

# **BIOCLIMATIC ARCHITECTURE:**

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INCORPORATING SUSTAINABLE DESIGN  
METHODS IN COLD CLIMATES



A photograph of a dense evergreen forest. In the foreground, a large, well-developed evergreen tree stands prominently. The rest of the forest extends to the horizon, appearing as a thick wall of green. The background is shrouded in a light mist or fog, creating a sense of depth and atmosphere. The overall color palette is dominated by various shades of green, from deep forest greens to lighter, misty tones.

**RESEARCH | LOCATION | PROCESS | PROGRAM**

A dense forest of evergreen trees, likely spruce or fir, with a semi-transparent white banner across the middle. The banner contains the text "RESEARCH | LOCATION | PROCESS | PROGRAM". The trees are dark green, and the background is a lighter, hazy green, suggesting a misty or overcast day. The banner is centered horizontally and vertically.

**RESEARCH** | LOCATION | PROCESS | PROGRAM



# **NDSU TRAVEL SCHOLARSHIP**

SUMMER 2022

# BIO SHIELD

ROOFING SYSTEM





# **SUSTAINABLE DESIGN IN THE PACIFIC NORTHWEST**

An exploration into the green building methods, materials, and incentives being enacted in the Pacific Northwest United States.

# GOALS

# 1

## GREEN CERTIFICATIONS

Explore the use of Green Building Certifications in the Pacific Northwest including:

- LEED
- WELL Building Standard
- Living Building Challenge
- Fitwel

# 2

## MASS TIMBER

Research the uses and limitations of Mass Timber products - specifically the use of Cross-Laminated Timber (CLT)

# 3

## INCENTIVIZED SUSTAINABILITY

Uncover the local and regional incentives for sustainable strategies and how they impact the construction process.

Incentives include:

- Solar
- Mass Timber
- Green Building Standards
- 2030 Challenge

# GREEN CERTIFICATIONS

## LEED:

*Focuses on creating healthy & efficient buildings.*

Rated Topics Include:

- Location & Transportation
- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Environmental Quality



## WELL BUILDING STANDARD:

*Focuses on creating a built environment that improves the nutrition, fitness, mood, sleep and performance of its occupants.*

Rated Topics Include:

- Air
- Water
- Nourishment
- Light
- Fitness
- Comfort
- Mind



## LIVING BUILDING CHALLENGE:

*Focuses on creating buildings that are regenerative, self sufficient, and remain within the resource limits of their site.*

Rated Topics Include:

- Place
- Water
- Energy
- Health + Happiness
- Materials
- Equity
- Beauty



## FITWEL:

*Focuses on the human experience.*

Rated Topics Include:

- Walkability & Transit Incentives
- Bike Parking
- Restorative Gardens
- Indoor Air & Water Quality
- Daylighting/Views
- Active Workstations
- Hygiene Signage
- Lactation Rooms
- Exercise Rooms
- Health Programming
- Healthy Food Incentives & Vending





# MASS TIMBER

## CROSS-LAMINATED TIMBER:

*Originally developed in Austria*

- Uses dimensioned lumber from small trees harvested during forest thinning.
- Strong enough to replace concrete and steel up to 12 stories
- Lighter & more flexible
- Can withstand earthquakes and storms
- Fire-resistant due to charring
- Non-toxic manufacturing processes
- Insulation properties
- Absorbs carbon
- Reduces carbon footprint of a building
- Customized for each project



# MASS TIMBER

## MARKET FOR CLT:

- Mixed Use
- Multi-Family
- Offices
- Tiny Homes
- Military Housing
- Disaster Housing
- Modular Construction

## TYPES OF TIMBER:

- Glulam Beams
- Parallel Strand Lumber
- Laminated Strand Lumber
- Laminated Veneer Lumber
- I-Joists
- Dowel-Laminated Timber
- Nail-Laminated Timber



90%

of buildings in the United States  
are less than 12 stories tall.

A photograph of a traditional Chinese garden. In the foreground, a large, gnarled tree with dense green foliage dominates the right side. A white wall with a dark, tiled roof runs across the middle ground. A circular opening in the wall, known as a moon gate, provides a view into another part of the garden. A stone path leads from the bottom left towards the moon gate. The ground is covered with various plants, including ferns and moss. The overall scene is peaceful and well-maintained.

# PORTLAND, OREGON

SUMMER 2022



CARBON 12



ALBINA YARD

# INCENTIVIZED SUSTAINABILITY

## SOLAR REBATE:

Funds solar and solar with paired storage systems for individuals, businesses, nonprofits, and other organizations.

## COMMUNITY RENEWABLE ENERGY GRANT:

Provides grants for planning and developing community renewable energy and energy resilience projects.

## PERCENT FOR GREEN GRANT:

Program is open to community groups that would like to complete large-scale green infrastructure projects to provide benefits to watershed health and the community.

## OTHERS:

The city of Portland incentivizes **electric vehicles, watershed conservation**, and more. There's a program that provides free trees for certain neighborhoods, and a "treebate" credit on your utility bill when you plant a tree.

A panoramic view of the Seattle skyline at dusk. The Space Needle is prominent on the left, illuminated with warm lights. The city lights are visible in the background, and the sky is a mix of soft orange and blue. A semi-transparent white banner is overlaid across the middle of the image, containing the text.

# SEATTLE, WASHINGTON

SUMMER 2022



U OF W LIFE SCIENCES BUILDING



F5 TOWER





**AMAZON SPHERES**



WATERSHED



**COLUMBIA TOWER**



**CHIHULY MUSEUM OF GLASS**



**BULLITT CENTER**

# INCENTIVIZED SUSTAINABILITY

## PRIORITY GREEN EXPEDITED:

Offers faster building permit review and processing for projects that meet green building requirements with a focus on clean energy, resource conservation, indoor air quality, and lead hazard reduction.

## GREEN BUILDING STANDARD:

Gives additional development capacity in specific zones in exchange for meeting green building requirements.

## LIVING BUILDING PILOT PROGRAM:

Offers additional height, floor area ratio (FAR), and Design Review departure requests for projects that meet aggressive energy and water requirements and Living Building Petal Certification.

## 2030 CHALLENGE:

Offers additional height, floor area ratio (FAR), and Design Review departure requests for projects that meet the 2030 Challenge.



# PERSPECTIVE



# **BIOCLIMATIC**

*adjective* | **bi·o·cli·mat·ic**

The relationship between living things and the climate.



# THE PROBLEM

Current sustainable strategies are optimized for warm climates.

# THE QUESTION

How can innovations in sustainable design be implemented in cold climates such as the midwestern United States in a way that is effective, efficient, and changes public perception on our environmental impact?



# GOALS



# GOALS

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## INTEGRATE INNOVATIVE SUSTAINABLE STRATEGIES:

Incorporate strategies and materials that can showcase the capabilities of current green building technologies.



# GOALS

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## EMPHASIZE OUR **IMPACT** ON THE ENVIRONMENT:

Display the impacts of construction on our environment by the numbers, and show the importance of conservation.



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## EDUCATE ON SUSTAINABILITY IN THE MIDWEST:

Provide educational spaces, signage, and programming to encourage future implementation within the community.

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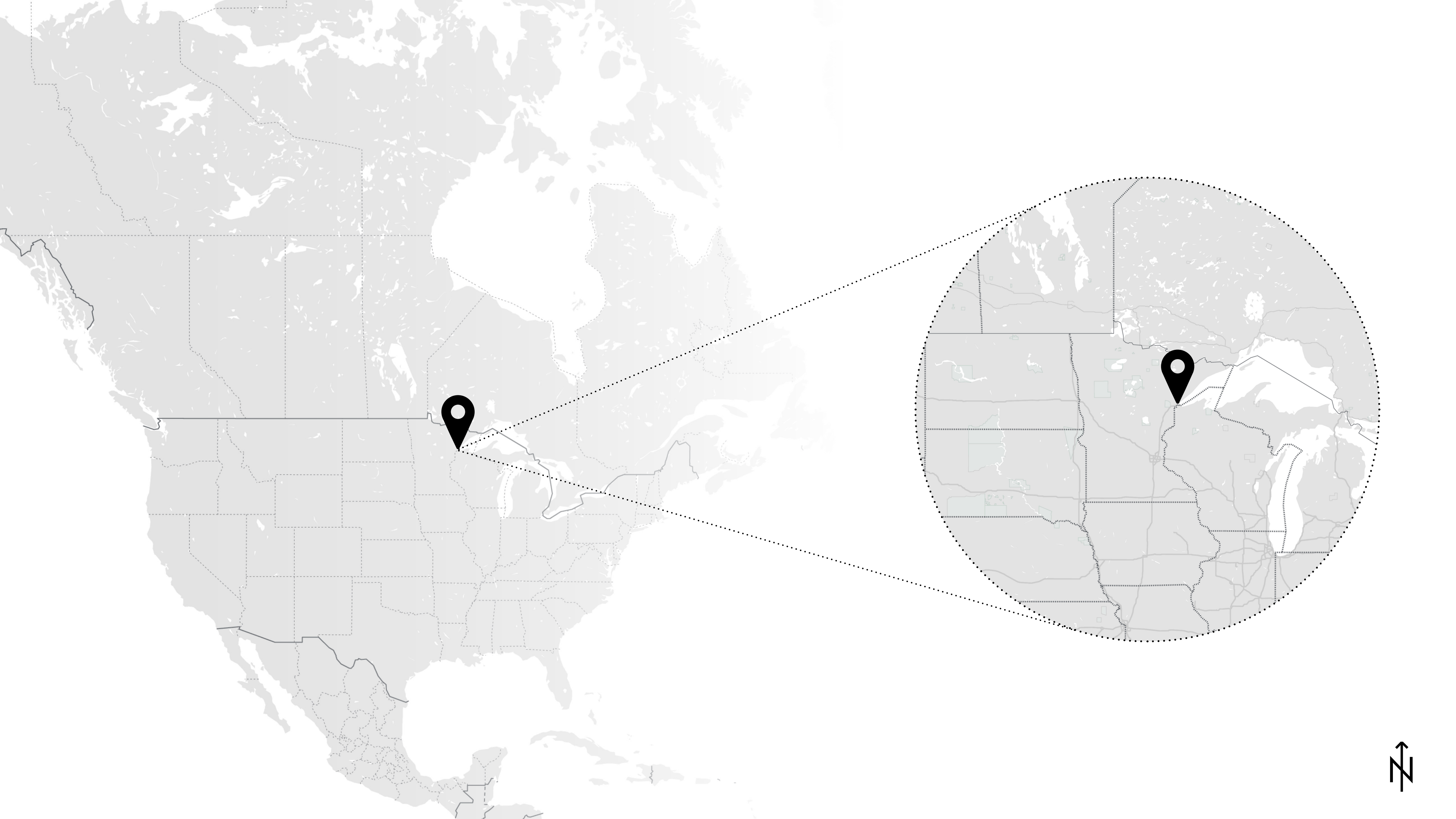
4

## CREATE AN INCLUSIVE LEARNING ENVIRONMENT:

Implementing different learning styles and spaces allows for users of all abilities and disabilities to participate in sustainable design. These include auditory, visual aids, and hands-on learning opportunities

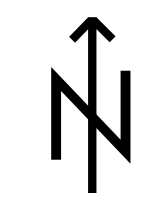
A dense forest of evergreen trees, likely spruce or fir, with a semi-transparent white banner across the middle. The banner contains the text "RESEARCH | LOCATION | PROCESS | PROGRAM" in a bold, sans-serif font. The word "LOCATION" is in black, while the other words are in a light gray color. The background shows a thick canopy of trees, with a few taller trees visible in the distance under a hazy sky.

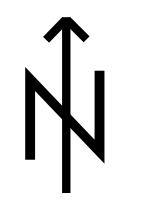
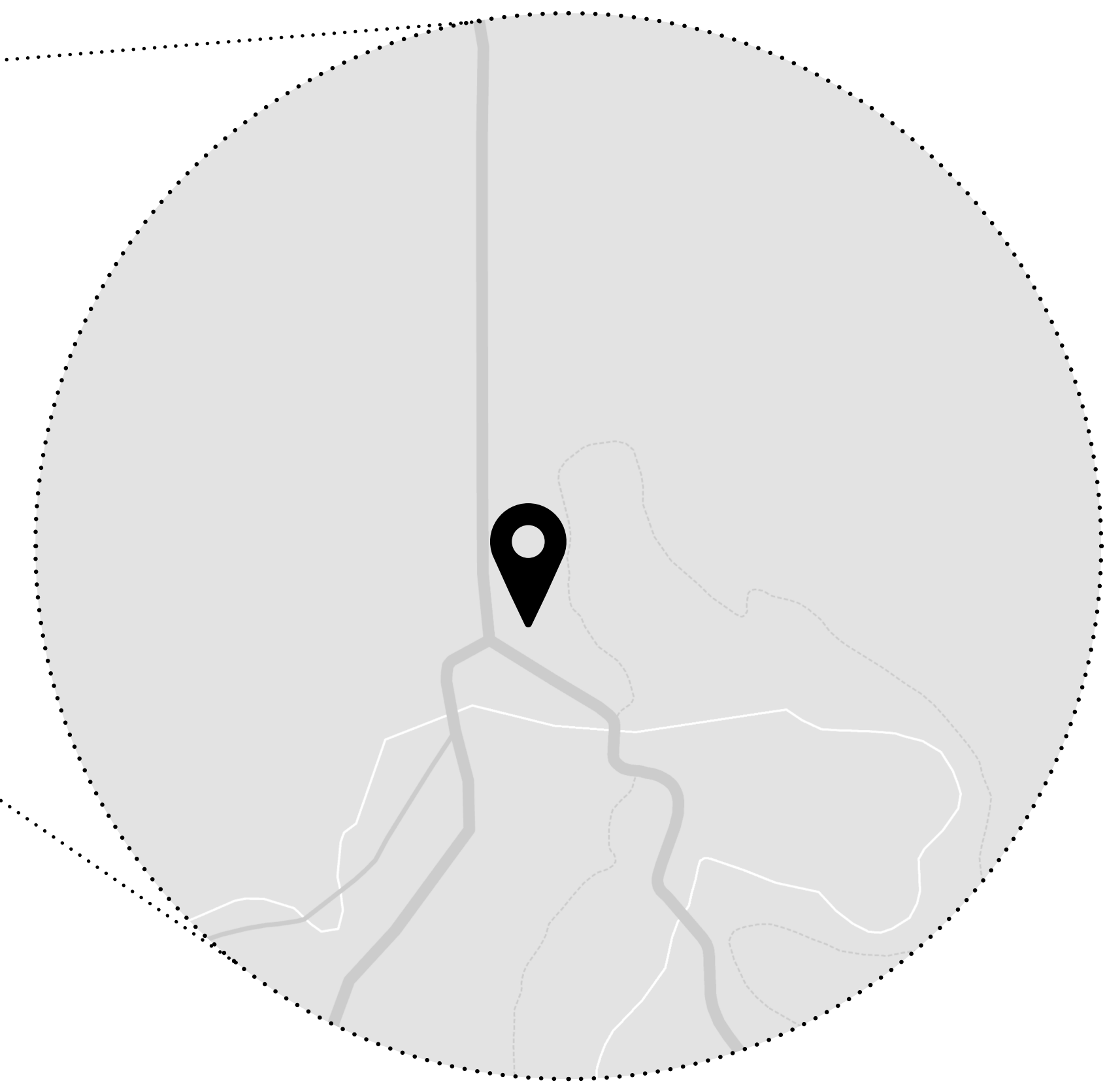
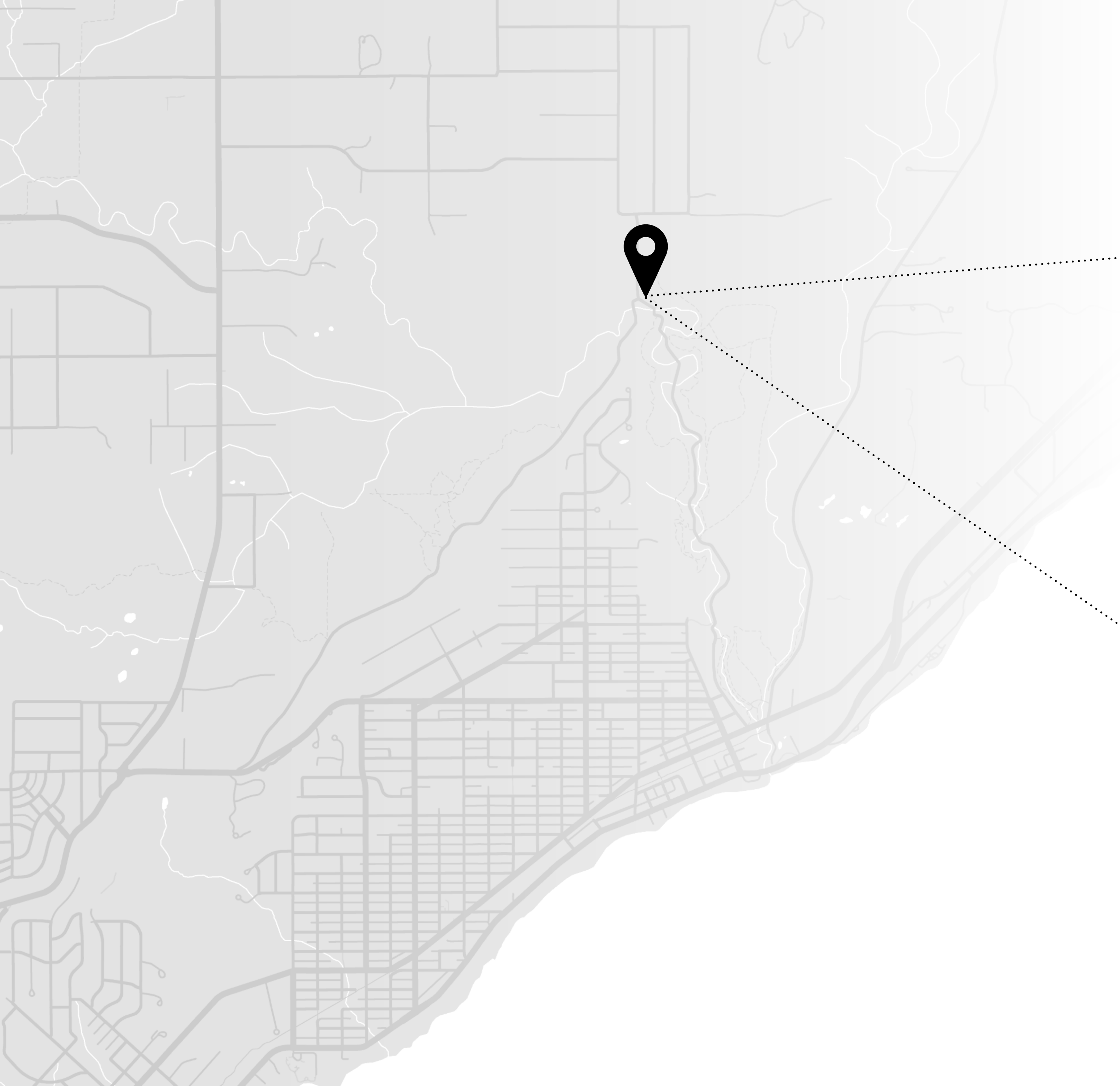
RESEARCH | **LOCATION** | PROCESS | PROGRAM













