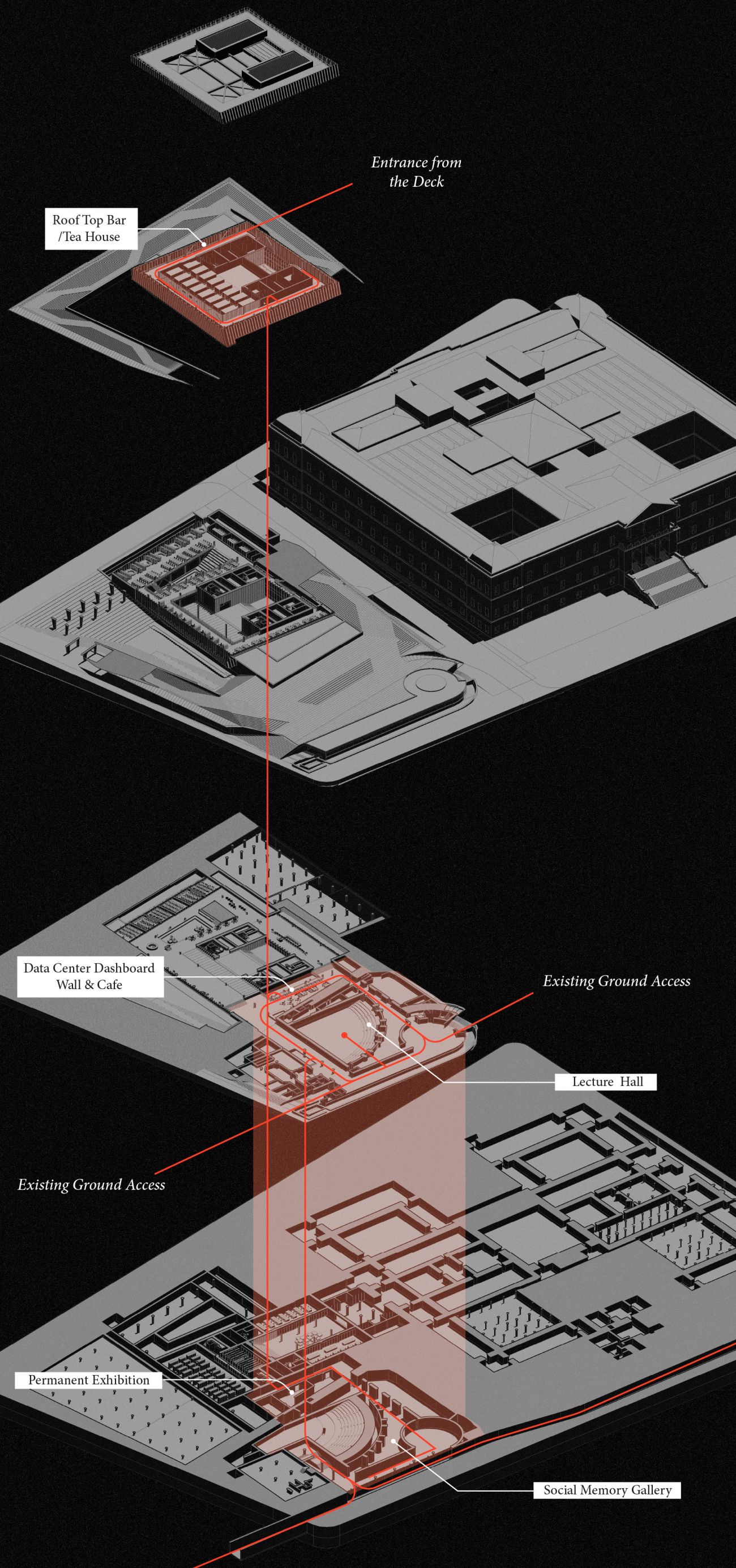
Digital Storage

↓

Public Exhibition

↓

Community Social Memory



Transparent Infrastructure Core

Civic Tech Hub + Data Center:

- Glass viewing corridors allowing students to observe server operations during classes
- Real-time infrastructure dashboards integrated into learning stations
- Exposed MEP systems
- Interactive displays showing data flow and energy consumption

- Learning-by-Observing Flow:

Digital Theory
from Classes (Abstract Concept)

↓

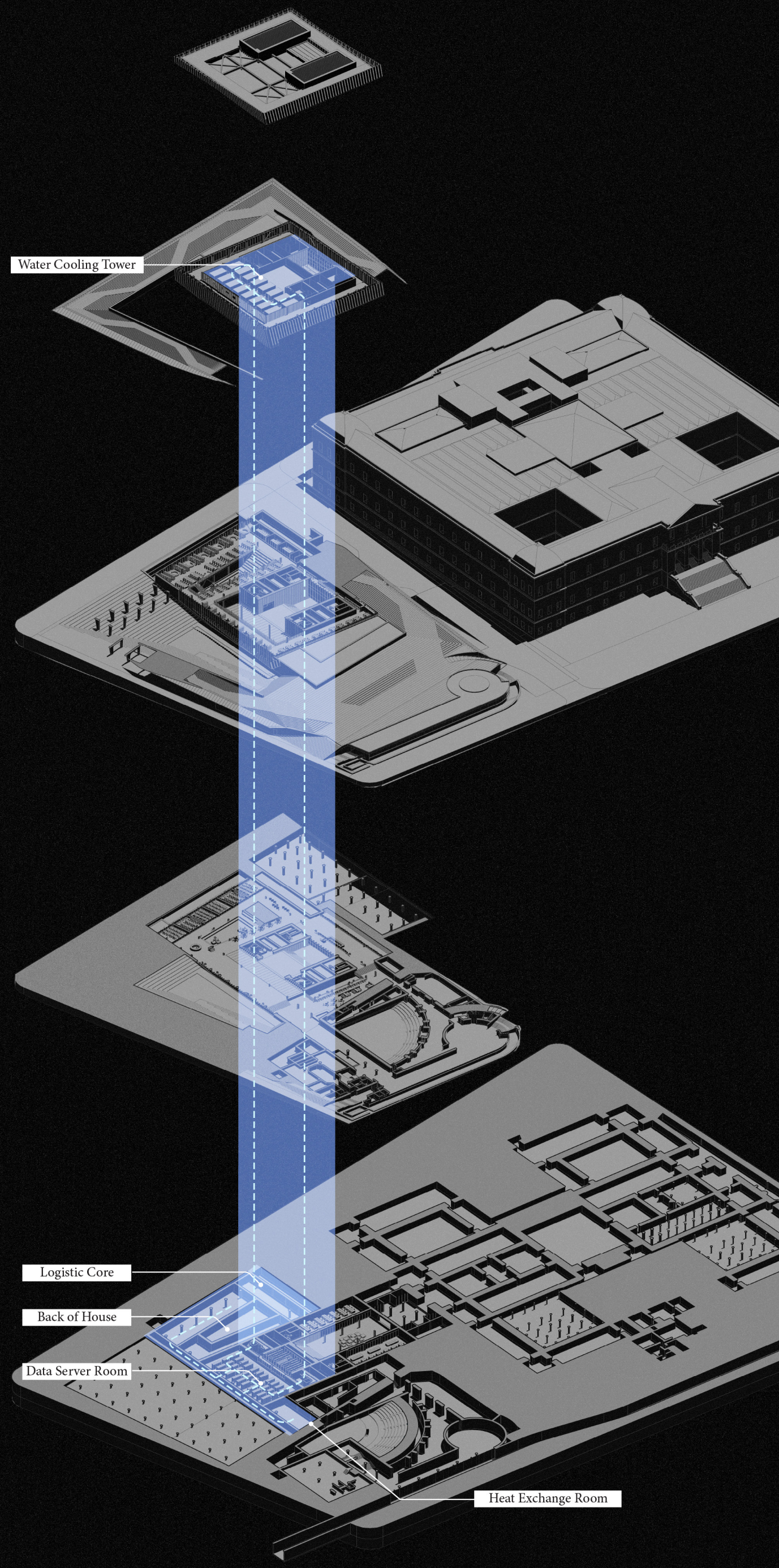
Live Observation
of Server Operation
(Physical Reality)

