Politecnico di Torino

WETLANDS RESEARCH CENTER

Eco-productive urban facility in Bogotá

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WETLANDS RESEARCH CENTER

Eco-productive facility to promote the environmental restoration of the sector around the wetland of “Techo”, in Bogotá.

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Para ti Yito,

Por haber sido una inmensa fuente de inspiración para todo aquél que te conoció. Por tu impregnable pasión por la vida y tu profesión, por tu ejemplo de decencia e integridad humana. Por haber sido un ejemplo y una referencia fundamental en mi vida. Por tu legado de honestidad, dedicación, ética y por encima de cualquier otra virtud tuya, tu legado de amor. Esta alegría de la etapa que termino te la debo a ti, en muchos aspectos.

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01

INTRODUCTION

Abstract

As relatively recent as *green* or *sustainable* architecture is, this design philosophy has already reached a tipping point. With approximately 40 years of application to environmental design problems, it is paradoxically becoming obsolete. The latest environmental diagnoses carried out by different non-governmental organizations have revealed the strong environmental deterioration and have become the basis for questioning what we consider *green design* and for the formulation of new architectural design currents that seek to overcome the design parameters that sustainable design presupposes at the moment.

This document is the result of research on the environmental conditions in which Planet Earth finds itself and how architectural design has tried to find solutions to combat climate change and other ecological challenges, for the formulation of an eco-productive urban facility, which in turn aims to contribute knowledge to the design currents that improve the concept of sustainable design. For this purpose are done a review of the conditions of the environment at a global level, a review of the concepts that have been proposed by architecture for sustainable development, an exposition of the concept of eco-productivity developed by the Colombian architect Andrés Ibáñez and a second diagnosis that shows the main environmental problems in Bogota to trigger the formulation of the project.

The proposed project is a Research Center of Wetlands, which is one of the most important ecosystems in the region where Bogota is located, in Colombia.

Problem

Sustainable or green architecture, since its conception has focused on mitigating and reducing the negative impacts of buildings on the environment in which they are placed. However, the most recent studies of environmental diagnosis of planet Earth show that currently the consumption of resources by human beings exceeds the global biocapacity. This means that the human being finishes the annual ecological productivity of the planet before the year comes to its end, affecting other forms of life, the resilience of the environment, the living conditions of human beings, among many other emergencies.

Even a biodiverse country like Colombia is not exempt from the problem, as a study on resource consumption revealed that if everyone consumed the way Colombia does, by 2021 Overshoot Day would be November 2 (Earth Overshoot Day Organization, 2021).

If planet Earth is no longer capable of supporting human consumption and pollution, the current philosophy of sustainable design paradoxically it's not enough considering today's ecological needs. What is the use of minimizing negative impacts on the environment when constructing a building if we are at a time in history where human beings have an annual debt with the planet that is progressively increasing?

Aims

General aim:

The principal aim of the thesis is to design an eco-productive project through the exploration of spatial and technological strategies to promote the environmental restoration of the sector surrounding the wetland of "Techo".

Specific aims:

- Achieve a quantifiable improvement of environmental conditions in the area surrounding the wetland of "Techo", through the generation of ecosystem services from architecture.

- Apply innovative environmental strategies through technological and spatial design to improve the quality of life in the area.

- Ensure the production of social capital through the development of a collective facility that in turn restores environmental conditions.

- Design a building that allows the creation of habitat for different forms of life, reincorporates diverse species to the urban environment and promotes their relationship with human beings.

Methodology

1. Research on the current environmental state of Planet Earth and the urgency for applying eco-productivity to architectural design.

2. Identification and analysis of the local problem, along with a conceptual framework and a research on referents of sustainable architectural projects.

3. Characterization of the project's site to recognize problematics and opportunities.

4. Proposal of an Urban and Architectural Eco-productive project, followed by an evaluation of its environmental performance.

02

GLOBAL PROBLEM

General problem

(A global concern)

From Green design to *Eco-productive design*

In contemporary architecture, ***sustainability*** has become one of the most sought-after and popular design trends, achieving advances in the efficiency of building performance. However, this design philosophy is paradoxically becoming outdated with only a few decades of application.