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RESEARCH | LOCATION | **PROCESS** | PROGRAM

# USERS



# USERS



DESIGNERS

# USERS



DESIGNERS



BUILDERS

# USERS



DESIGNERS



BUILDERS



STUDENTS



# USERS



DESIGNERS



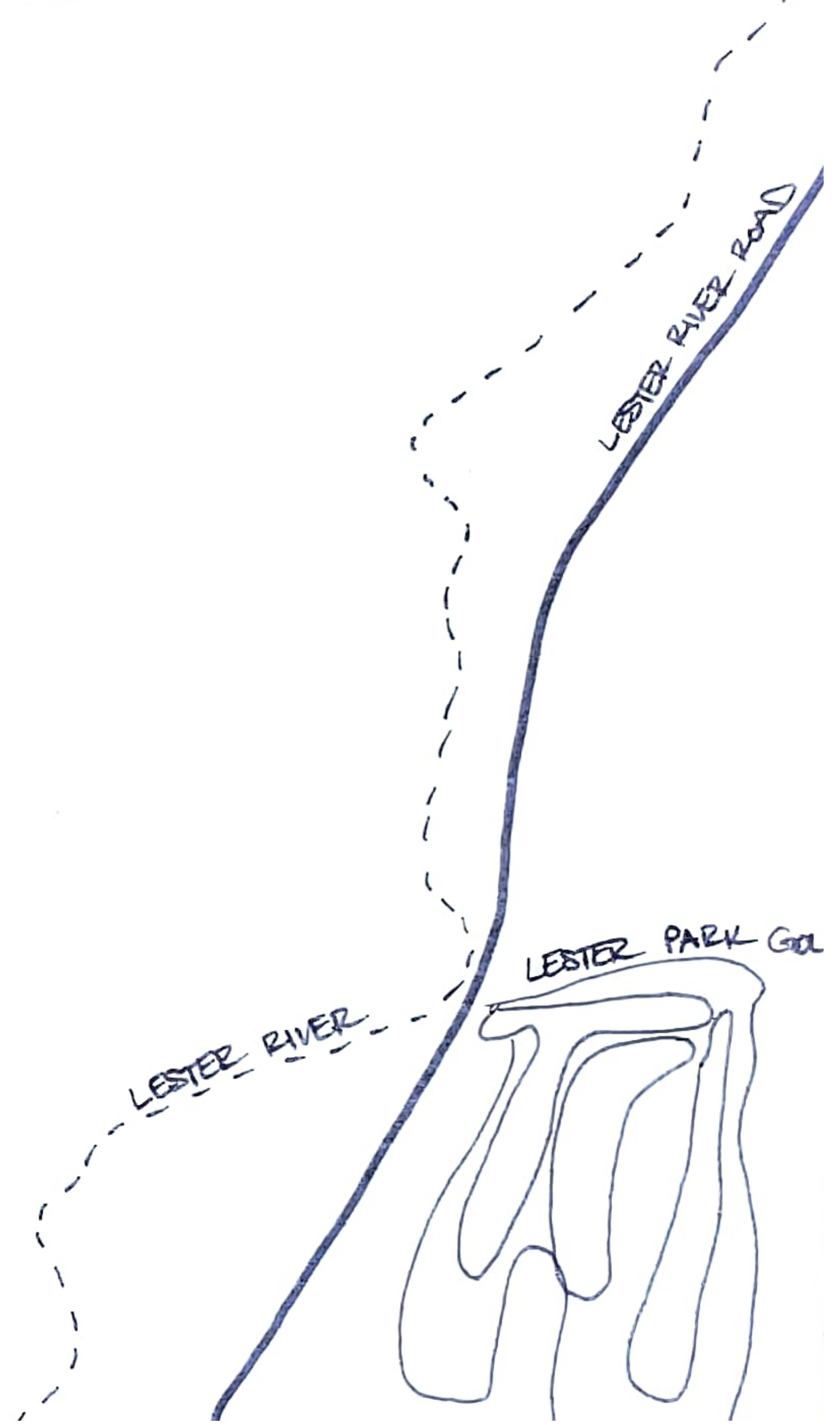
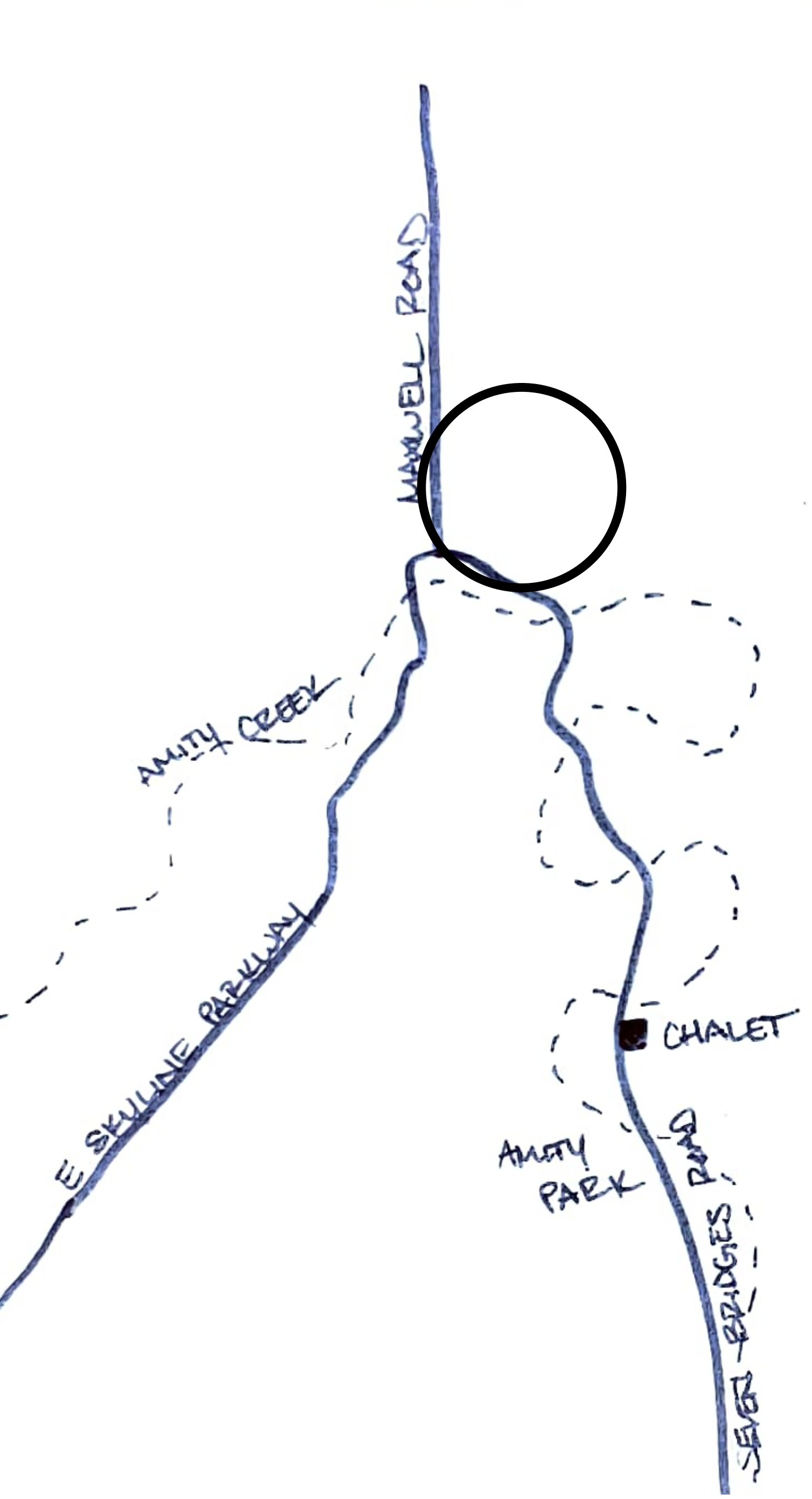
BUILDERS