↓

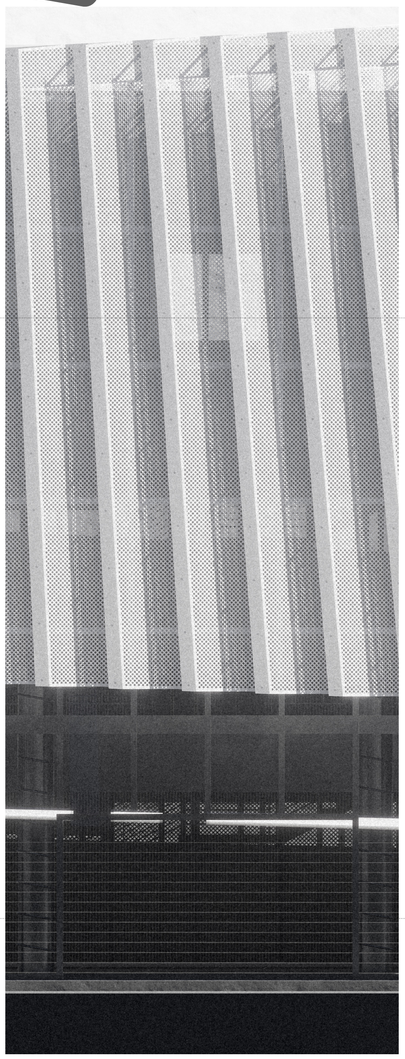
Real Understanding
(Informed Citizenship)