Since the middle of the 18th century, the Industrial Revolution has accelerated the transformation of many areas in an abrupt manner; from some perspectives it did so in a positive way, however, the development process it unleashed produced strong environmental impacts. Some of the most striking consequences have been the *loss of more than 85% of Earth's area of wetlands* and the *alteration of 75% of ice-free land surface* (WWF, 2020, p.12). Decades later, there was great concern about the decisions that were being made regarding the most important ecological problems, which led to the need to propose a new development model for humanity in order to avoid worsening the conditions of planet Earth.

In 1983 the United Nations (UN) created the *World Commission on Environment and Development* (WCED) to focus studies and answer to different concerns related to globalized economic growth and the environmental impacts of human actions. The former Norwegian Prime Minister Gro Harlem Brundtland was the main director of the commission, which later in the year 1987 would publish the report titled *Our Common Future*. On this document was stated for the first time the definition of *sustainable development* and became a milestone for the further studies and theories of development (Gómez, 2013, p. 91).

1987 ***Our Common Future*** *report stated:*

> "***Sustainable development*** *is development that meets the* ***needs of the present without compromising*** *the ability of* ***future generations*** *to meet their own needs."*

1972
- **"The Limits of Growth"** Report
By The Club of Rome

- **Earth Summit in Stockholm**
By The United Nations
The result was the ***Stockholm Declaration***

1983
- **World Commission on Environment and Development** (WCED) creation
By the United Nations

1987
- **"Our Common Future"** Report
By the WCED
States for the first time the definition of ***sustainable development***

1992
- **Earth Summit in Rio de Janeiro**
By the United Nations
The result was the ***Rio Declaration*** *and the* ***Agenda 21***

1997
- **Kyoto Protocol**
International treaty
It set binding targets for 44 industrialized countries committing them to ***reduce greenhouse gas emissions*** *of at least* ***5.2%*** *over the 2008-2012 period.*

2001
- **Stockholm Convention**
Global treaty
Done to protect human health and the environment from persistent organic pollutants (POPs)

2007
- **IPCC Fourth Assessment Report**
By the United Nations
Established the correlation between ***CO2 concentration*** *in the atmosphere and* ***climate change***

2015
- **COP21 in Paris Conference on Climate change**
By the United Nations
The result was the Paris Agreement that aims to limit the ***global warming*** *to well* ***bellow 2°C***

2021
- **COP26 in Glassgow Conference on Climate change**
By the United Nations
The result was The Glasgow Climate Pact that aims to accelerate actions for the ***mitigation***, ***adaptation***, ***finance*** *&* ***collaboration*** *between governments.*

Sometime later, when sustainability was applied to architectural know-how, *green design* and *sustainable design* currents emerged. These design currents have focused mainly on seeking design alternatives to reduce and mitigate the negative impacts of buildings on the environment.

According to Cole (2012), green design is a term that emphasizes the environmental performance of those buildings that have better ecological performance than traditional buildings. In that sense, the author raises the fundamental premises of green buildings, which are:

> **1.** ***Reduces*** damage to natural or sensitive spaces.
> **2.** ***Reduces*** the need for new infrastructure.
> **3.** ***Reduces*** impacts on natural and ecological elements of a site during construction.
> **4.** ***Reduces*** potential environmental damage from potential emissions and leakage.
> **5.** ***Reduces*** contribution to global environmental damage.
> **6.** ***Reduces*** resource use - energy, water and materials.
> **7.** ***Minimizes*** discomfort of building users.
> **8.** ***Minimizes*** harmful and irritating substances inside the building. (p. 40)

These premises are also applicable to *sustainable designs*, which are buildings that seek to comply with design parameters and rules that evaluate the environmental performance of a building. However, the quest to obtain certifications that accredit the environmental performance of a building has often led to projects seeking to comply with efficiency and natural resource savings from different isolated items, not really an integrated approach that allows the project to be completely environmentally friendly (Cole, 2012, p. 41).

However, despite these efforts and advances, sustainability in architecture has reached a breaking point. The most extensive and experienced non-governmental organization in environmental conservation, *The World Wildlife Fund International* (WWF), through its *Living Planet Report* documents in its 2010, 2016 and 2021 editions has evidenced the alarming situation of deterioration of planet Earth.