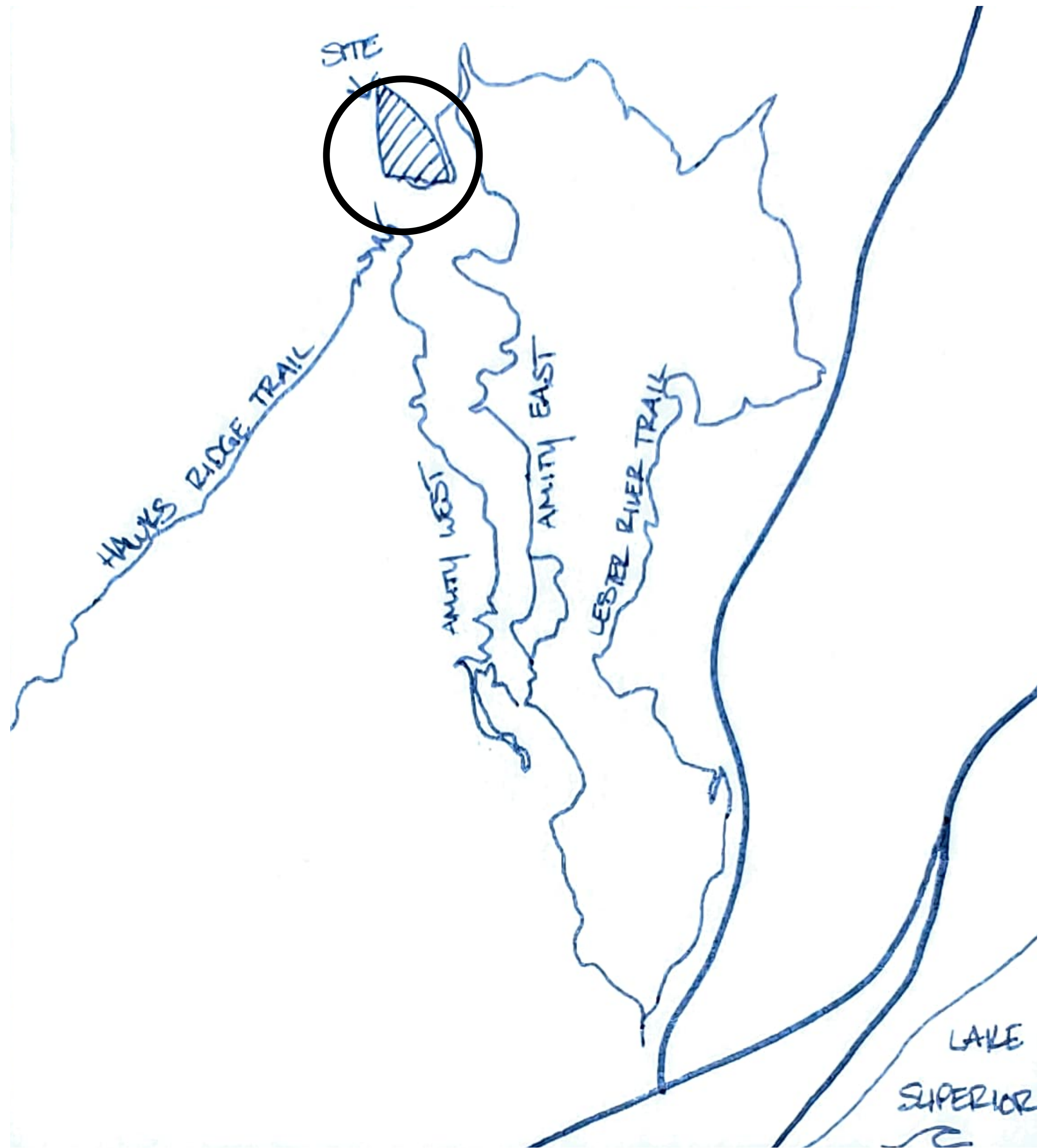


STUDENTS



COMMUNITY



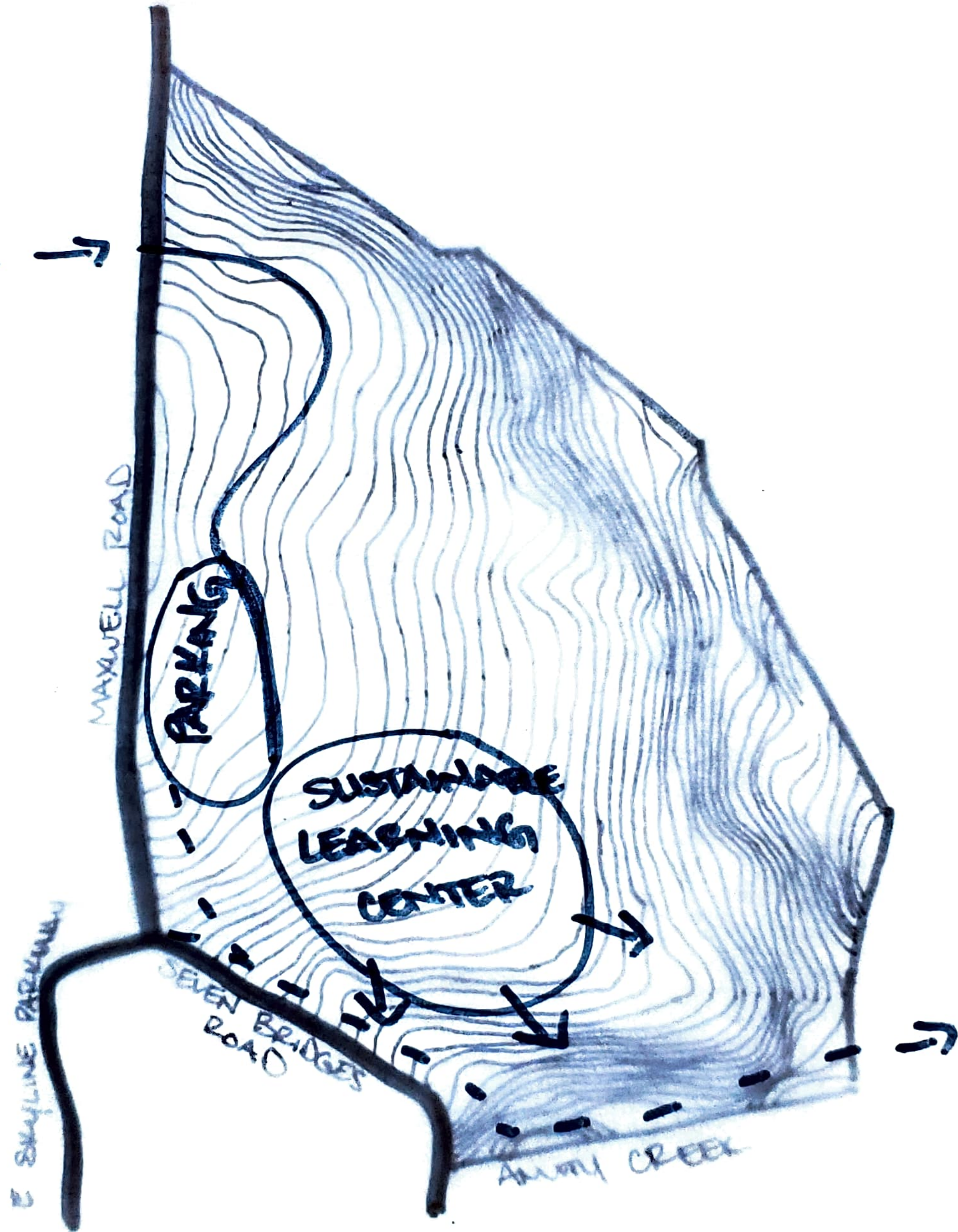


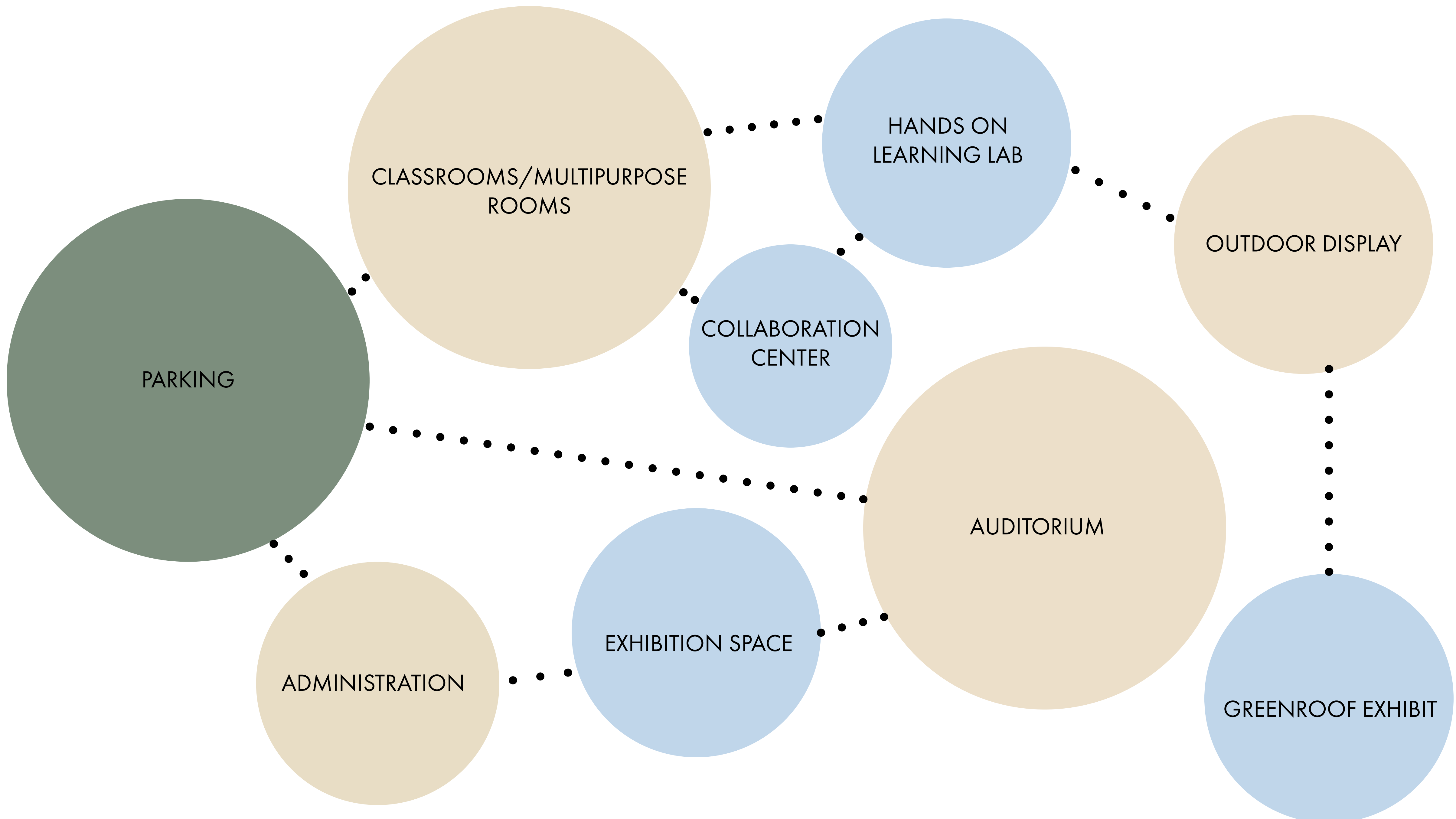
14 ACRES  
CITY LAND

ENTER →

NOTES:

- TRAILHEAD PARKING
- PROVIDE TRAIL GUIDES, BATHROOMS, ETC?
- ENTRANCE GOES THROUGH TREES (SECLUDED FEEL)
- VIEWS TO EAST + SOUTH (RAPIDS + SUPERIOR)





PARKING

CLASSROOMS/MULTIPURPOSE  
ROOMS

HANDS ON  
LEARNING LAB

OUTDOOR DISPLAY

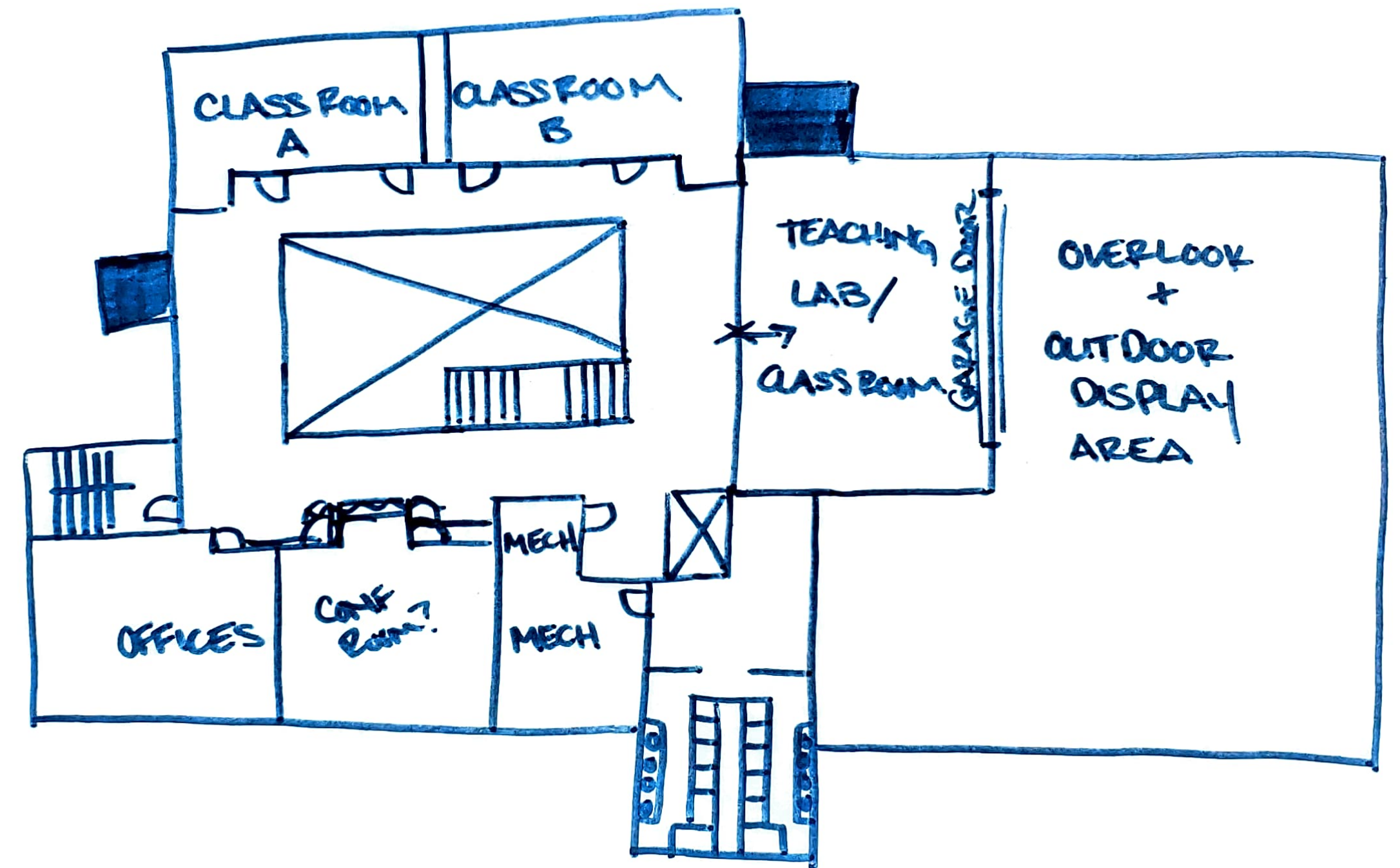
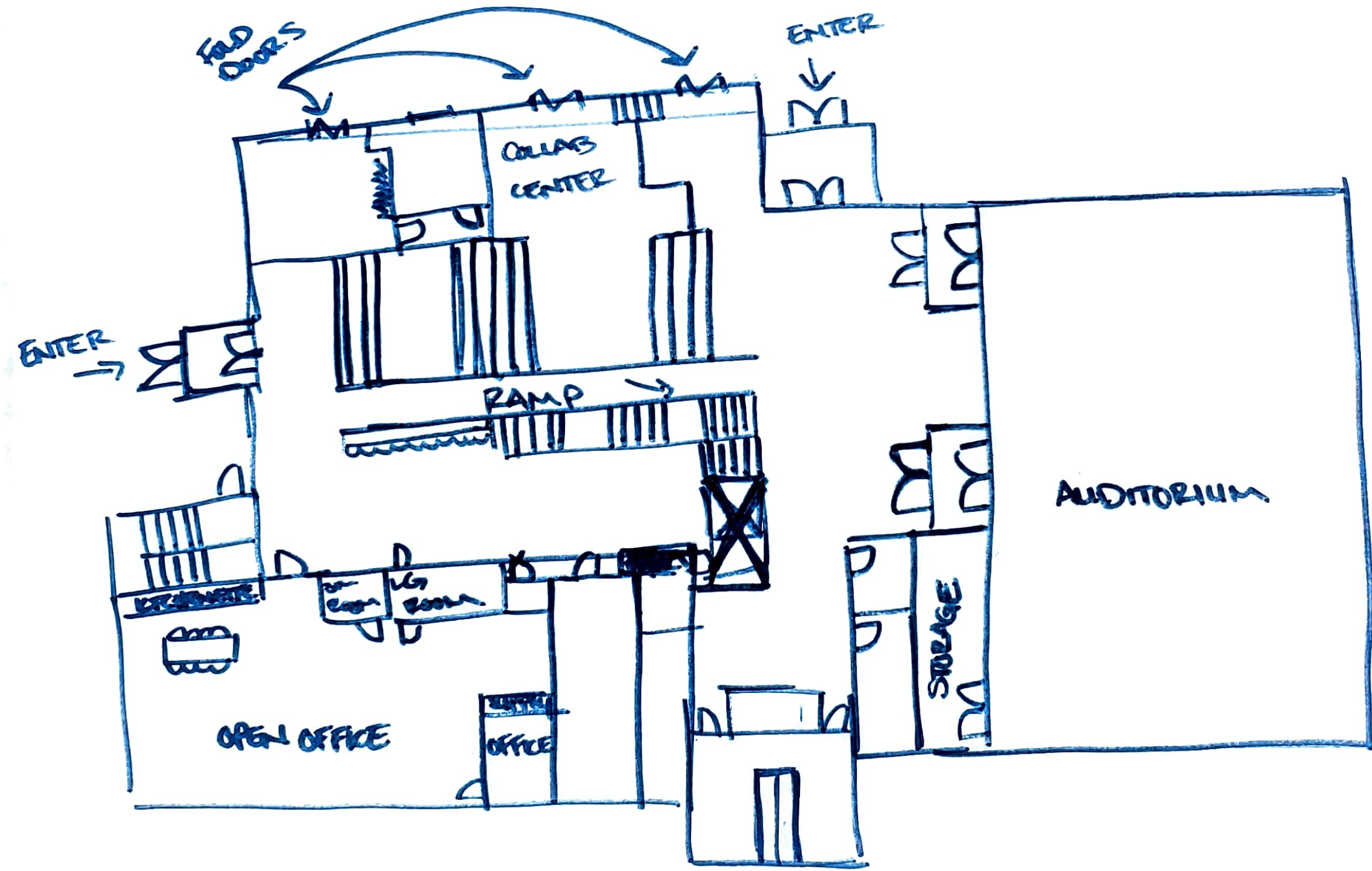
COLLABORATION  
CENTER

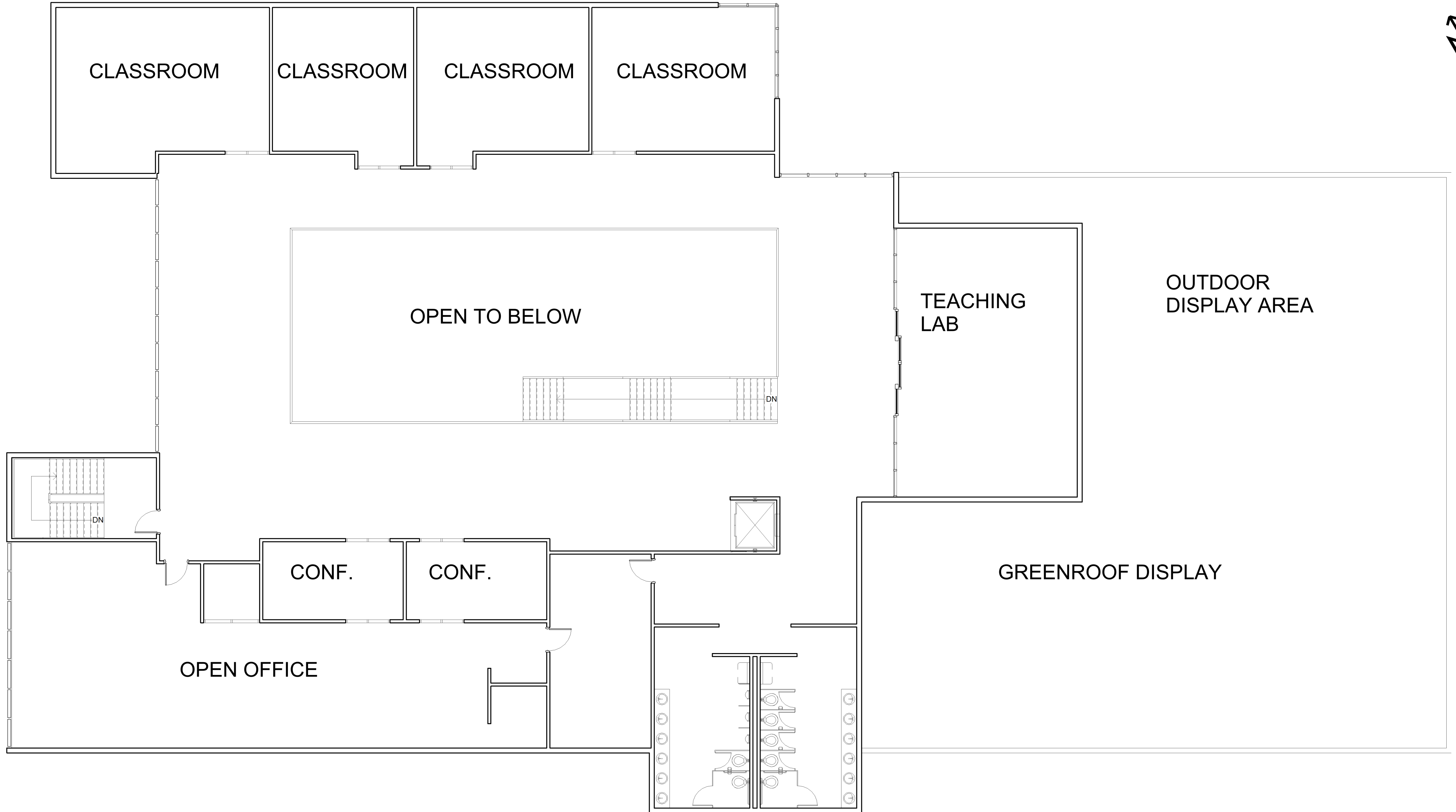
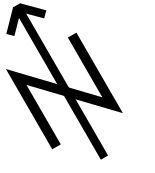
AUDITORIUM

ADMINISTRATION

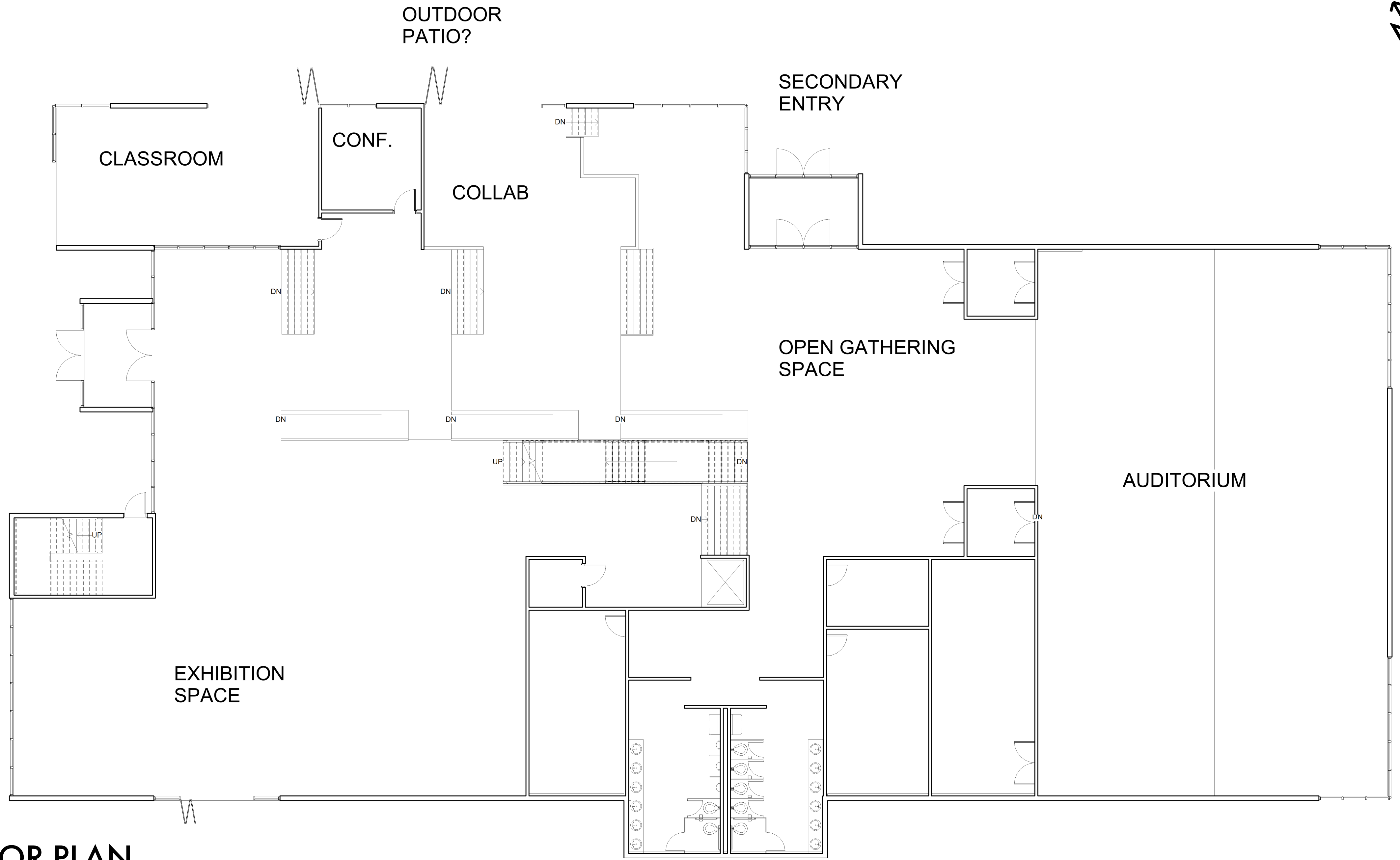
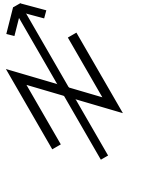
EXHIBITION SPACE