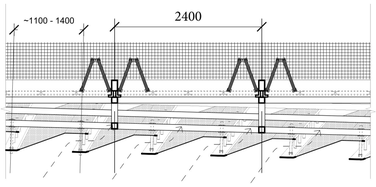
↓

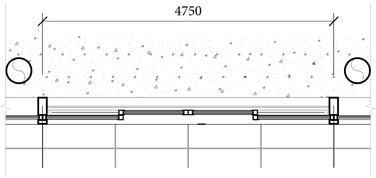
Other
Practical Application



NORTH FACADE ELEVATION & PLAN 1:50

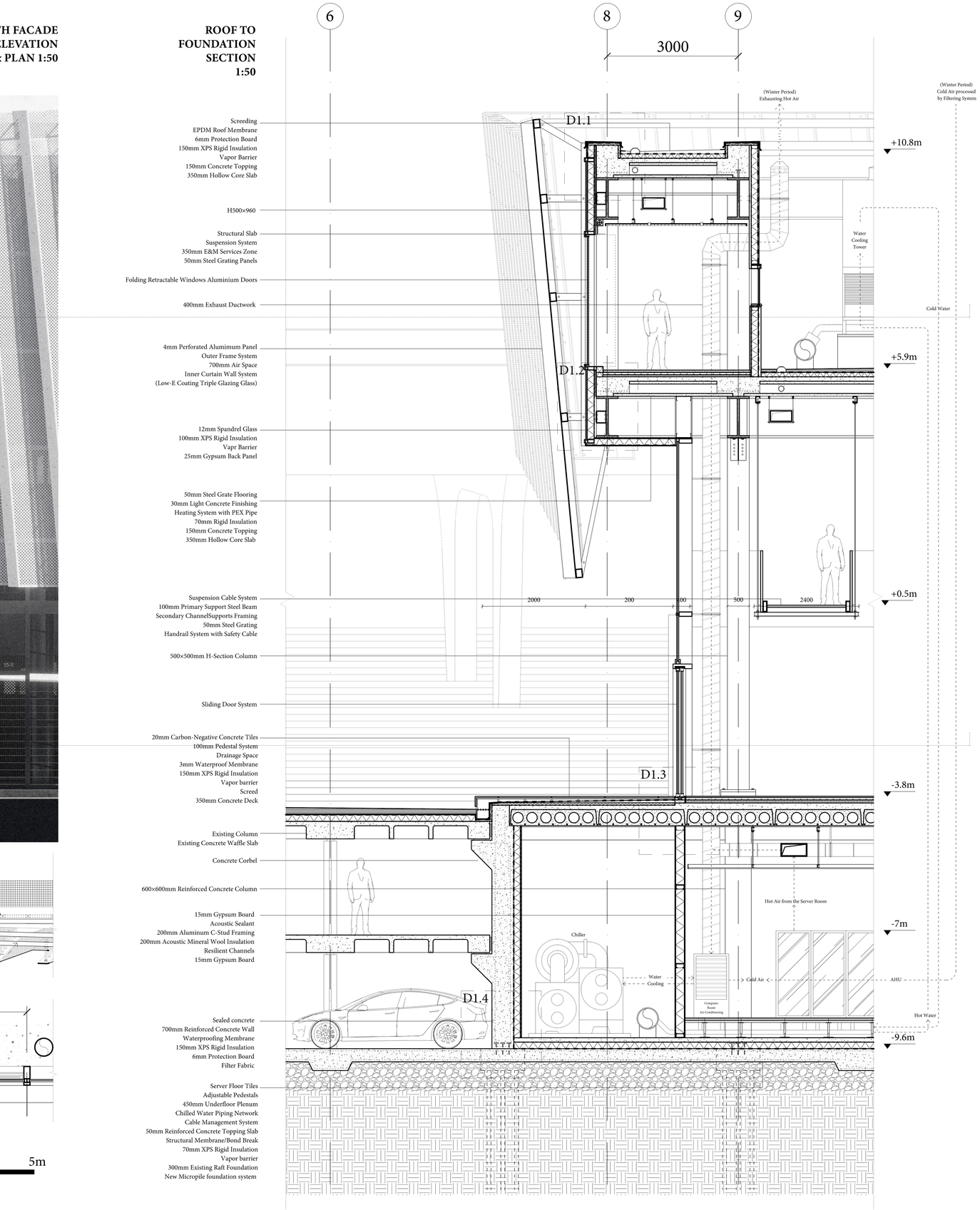






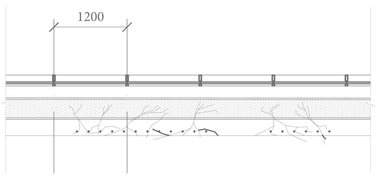
0 1 2 3 5m

ROOF TO FOUNDATION SECTION 1:50



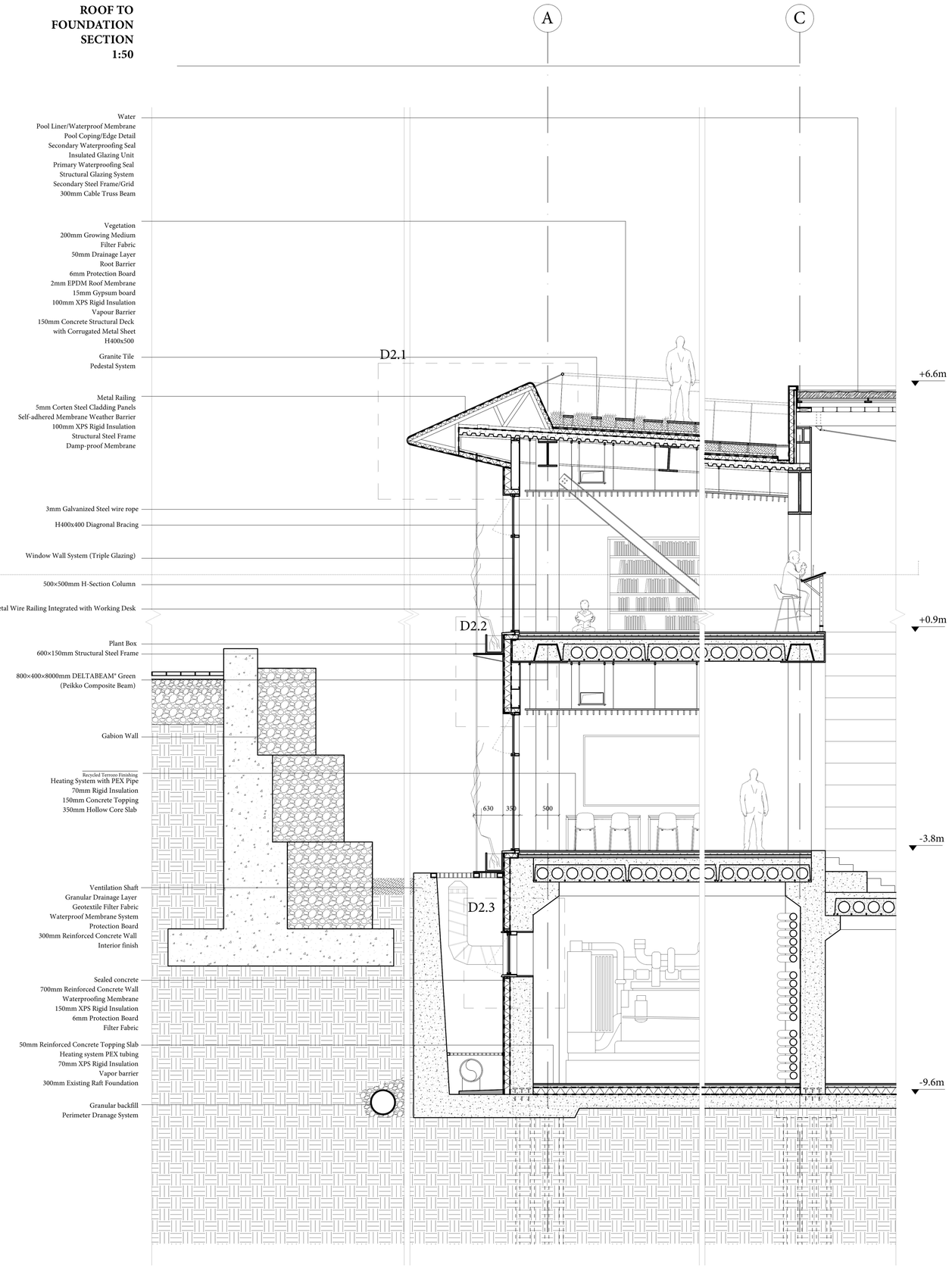
EAST FACADE ELEVATION & PLAN 1:50