GREENROOF EXHIBIT



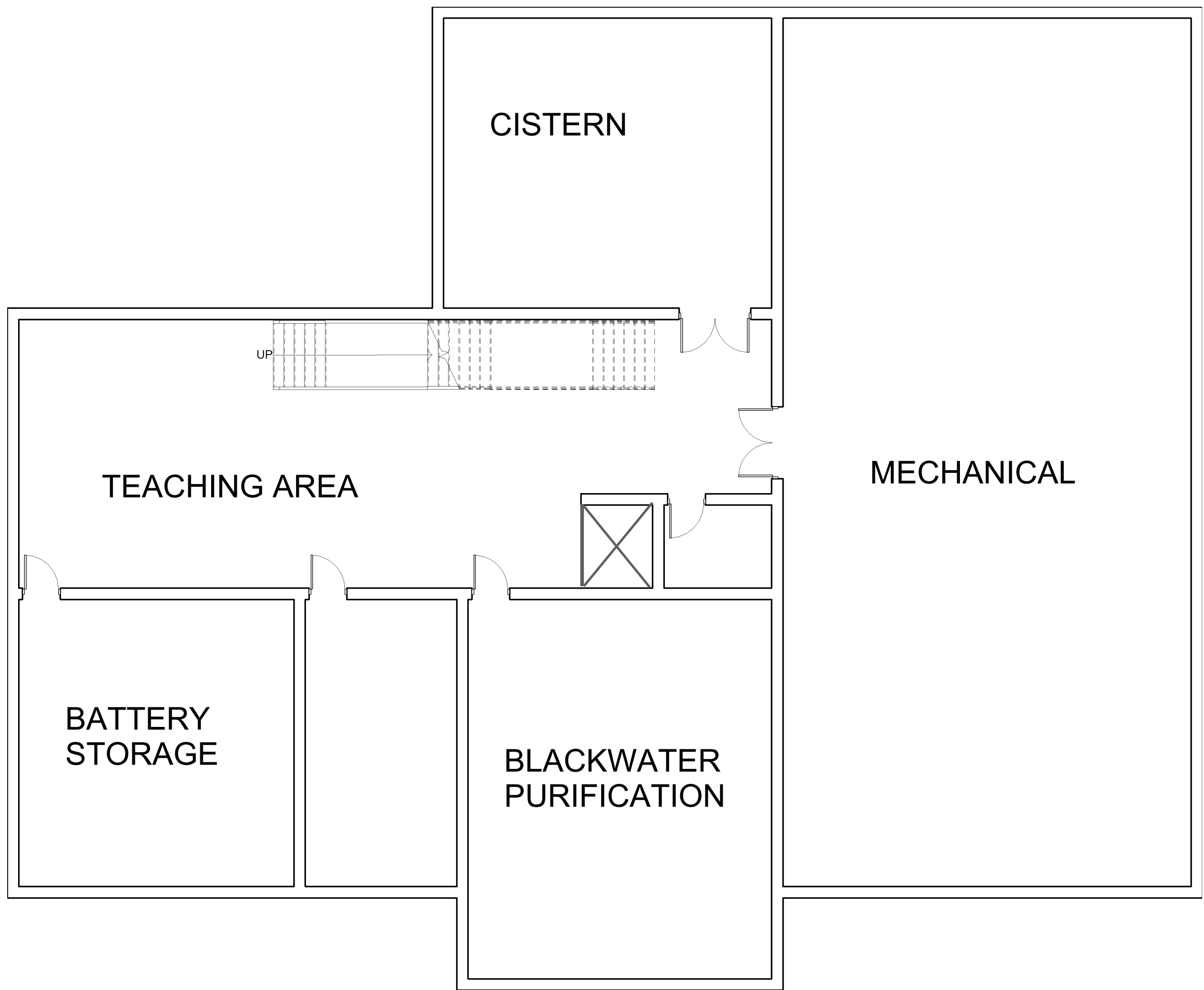


**LEVEL 2 FLOOR PLAN**



**LEVEL 1 FLOOR PLAN**





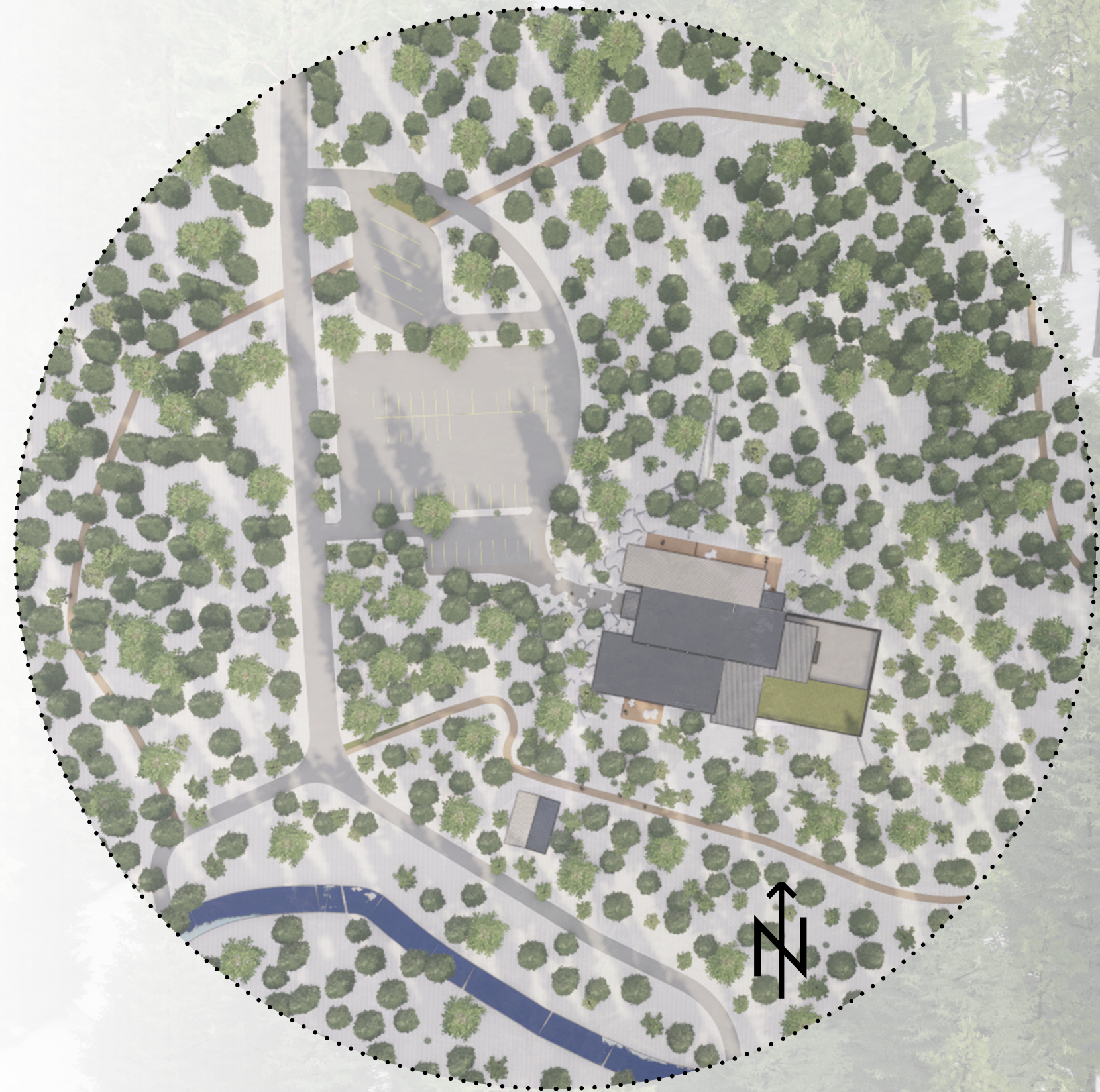
**LOWER LEVEL FLOOR PLAN**

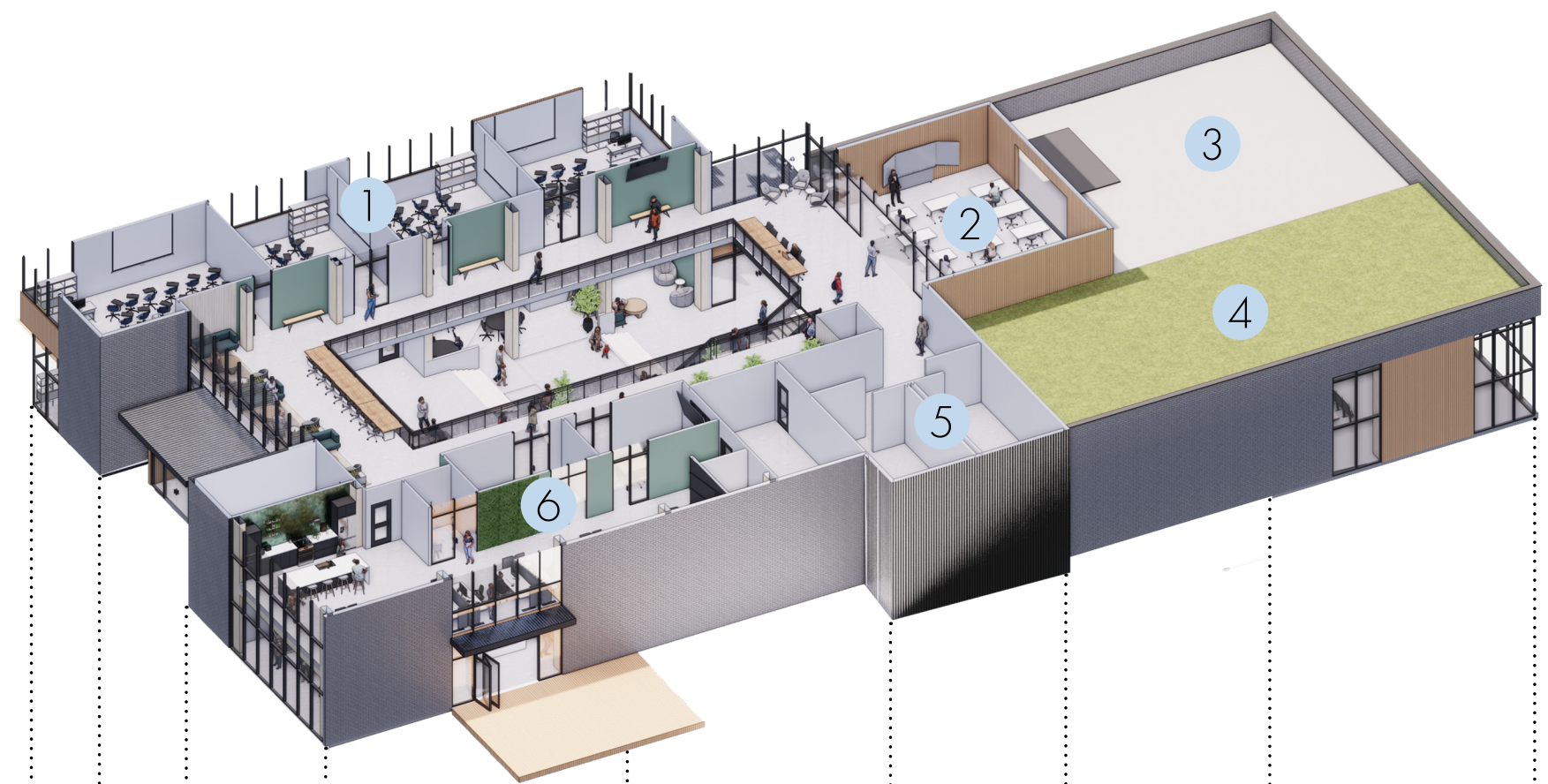
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RESEARCH | LOCATION | PROCESS | **PROGRAM**

# DULUTH SUSTAINABLE DESIGN LEARNING CENTER

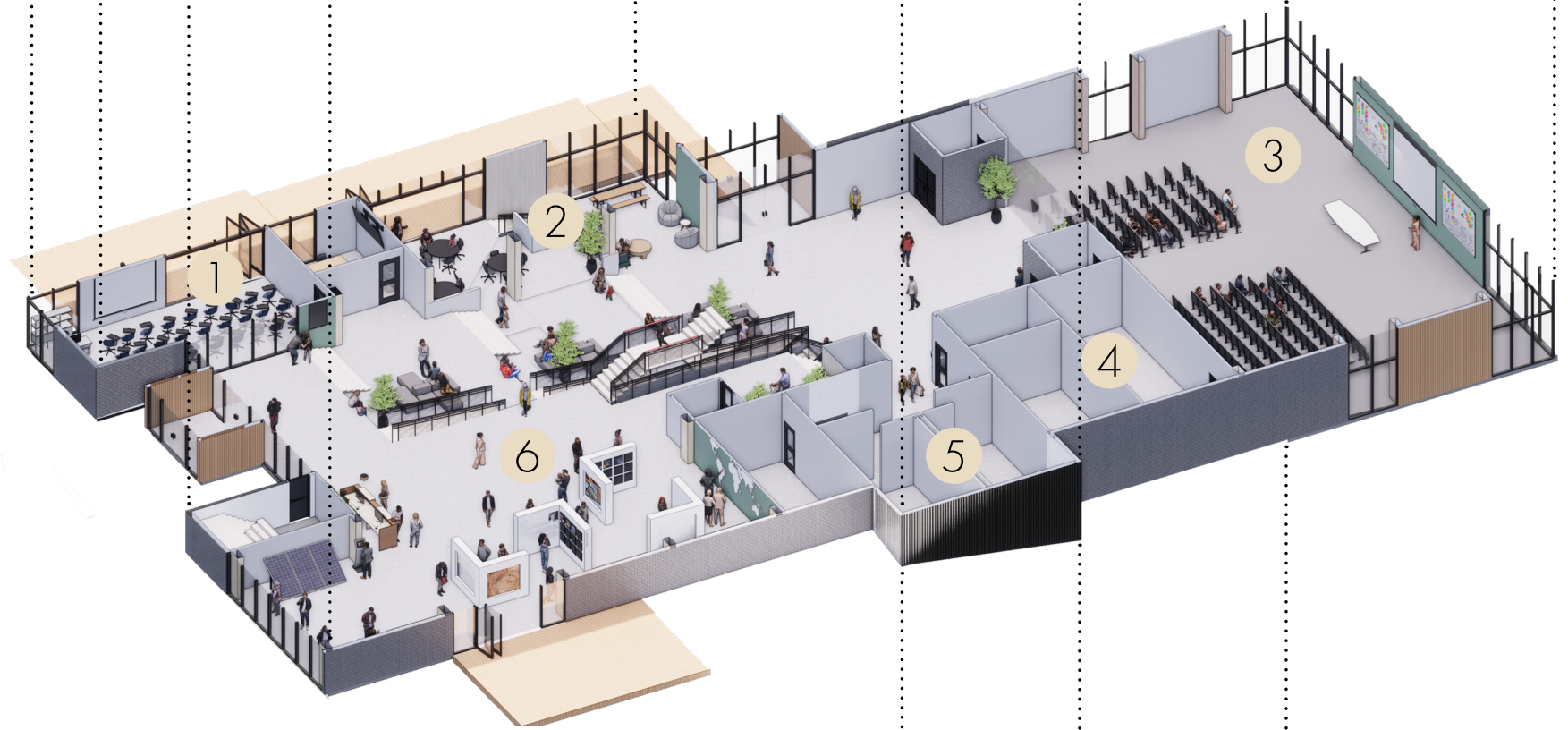






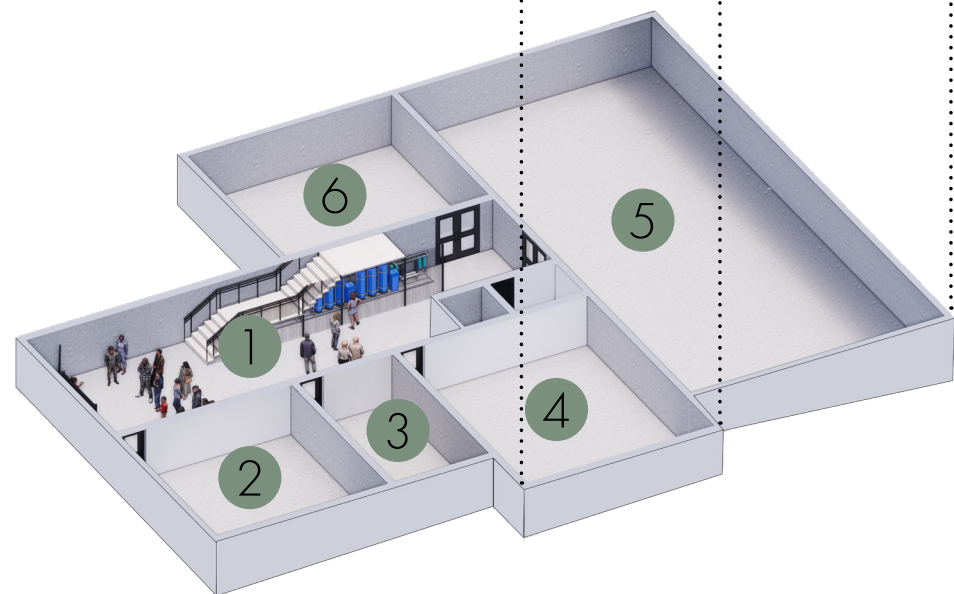
## LEVEL 2: EDUCATION + ADMIN

1. Classrooms
2. Learning Lab
3. Rooftop Exhibition
4. Green Roof
5. Restrooms
6. Open Office



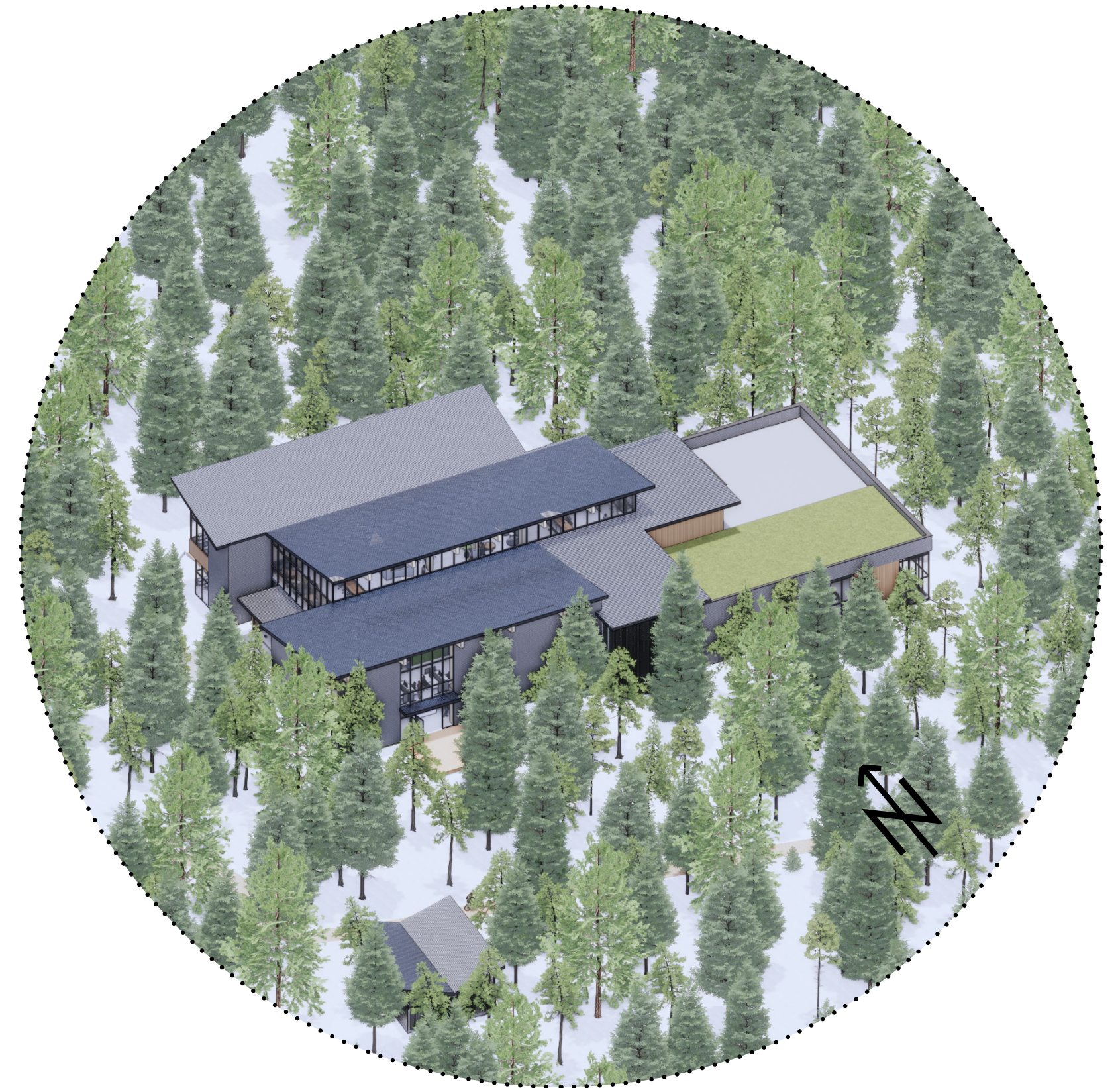
## LEVEL 1: COLLABORATION

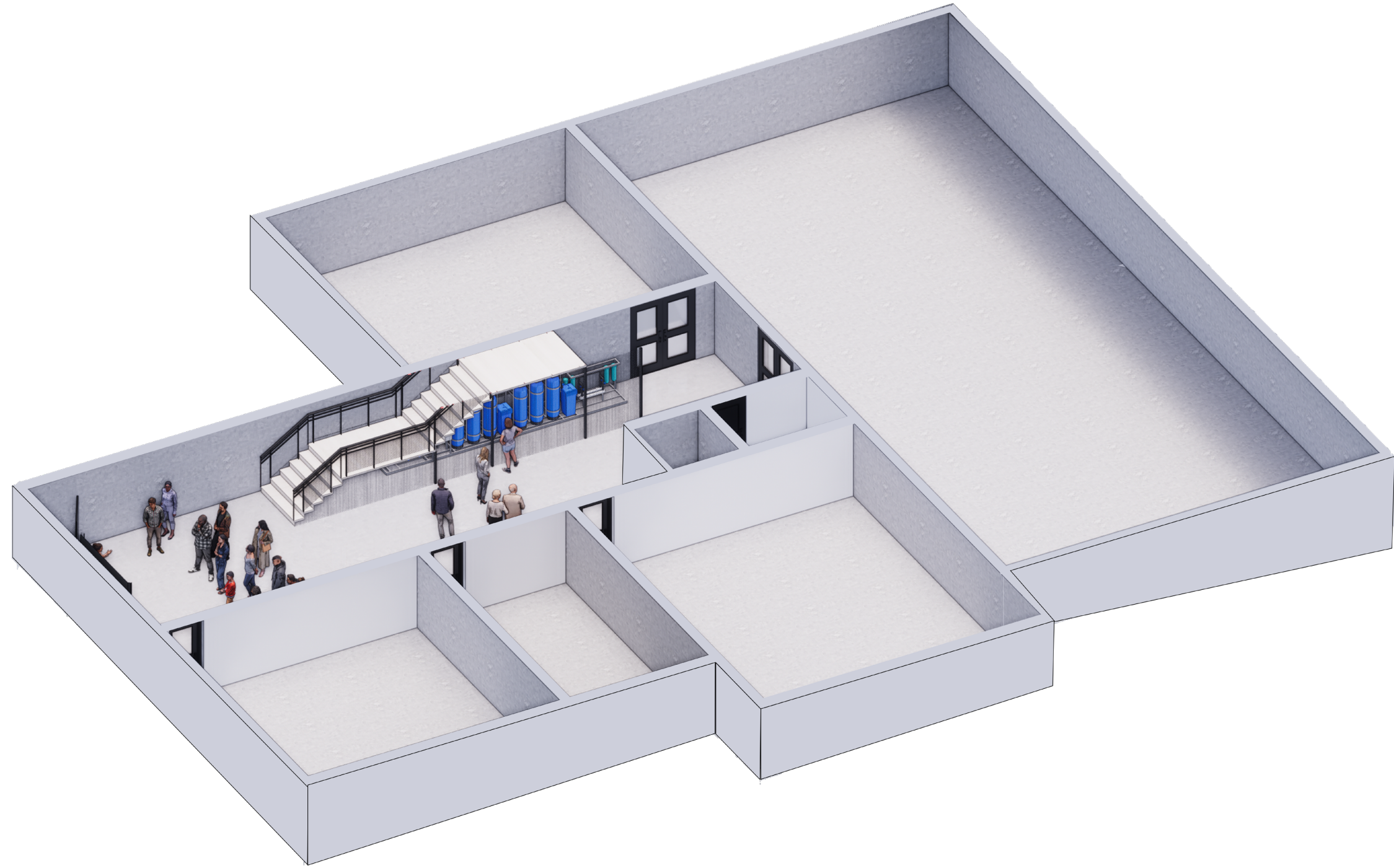
1. Large Classroom
2. Collaboration Center
3. Auditorium
4. Storage
5. Restrooms
6. Sustainable Design Exhibition



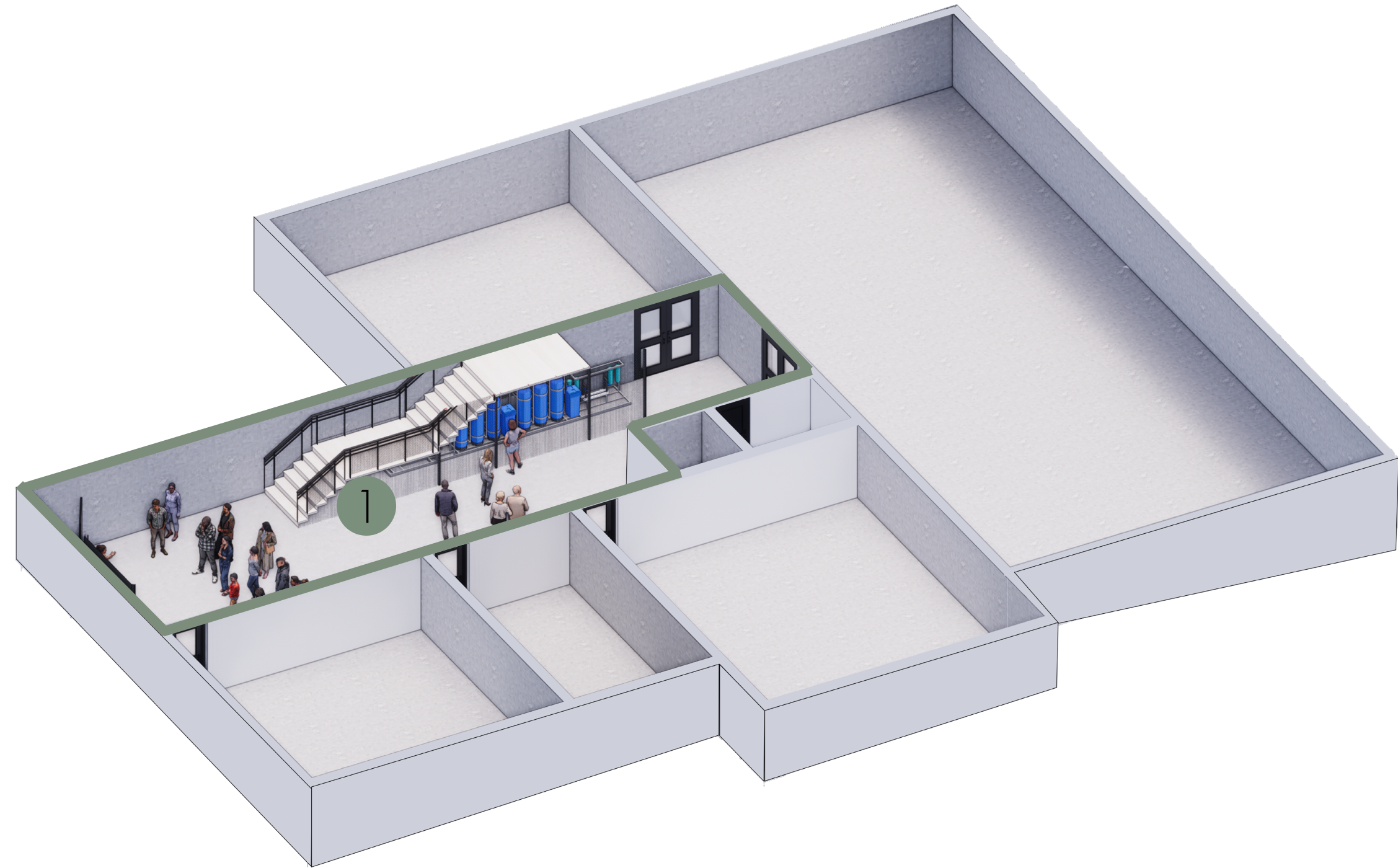
## LOWER LEVEL: MECHANICAL

1. Mechanical Systems Teaching Lab
2. Backup Power + Battery Storage
3. Custodial Storage
4. Water Filtration
5. Mechanical + Storage
6. Rainwater Collection Cistern