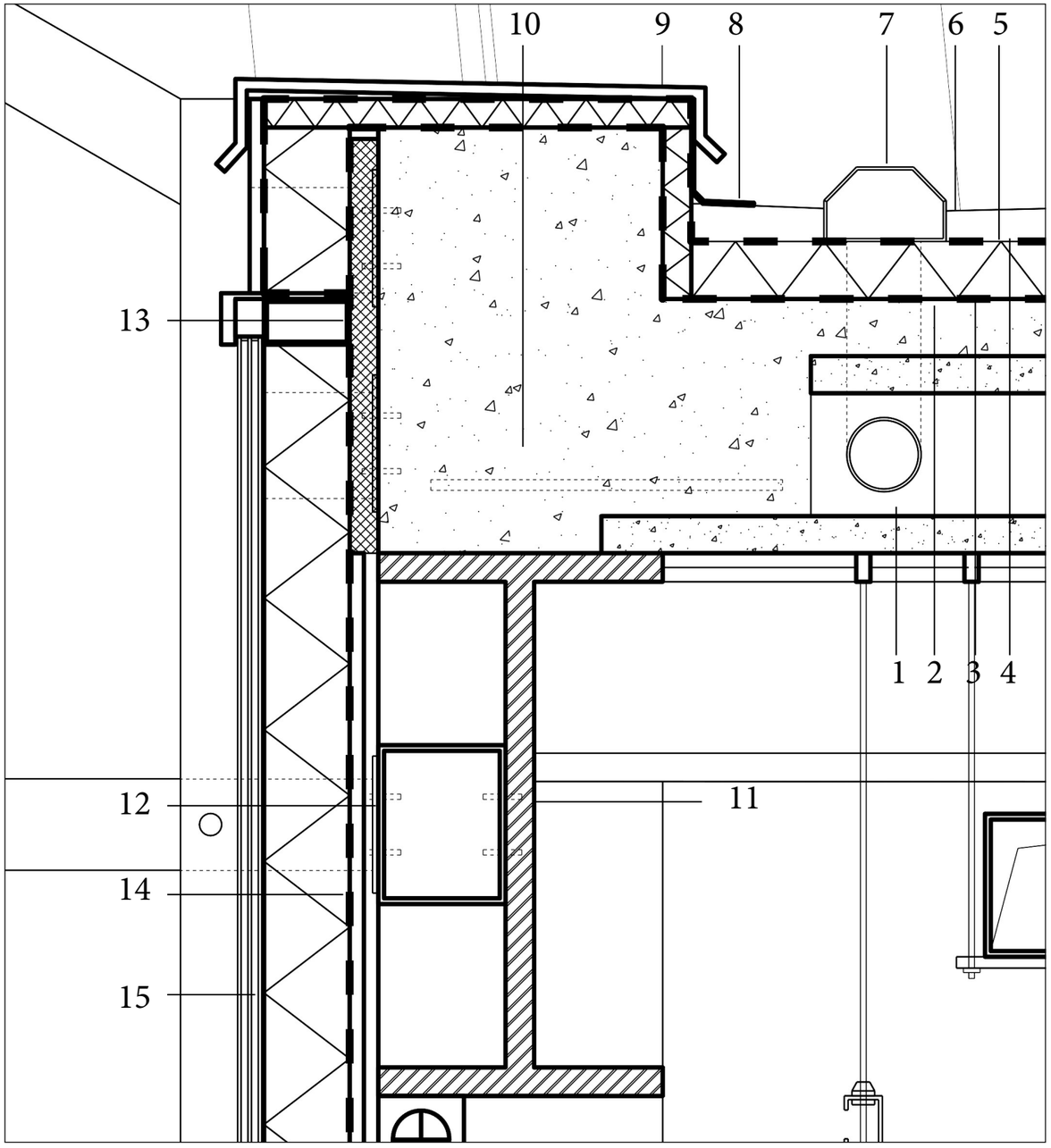




0 1 2 3 5m

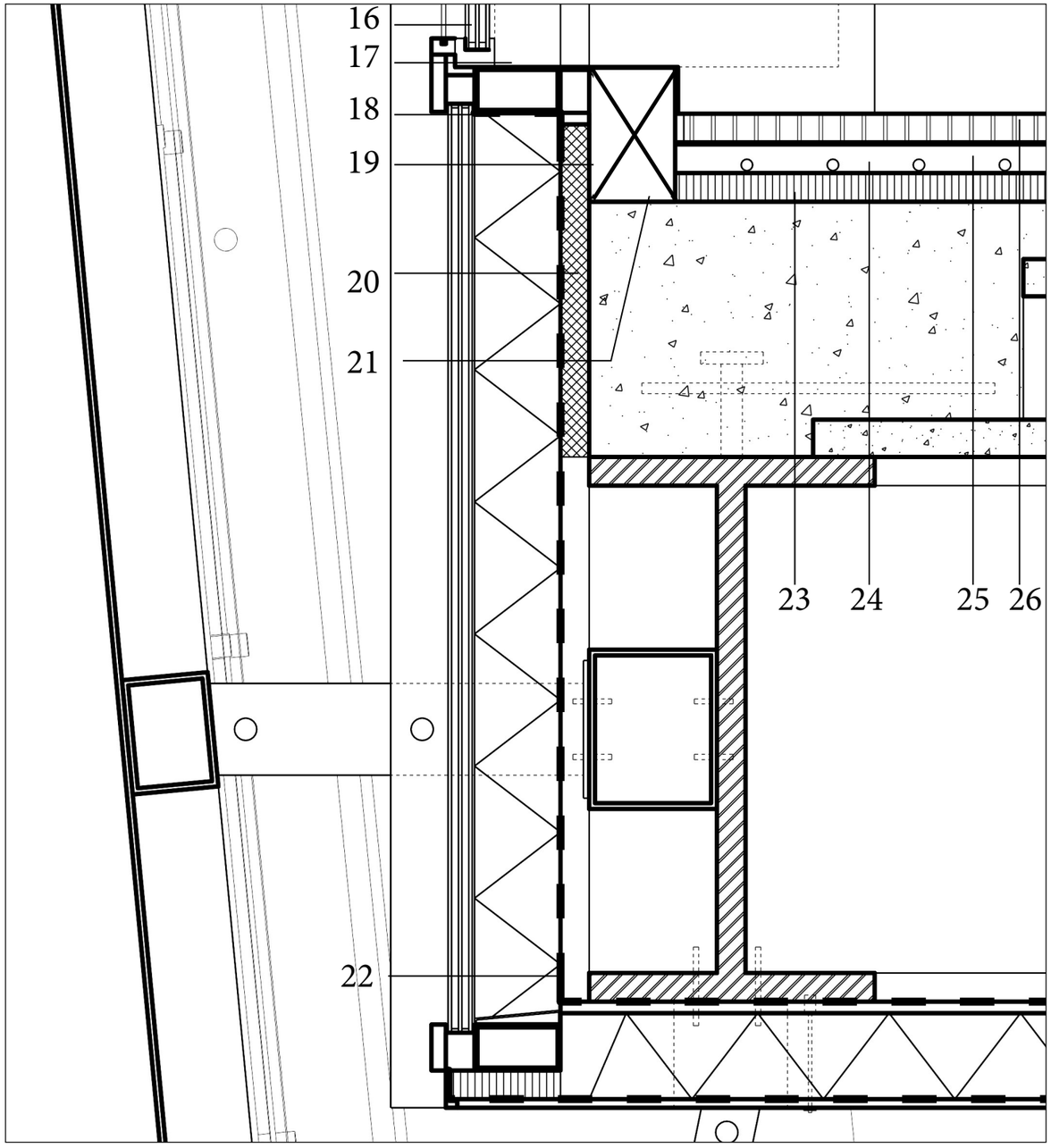
ROOF TO FOUNDATION SECTION 1:50





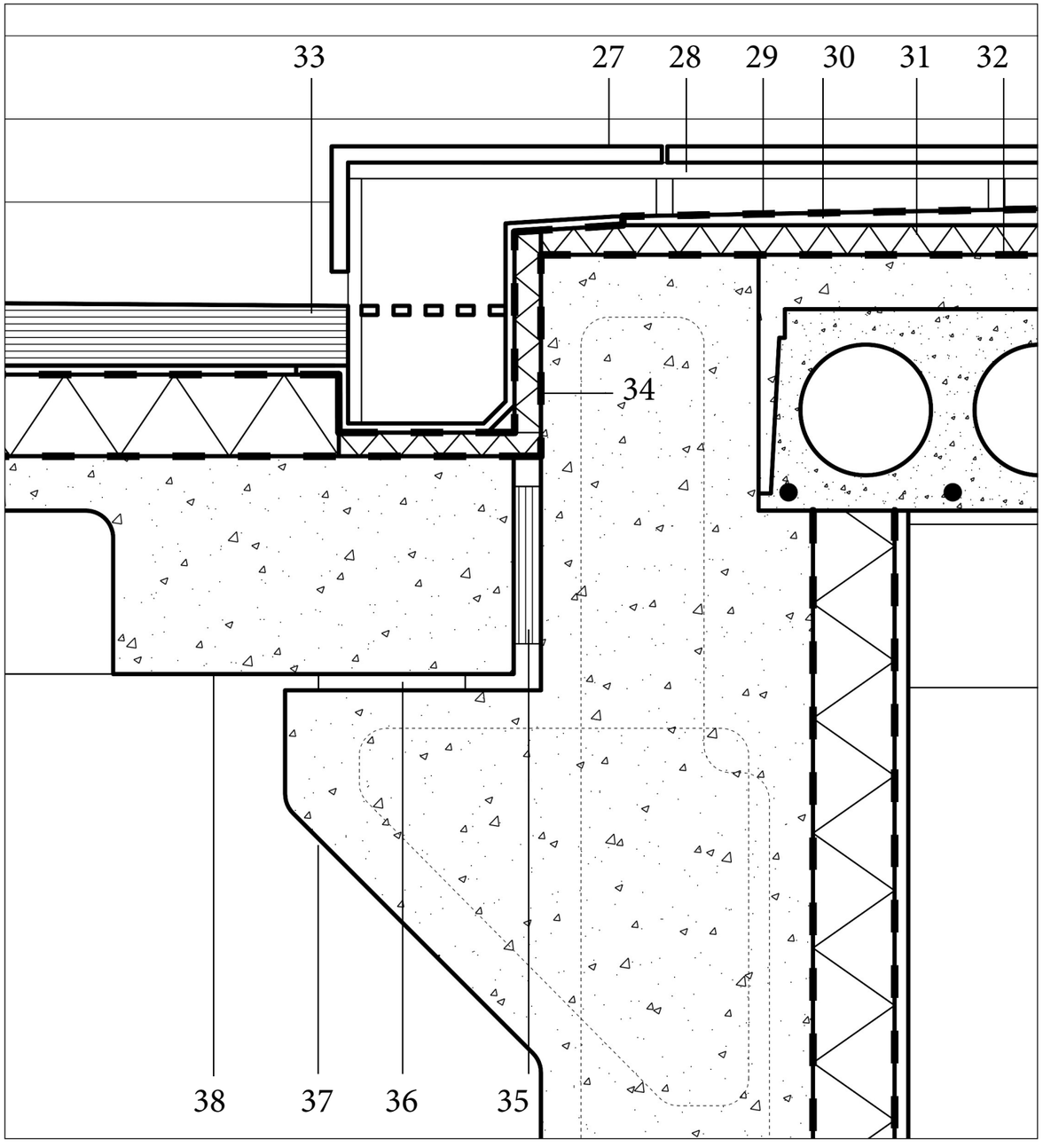
D1.1 ROOF DETAIL 1:10

1. 340mm Hollow Core Slab
2. 150mm Concrete Topping
3. Vapor barrier/Air barrier membrane
4. 100-150mm XPS rigid insulation boards
5. Waterproofing membrane system
6. Fall to drain screed (1:80 slope)
7. Drainage System
8. Metal flashing and counterflashing
9. 150mm Aluminum parapet cap with drip edge
10. Shear Connector
11. H500x960 structural steel beam
12. Curtain wall mounting bracket/anchorage
13. Curtain wall transom
14. Back panel/spandrel panel system
15. Spandrel glass unit