**LOWER LEVEL: MECHANICAL**



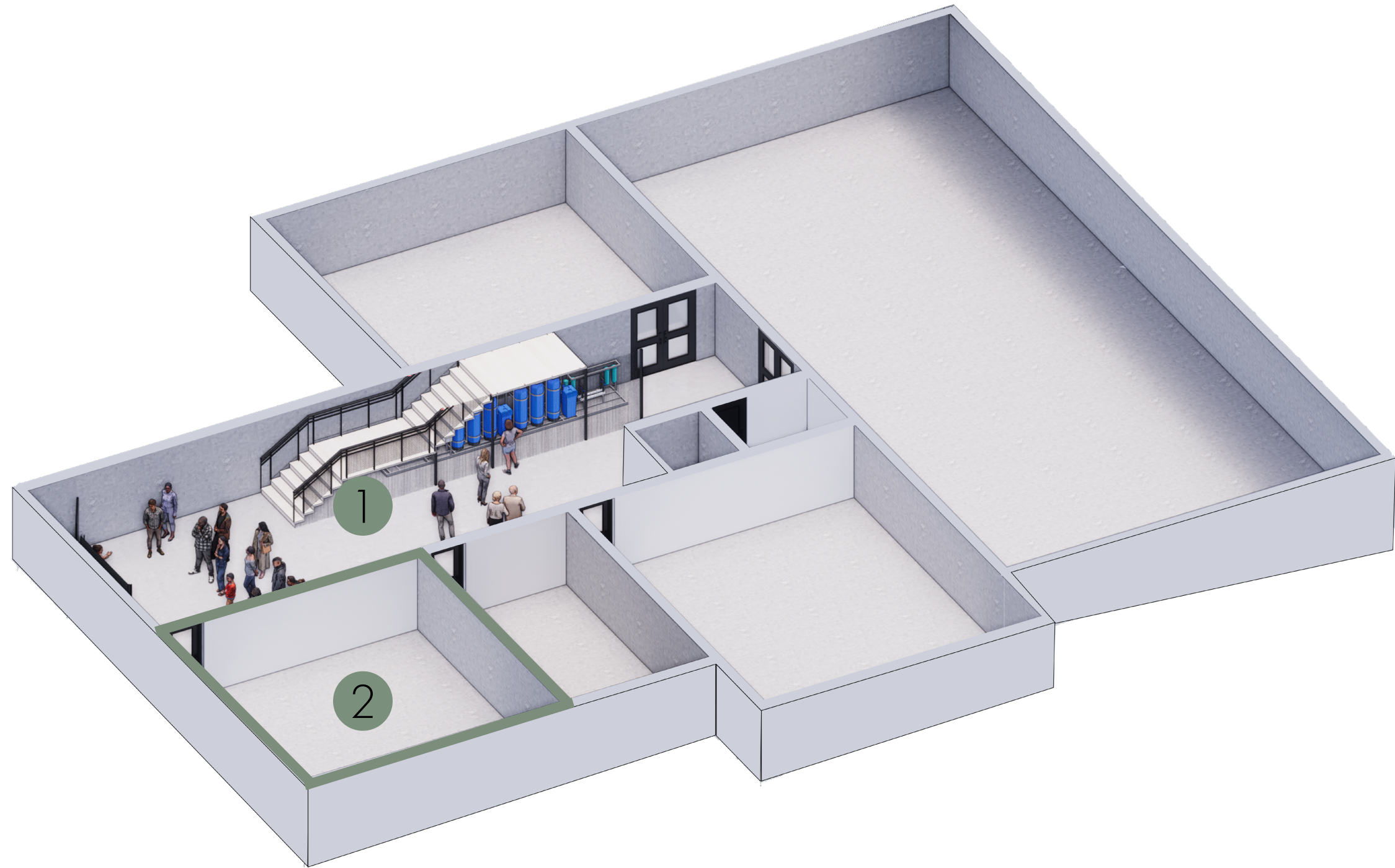
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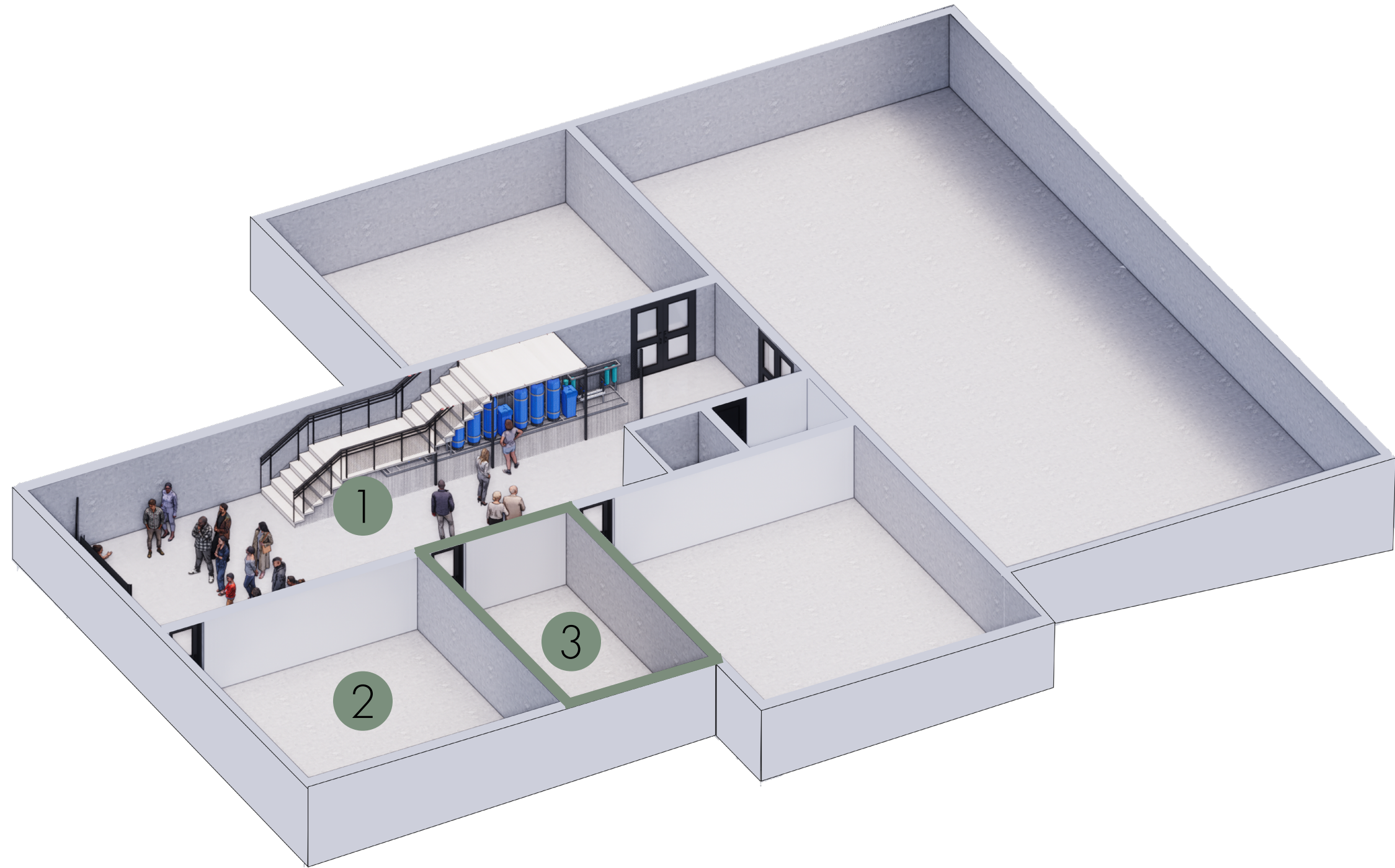
**MECHANICAL SYSTEMS TEACHING LAB**





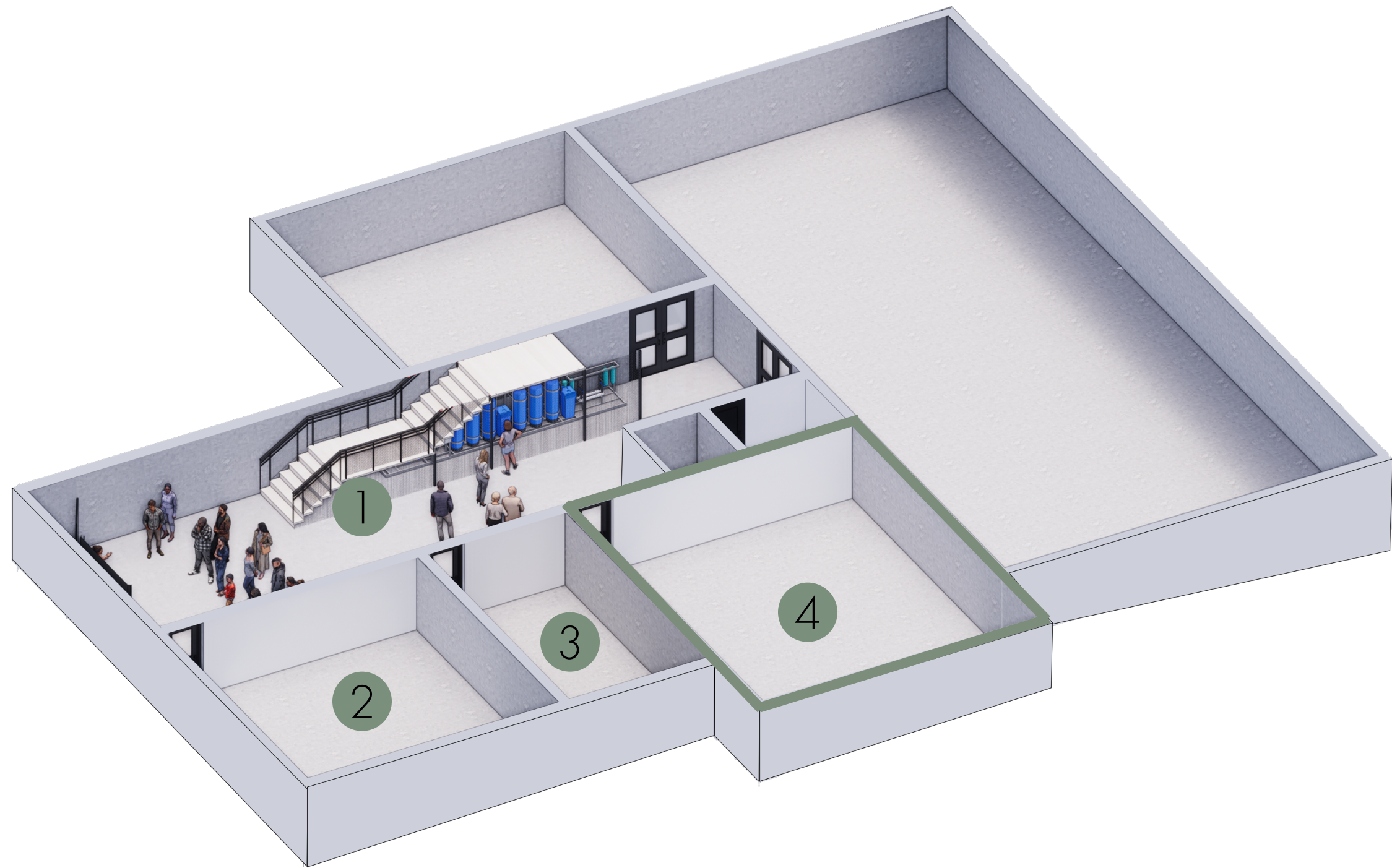
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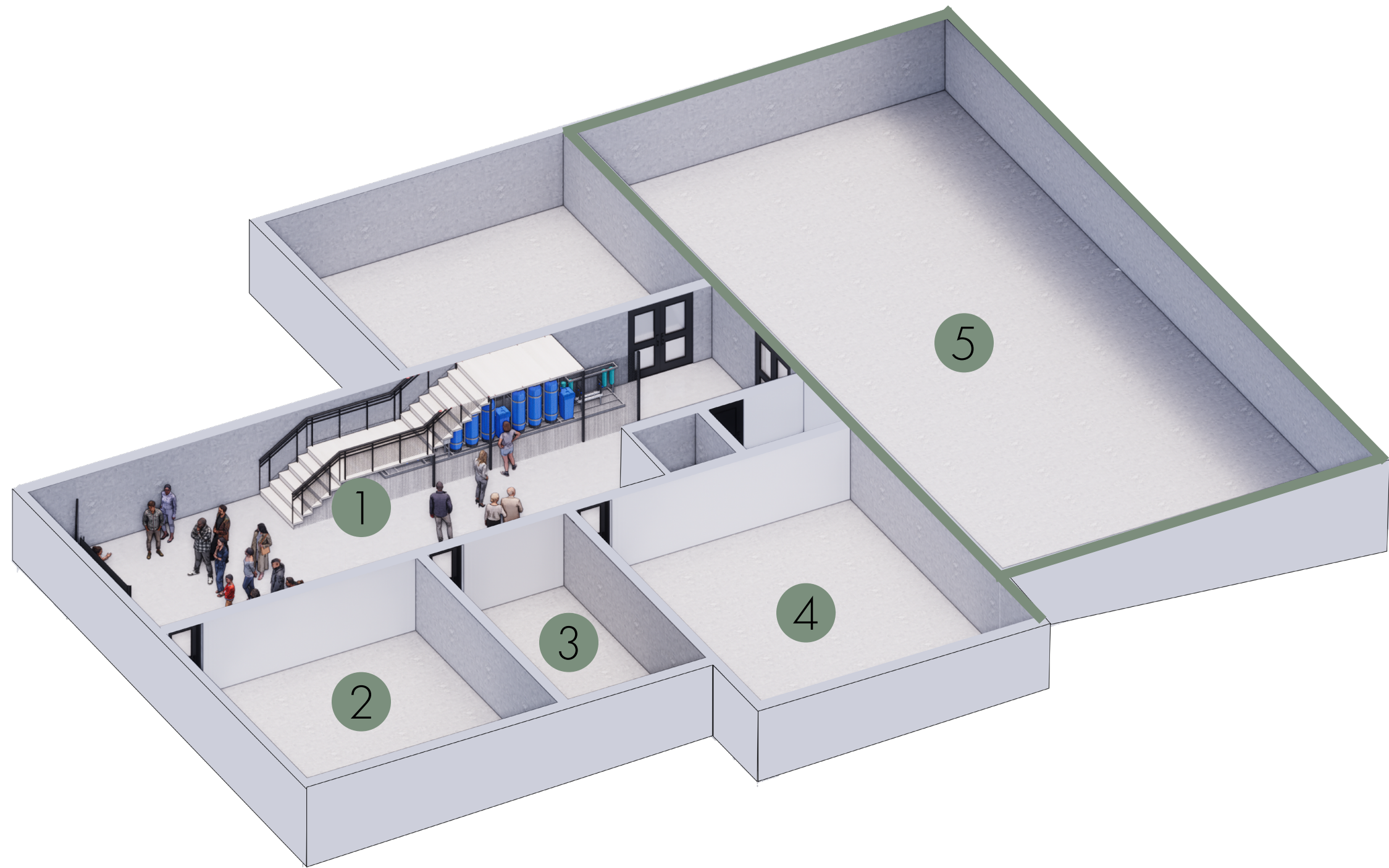
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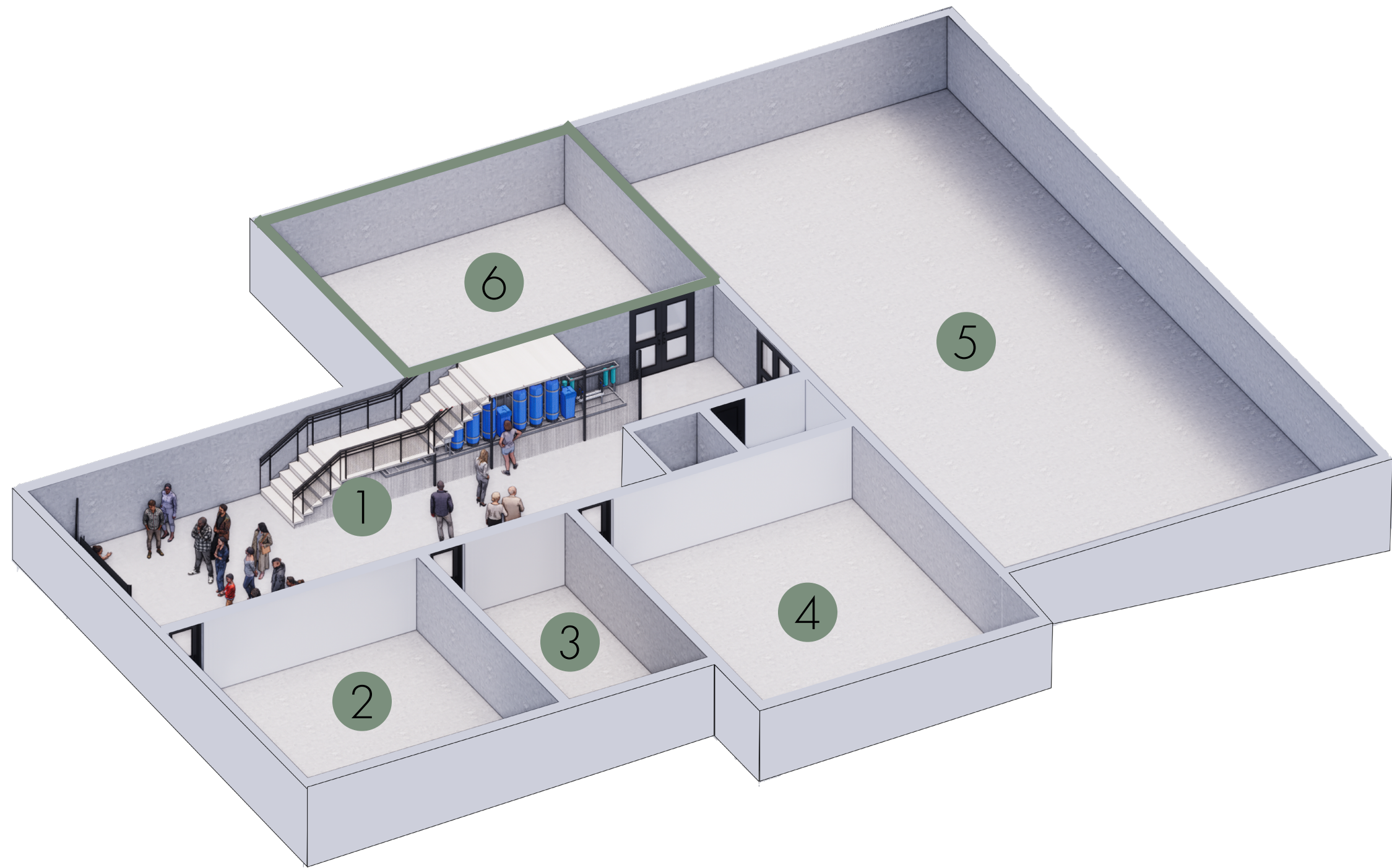
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**LEVEL 1: COLLABORATION**