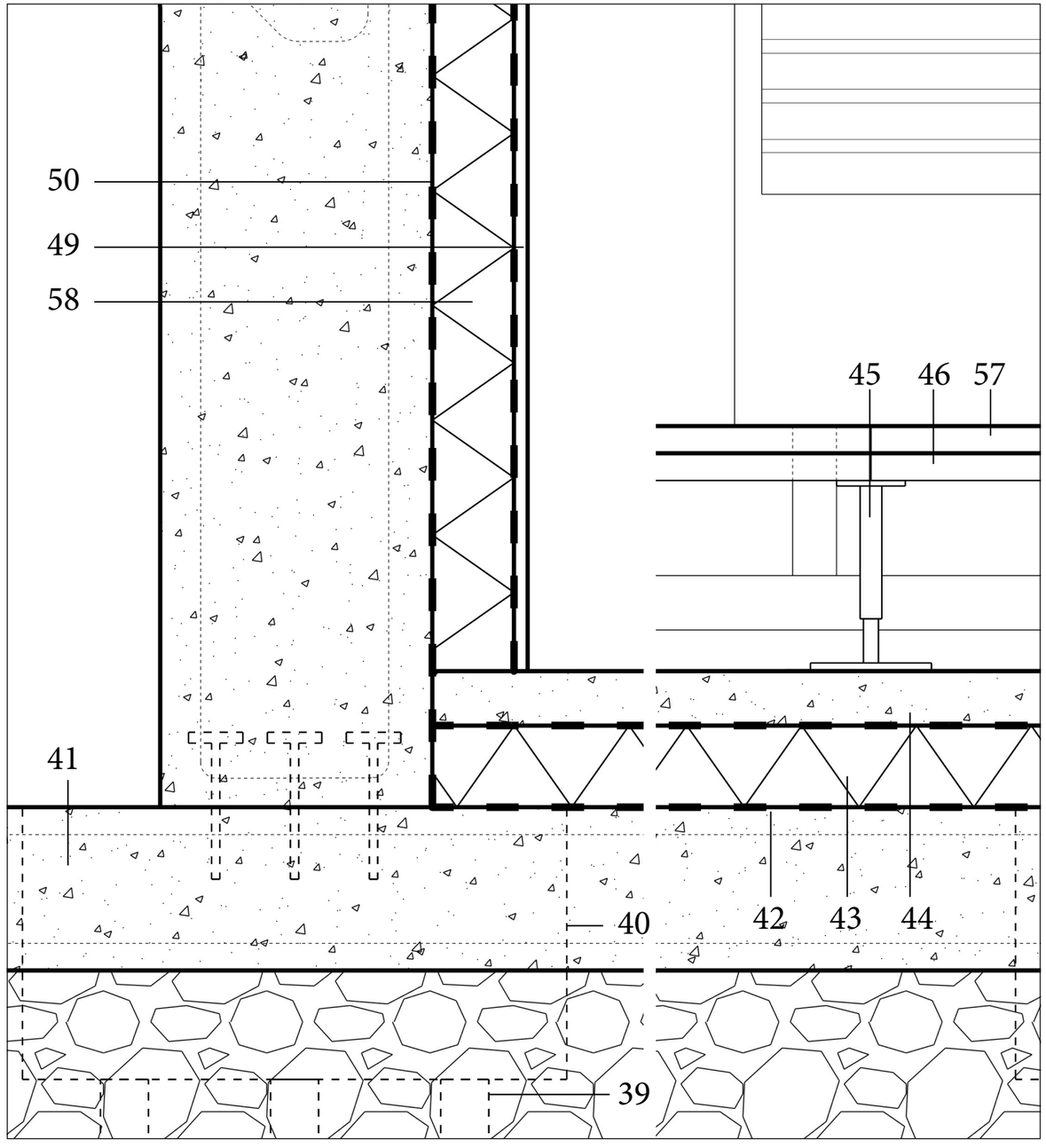
D1.2 WINDOW TO SLAB DETAIL 1:10

16. Triple Glazing Unit
17. Curtain wall mullion/frame system
18. Thermal break gasket/seal
19. Structural connection to slab edge
20. 50mm Mineral wool fire barrier
21. Fire-rated smoke sealant
22. Vapor barrier membrane
23. 50mm Rigid insulation board (under heating system)
24. Underfloor heating pipe system in screed
25. 50mm Heating screed/topping
26. Metal grate flooring finish



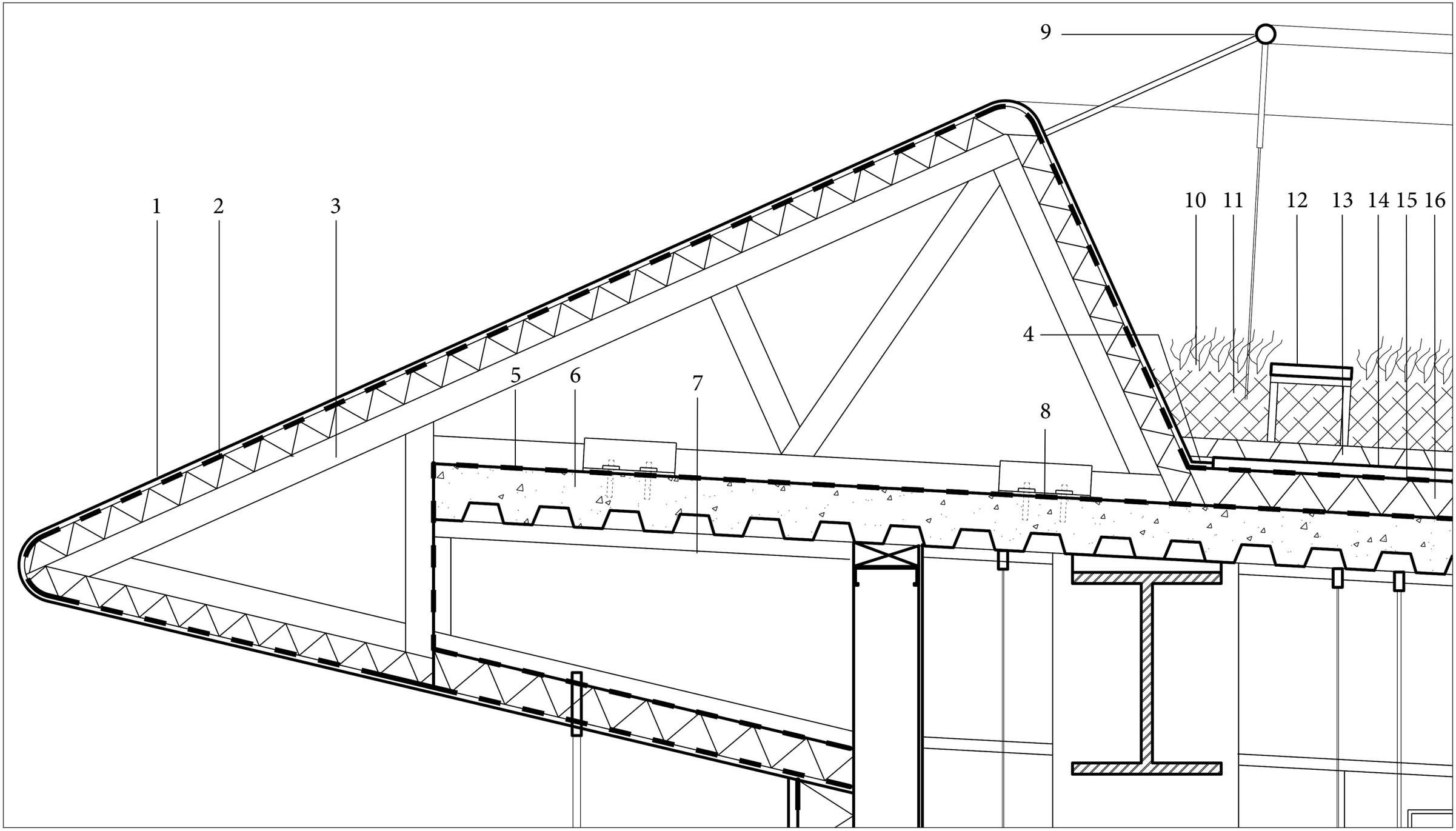
D1.3 OLD & NEW CONNECTION DETAIL 1:10

27. 50mm Concrete pavers
28. Adjustable Pedestals
29. Drainage Mat
30. 25mm Additional fall screed
31. 100mm rigid insulation
32. Protection board over Waterproofing membrane
33. Exterior concrete finishing topping with 25mm Additional fall screed
34. Water Drianage
35. 25-50mm Seismic joint with flexible sealant
36. Bearing Pad
37. Concrete Corbel
38. 400mm Existing Waffle Slab



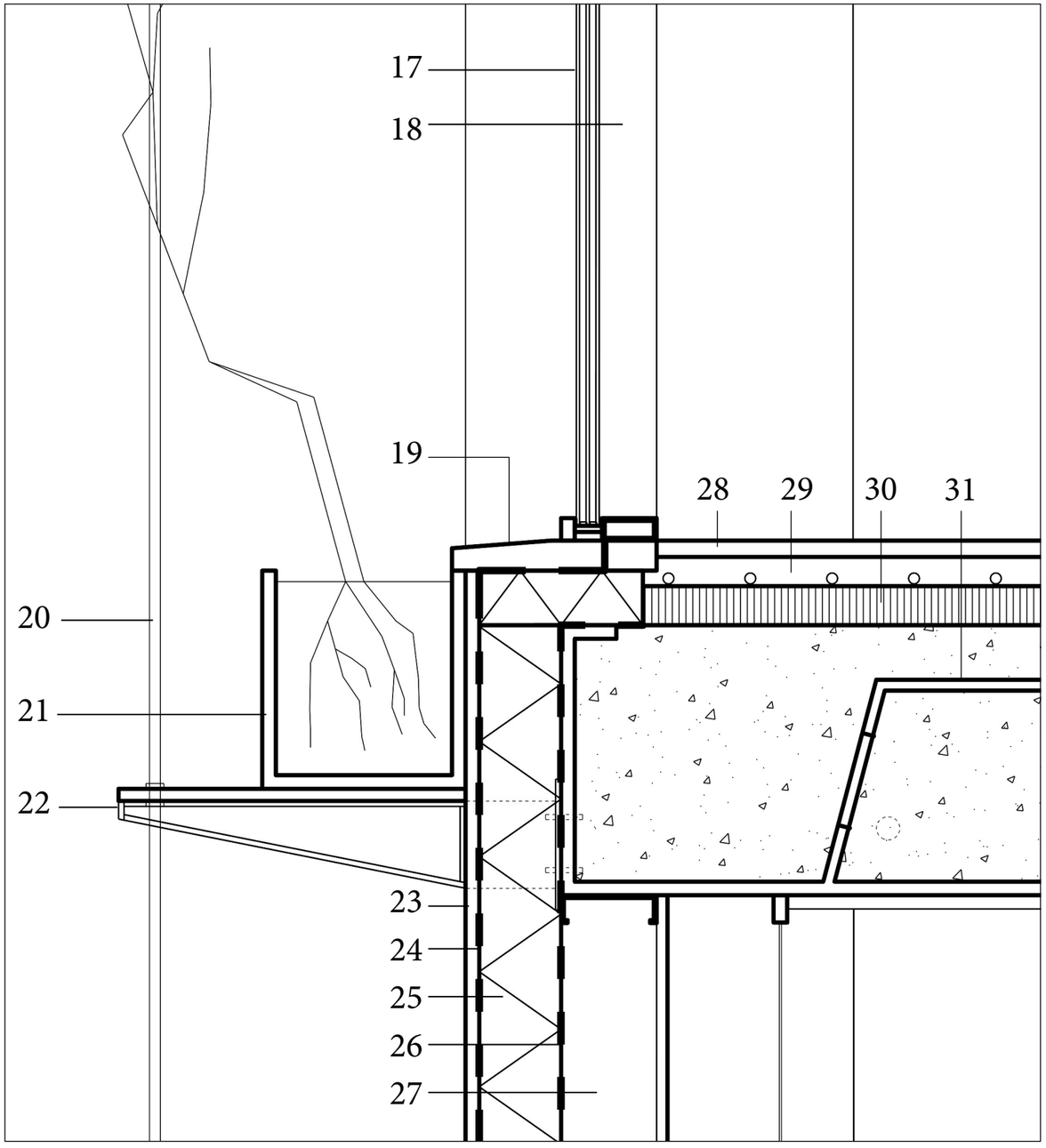
D1.4 REINFORCED FOUNDATION DETAIL 1:10

39. Micropile foundation system (new)
40. 500mm Concrete grade foundation
41. Existing concrete floor slab (retained)
42. Vapor barrier membrane
43. 150mm XPS rigid insulation boards
44. 150mm Concrete topping
45. Adjustable steel pedestals (150-600mm height)
46. Steel grid framework system
47. 600x600mm Anti-static raised floor panels
48. 150mm Wall insulation
49. 25mm Protection board on wall
50. Weather barrier/vapor control layer