**ENTRY COMMONS & ATRIUM**



**COMMONS & ATRIUM**





COMMONS



## LEVEL 1: COLLABORATION

1. Large Classroom



LEVEL 1 CLASSROOM



## LEVEL 1: COLLABORATION

1. Large Classroom
2. Collaboration Center



**COLLABORATION CENTER**



**OUTDOOR OBSERVATION DECK**



## LEVEL 1: COLLABORATION

1. Large Classroom
2. Collaboration Center
3. Auditorium



AUDITORIUM





## LEVEL 1: COLLABORATION

1. Large Classroom
2. Collaboration Center
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4. Storage



## LEVEL 1: COLLABORATION

1. Large Classroom
2. Collaboration Center
3. Auditorium
4. Storage
5. Restrooms



## LEVEL 1: COLLABORATION

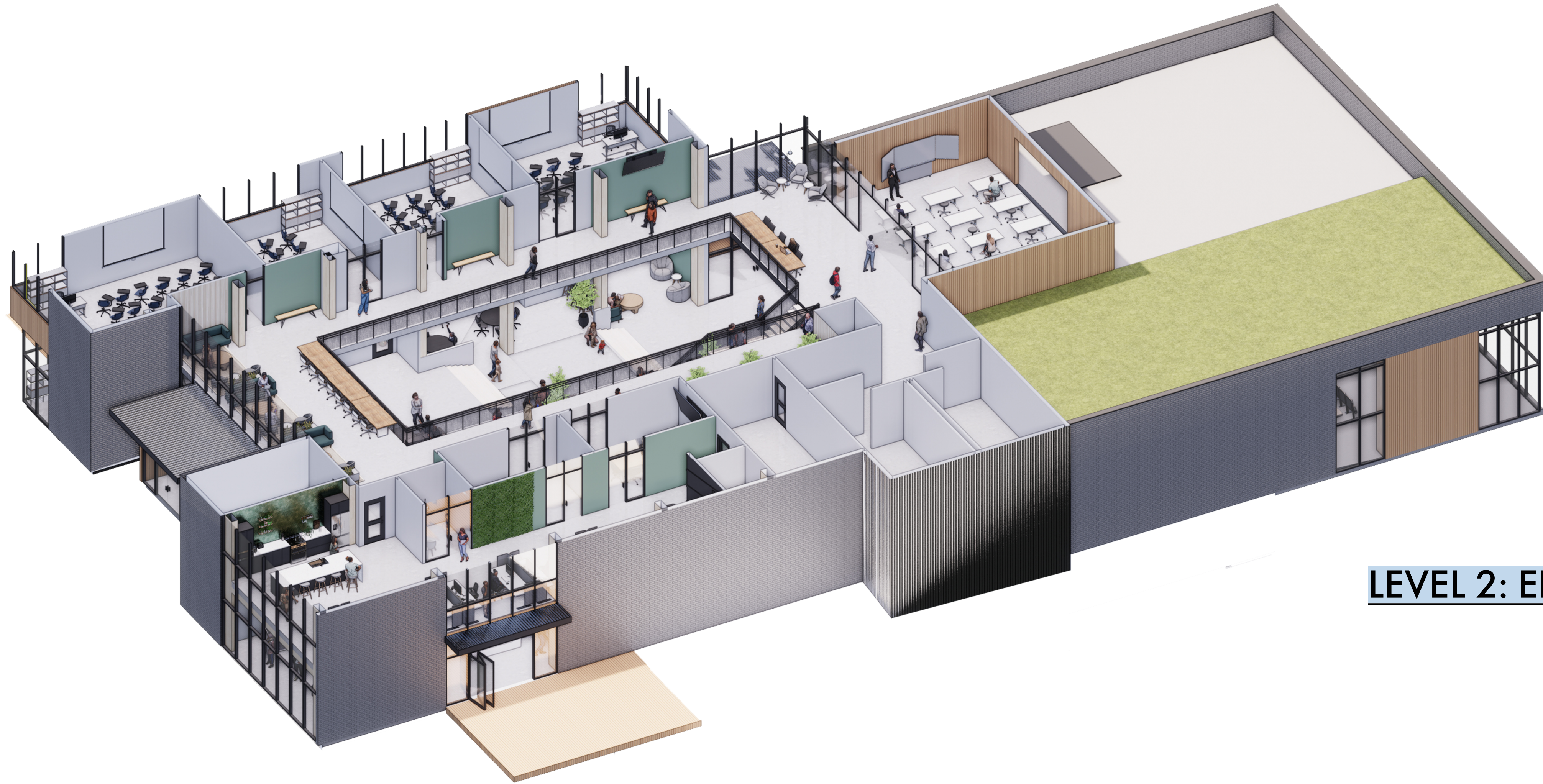
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**SUSTAINABLE DESIGN EXHIBITION**