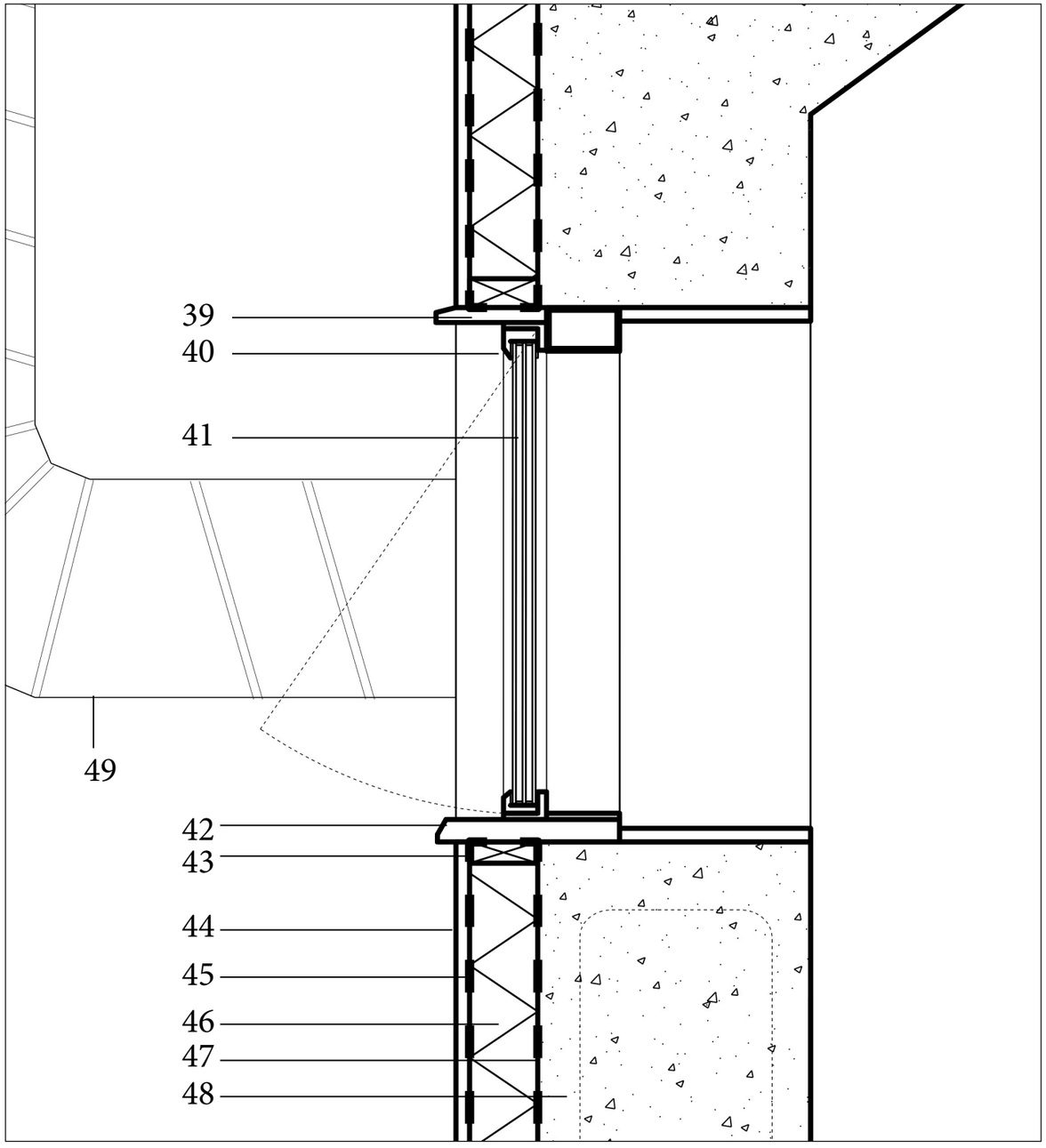
D2.1 PEDESTRIAN DECK PARAPET DETAIL 1:10

1. 8mm Corten steel cladding
2. Waterproofing Layer
3. Metal frame parapet with insulation infill
4. Continuous flashing and sealant
5. Vapor control layer
6. 100mm Reinforced concrete deck with corrugated aluminum formwork
7. Steel H-beam primary structure
8. Anchor plates with thermal breaks
9. 25-50mm Seismic joint with flexible sealant
10. 100m Extensive vegetation
11. 150mm Growing medium/soil substrate
12. 20mm Granite tiles with Adjustable pedestal
13. Root barrier membrane
14. 25mm rigid Protection board
15. Primary EPDM waterproofing membrane
16. 150mm - XPS insulation



D2.2 PLANT BOX FACADE DETAIL 1:10

27. 50mm Concrete pavers
28. Adjustable Pedestals
29. Drainage Mat
30. 25mm Additional fall screed
31. 100mm rigid insulation
32. Protection board over Waterproofing membrane
33. Exterior concrete finishing topping with 25mm Additional fall screed
34. Water Drianage
35. 25-50mm Seismic joint with flexible sealant
36. Bearing Pad
37. Concrete Corbel
38. 400mm Existing Waffle Slab



D2.3 BASEMENT VENTILATION SHAFT 1:10

39. Precast concrete sill with integrated drip edge
40. Window Frame
16. Triple Glazing Unit
41. Precast concrete sill with integrated drip edge
    Sill flashing membrane (lapped under window)
42. Sealant bead
43. 25mm Protection board
44. Weather resistant barrier/membrane
45. 100mm - External insulation (mineral wool)
46. Air/vapor barrier
47. 500mm - Reinforced concrete wall structure
48. Ventilation Pipe