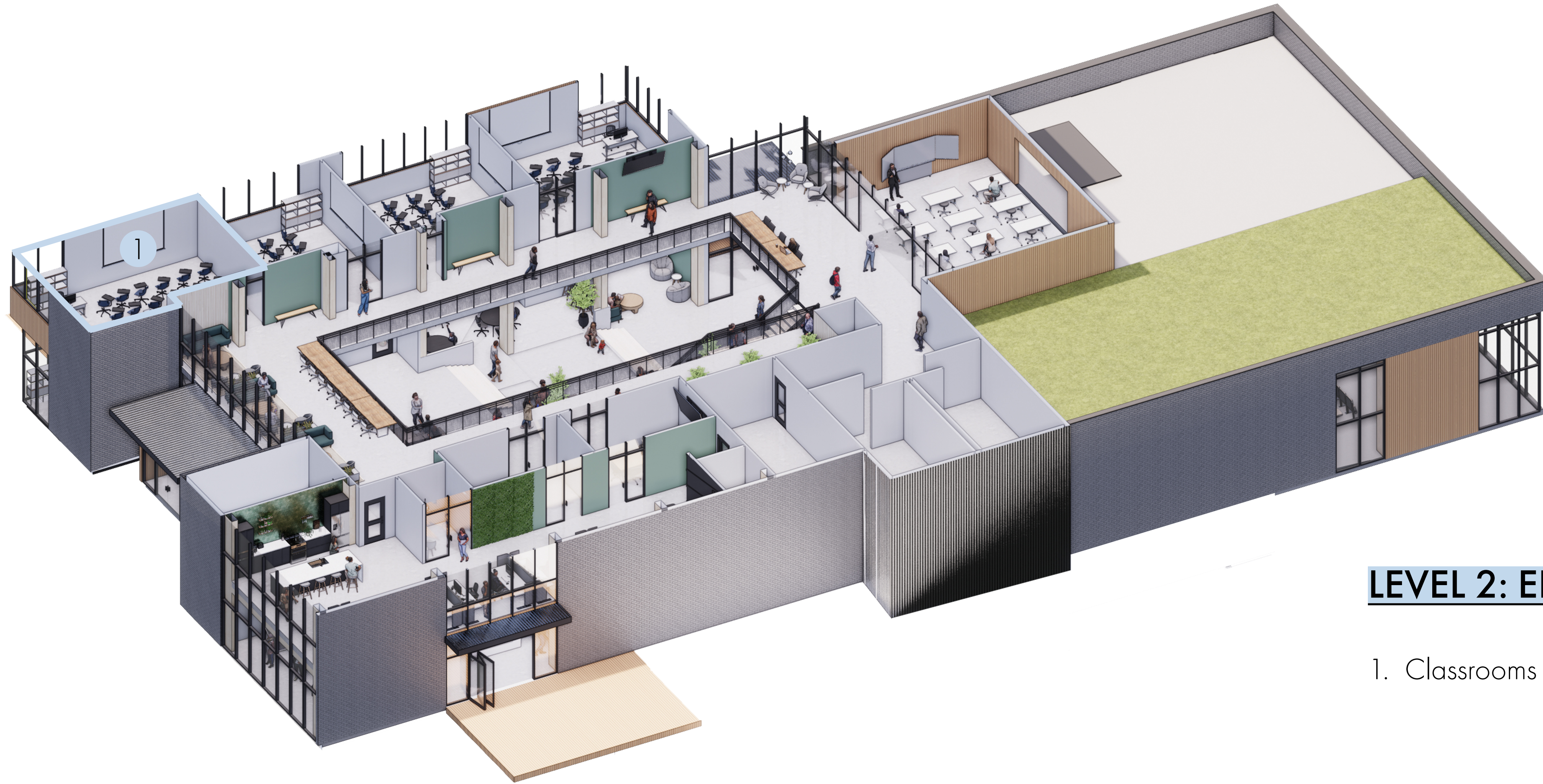
**TRAIL VIEW & RESTROOM FACILITY**



**LEVEL 2: EDUCATION + ADMIN**



SECOND FLOOR ATRIUM VIEW



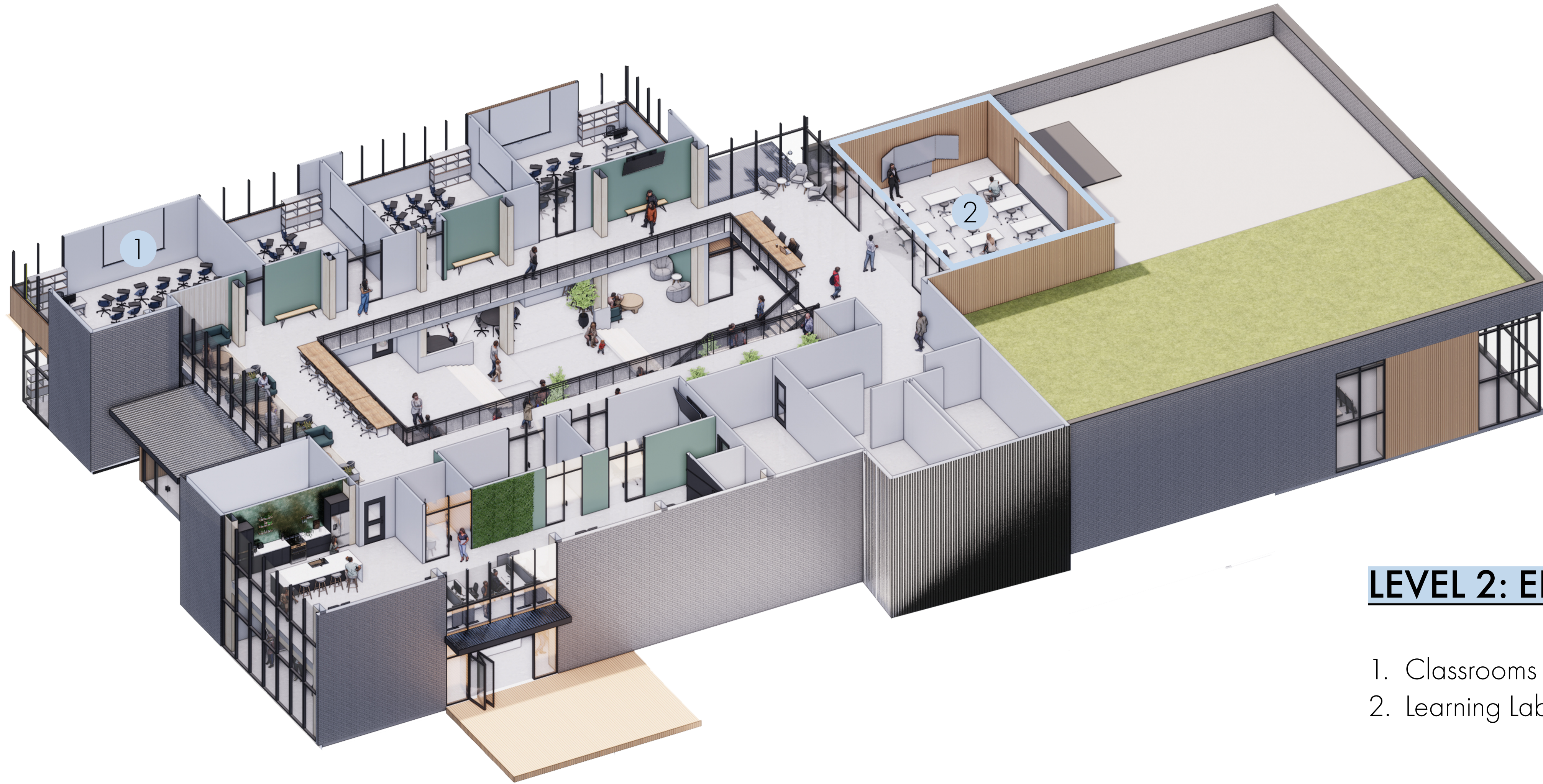
## LEVEL 2: EDUCATION + ADMIN

1. Classrooms





LEVEL 2 CLASSROOM

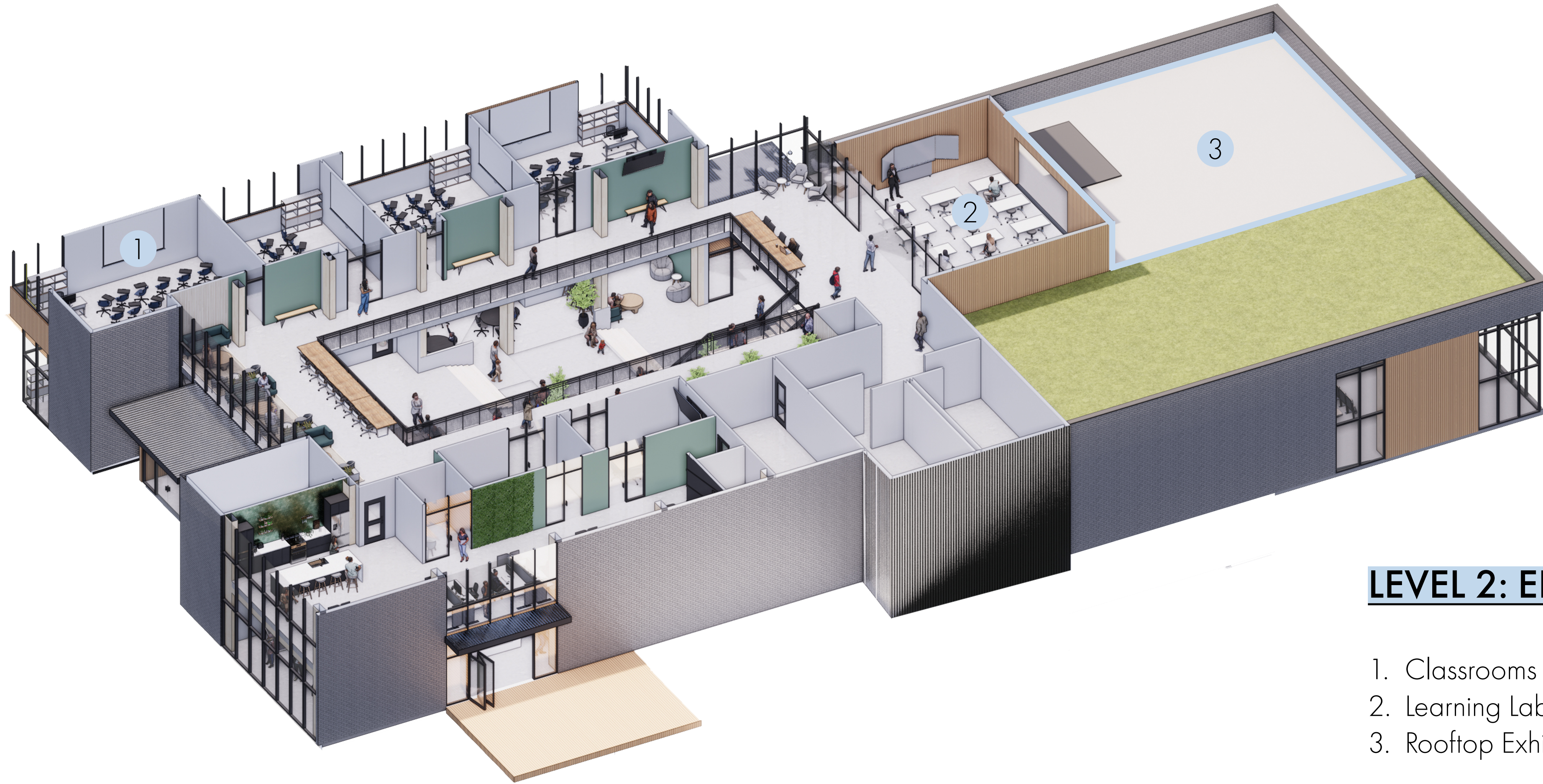


## LEVEL 2: EDUCATION + ADMIN

- 1. Classrooms
- 2. Learning Lab

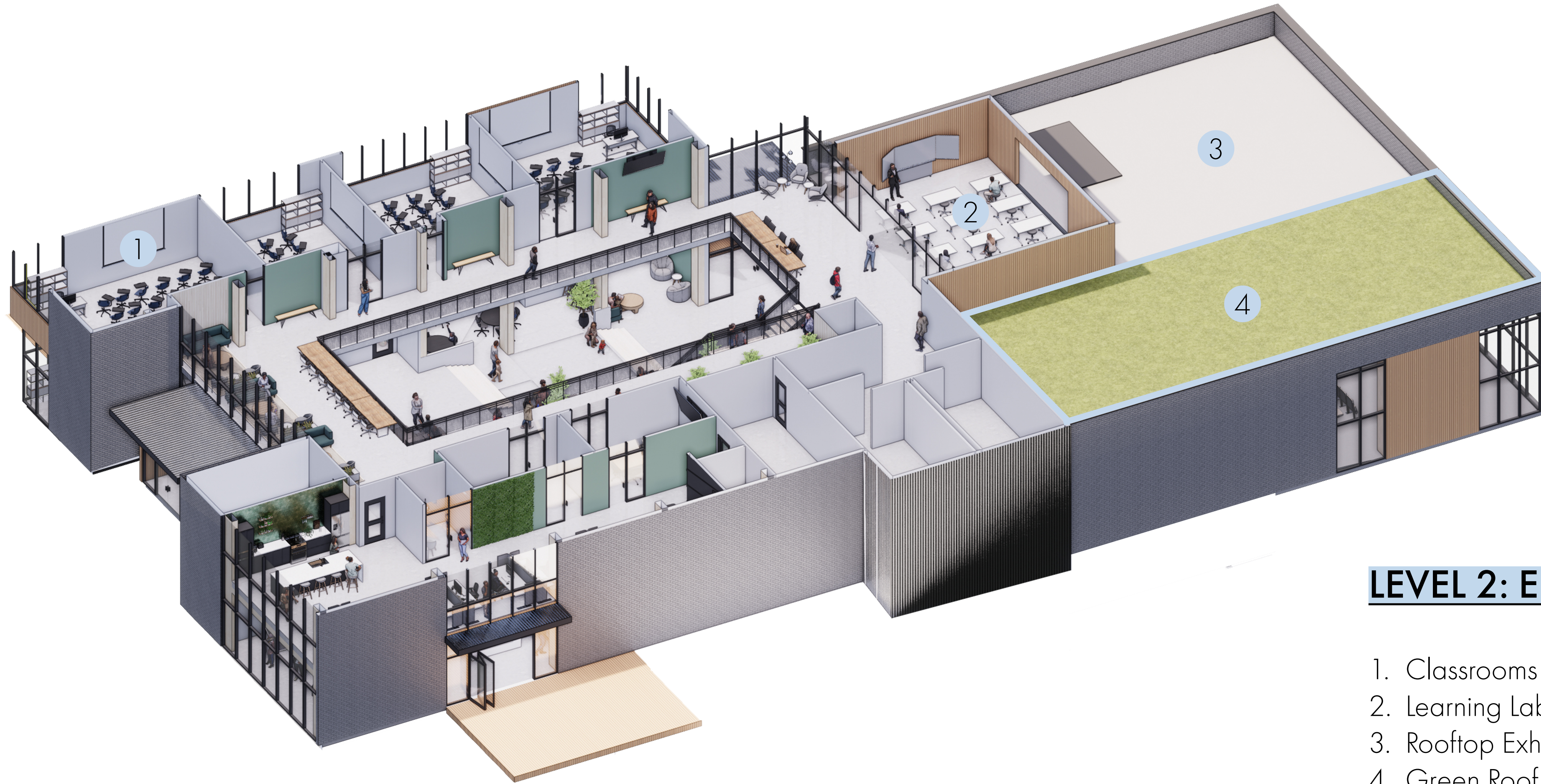


**LEARNING LAB**



## LEVEL 2: EDUCATION + ADMIN

1. Classrooms
2. Learning Lab
3. Rooftop Exhibition

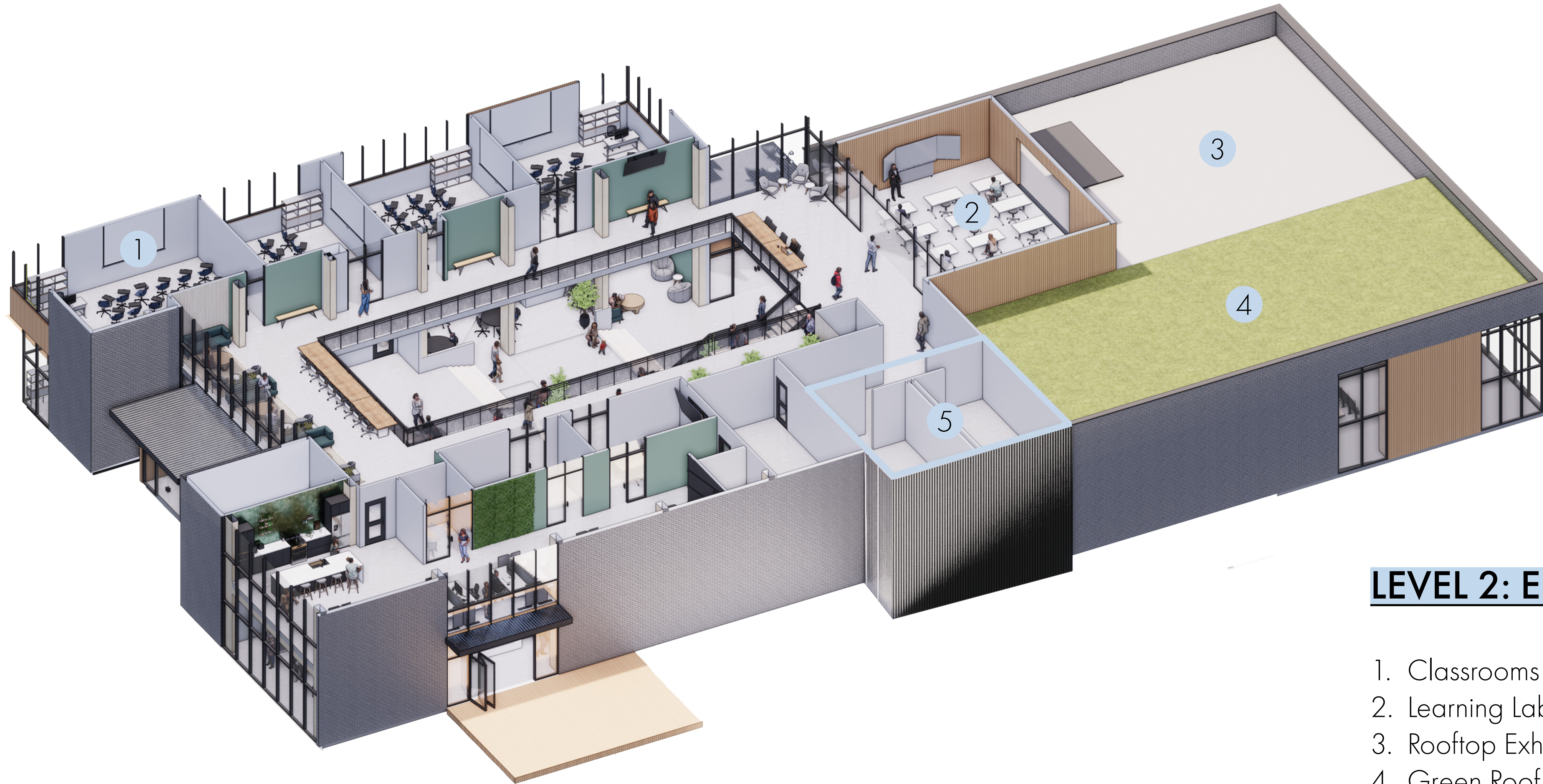


## LEVEL 2: EDUCATION + ADMIN

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2. Learning Lab
3. Rooftop Exhibition
4. Green Roof

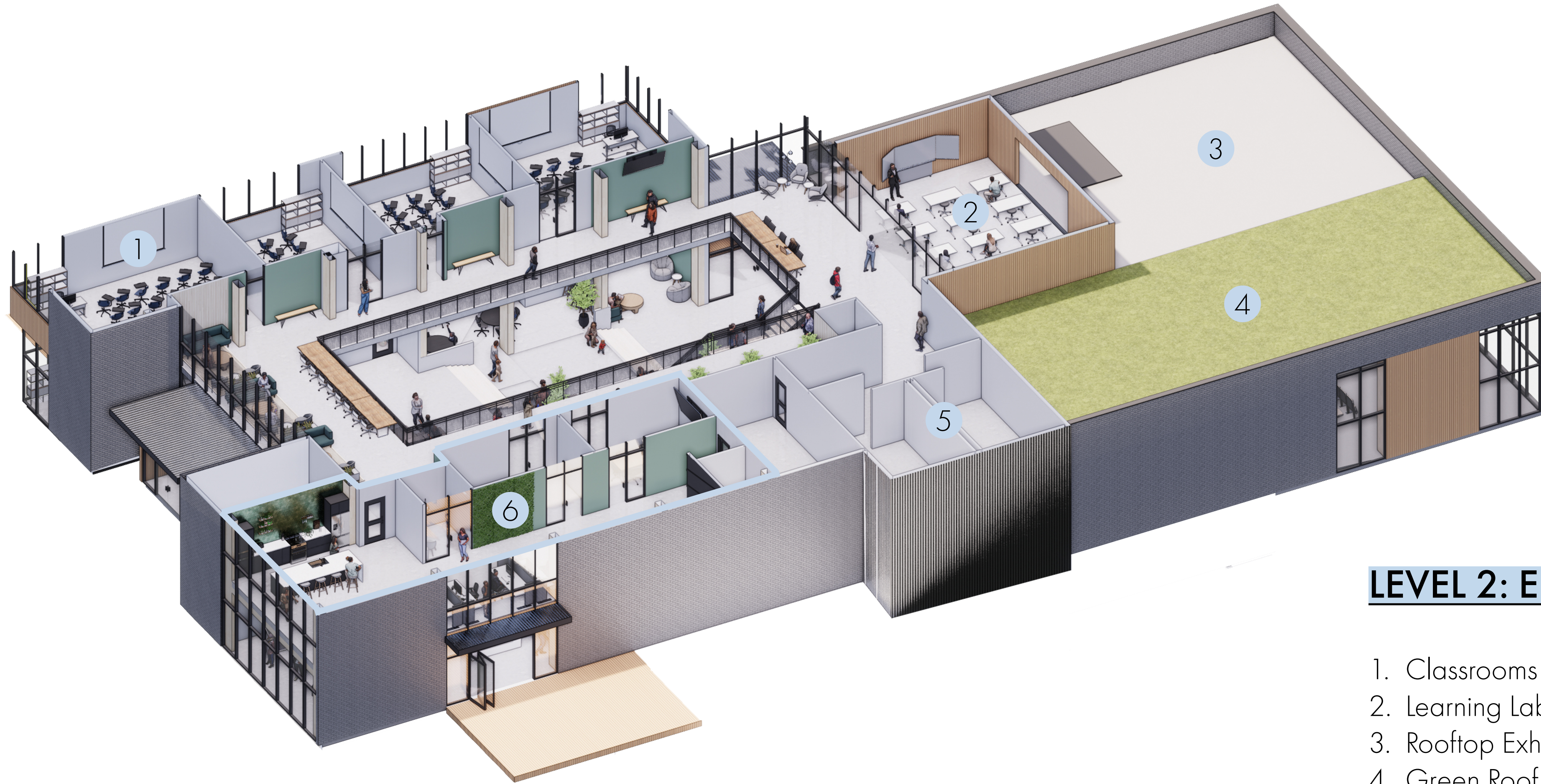


**ROOFTOP DISPLAY & GREEN ROOF**



## LEVEL 2: EDUCATION + ADMIN

1. Classrooms
2. Learning Lab
3. Rooftop Exhibition
4. Green Roof
5. Restrooms



## LEVEL 2: EDUCATION + ADMIN

1. Classrooms
2. Learning Lab
3. Rooftop Exhibition
4. Green Roof
5. Restrooms
6. Open Office





OFFICE



OFFICE & BREAK ROOM

# SUSTAINABLE BY DESIGN

## ENERGY + POWER



**ELECTROCHROMIC GLASS** maintains optimal indoor lighting conditions and allows users to change the opacity.



**ROOM OCCUPANCY SENSORS** allows the building to maintain energy efficient lighting, heating and cooling.



The use of **DAYLIGHTING** brings sunlight into spaces without the use of fixtures.

## HEATING + COOLING



**PASSIVE COOLING** is accomplished through the use of operable windows.



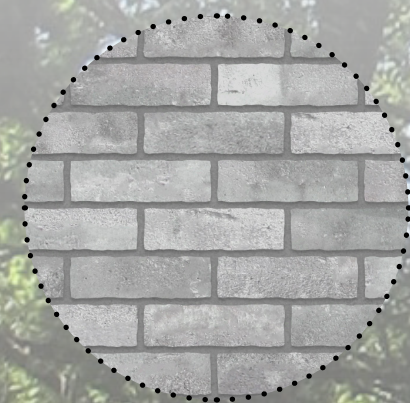
In winter months, **BIOMASS SPACE HEATING** is utilized by burning locally sourced wood pellets.



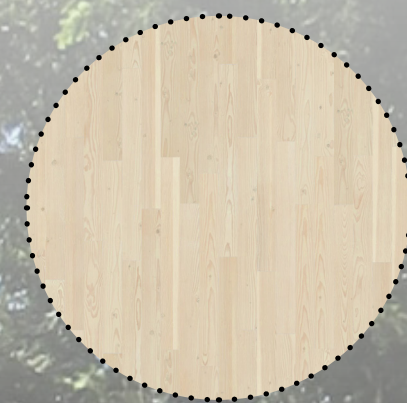
A **GREEN ROOF** helps reduce energy use by cooling roofs and providing shading, thermal mass and insulation.



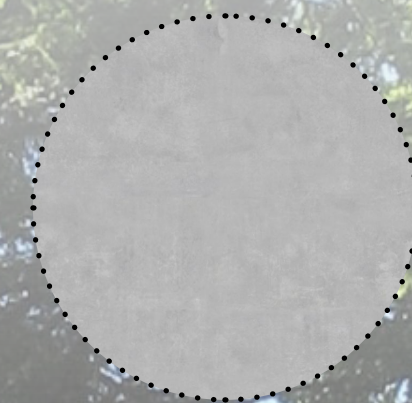
WOOD PLANK



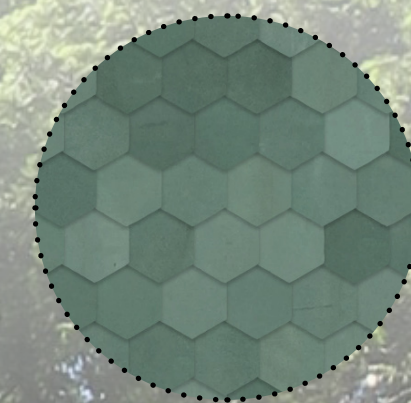
GREY BRICK



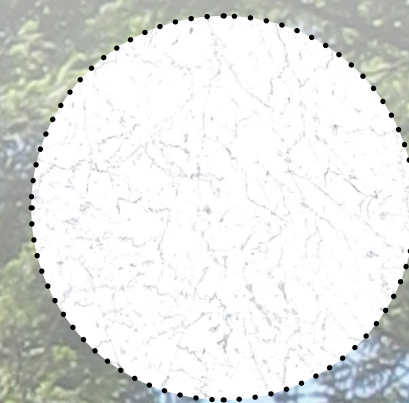
FIR CLT



POLISHED CONCRETE



PATINATED TILE



WHITE GRANITE

## RESOURCE MANAGEMENT



**REFORESTATION EFFORTS** include forest maintenance and planting trees to replace those removed during construction.



A **RAINWATER COLLECTION** system located on the roof provides non-potable water for irrigation and plumbing.



**WATER EFFICIENCY** is achieved through low-flow plumbing fixtures.

## MATERIAL SELECTION






**LOCALLY SOURCED MATERIALS** such as wood harvested and processed in Two Harbors, Minnesota reduces transportation costs.






**NO RED LIST MATERIALS OR CHEMICALS** are used to improve the health of the building and its occupants.




## ENERGY + POWER

-  **ELECTROCHROMIC GLASS** maintains optimal indoor lighting conditions and allows users to change the opacity.
-  **ROOM OCCUPANCY SENSORS** allows the building to maintain energy efficient lighting, heating and cooling.
-  The use of **DAYLIGHTING** brings sunlight into spaces without the use of fixtures.



## HEATING + COOLING

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## RESOURCE MANAGEMENT

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## MATERIAL SELECTION

-  **LOCALLY SOURCED MATERIALS** such as wood harvested and processed in Two Harbors, Minnesota reduces transportation costs.
-  **NO RED LIST MATERIALS OR CHEMICALS** are used to improve the health of the building and its occupants.



LATITUDINAL SECTION PERSPECTIVE

LONGITUDINAL SECTION PERSPECTIVE



# DULUTH SUSTAINABLE DESIGN LEARNING CENTER

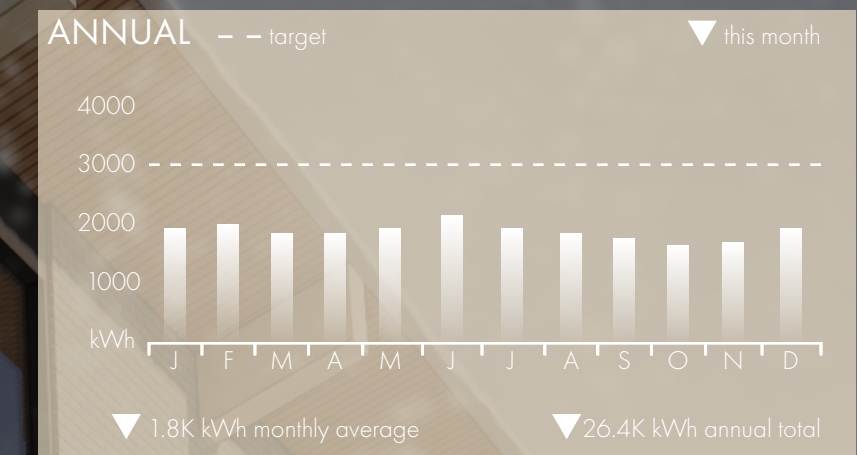
5/2/23  
2:25 PM

## DASHBOARD

### ENERGY USE

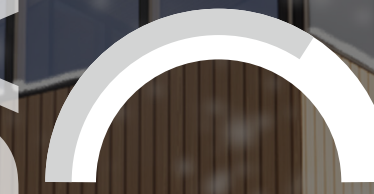
#### COMBINED

This is a snapshot of the SDLC's total energy use over the past 12 months to track if we are meeting, exceeding, or falling short of our energy reduction target.



#### PLUG LOADS

Usage is down.



#### LIGHTING

Usage is down.



#### HVAC

Usage is down.



### WATER USE

#### POTABLE WATER

This is a snapshot of the SDLC's total water use over the past 12 months to track if we are meeting, exceeding, or falling short of our energy reduction target.



### CARBON FOOTPRINT

#### CARBON OFFSET

This is a two year review of the SDLC's annual carbon footprint, offset through tree planting. Working with Forterra, we plant trees to offset our carbon at a rate of 1 tree for every 5 tons of carbon emitted.



# GOALS



1

## INTEGRATE INNOVATIVE SUSTAINABLE STRATEGIES:

Incorporate strategies and materials that can showcase the capabilities of current green building technologies.

2

## EMPHASIZE OUR IMPACT ON THE ENVIRONMENT:

Display the impacts of construction on our environment by the numbers, and show the importance of conservation.

3

## EDUCATE ON SUSTAINABILITY IN THE MIDWEST:

Provide educational spaces, signage, and programming to encourage future implementation within the community.

4

## CREATE AN INCLUSIVE LEARNING ENVIRONMENT:

Implementing different learning styles and spaces allows for users of all abilities and disabilities to participate in sustainable design. These include auditory, visual aids, and hands-on learning opportunities

A scenic view of a forest with a waterfall cascading over rocks. The waterfall is the central focus, with white water splashing over dark, jagged rock formations. The surrounding forest is dense with tall, thin trees, some evergreen and some deciduous, creating a lush green backdrop. The lighting is soft, suggesting an overcast day. A semi-transparent white banner is overlaid across the middle of the image, containing a quote in bold black text.

**“The climate we experience in the future depends on our decisions now.”**

# THANK YOU

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