Illus. 1. Wildfire in Greece, 2021.

2020 ***The World Wildlife Fund Int.*** *(WWF):*

> *"Since **1970**, our Ecological Footprint has **exceeded** the **Earth's rate of regeneration**. This **overshoot** erodes the planet's health and, with it, humanity's prospects.* (p. 56) *"*

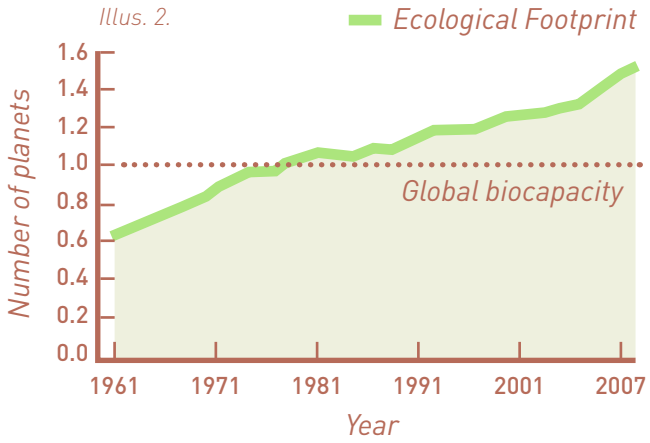
In the 2010 environmental assessment, *Living Planet Report 2010: Biodiversity, biocapacity and development*, studies showed the increase in demand on natural resources from 1961 to 2007. The results were that the human ecological footprint had more than doubled, exceeding the Earth's biocapacity to support such demand. Biocapacity refers to the total biologically productive land and water areas within the boundaries of a territory, and how productive they are. The graph shows that in 2007, approximately **1.5 planets like the Earth were needed** to supply the resource consumption of human beings.

The studies also emphasized the main threats to biodiversity in the world, being these:

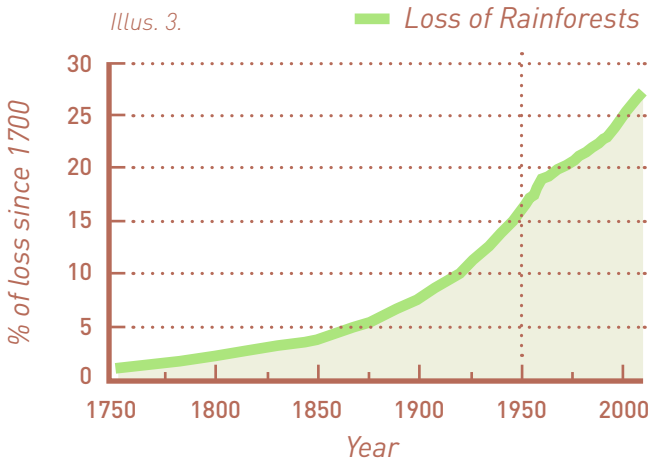
> **1.** ***Habitat alteration and loss:*** Mainly due to land transformation for agriculture, industry or urbanization. Negatively affecting water systems and the permeability and water infiltration capacity of the land.
> **2.** ***Overexploitation of species:*** Mainly the breeding of animals and some plants for mass reproduction for consumption.
> **3.** ***Pollution:*** Directly caused by the excess of pesticides in agriculture and by waste from urban environments.
> **4.** ***Climate change:*** Due to high levels of greenhouse gases in the atmosphere as a result of deforestation and industrial processes.
> **5.** ***Invasive species:*** The insertion of foreign species in an inadvertent and uncontrolled manner, affecting native species and turning them into predators and competitors. (p. 12)

Three of the five most important threats are related to the built urban environment and are gradually contributing to the fact that the planet does not have the capacity to renew the resources that are threatened. One of the most important issues is the amount of carbon that has been generated since 1961. According to WWF (2016) there is a strong relationship between the increase in the amount of carbon dioxide (CO2) in the atmosphere and the great loss of tropical forest areas, finding that by the year 2000 approximately **27% of the amount of forest had been lost** with respect to what it was in the year 1750 (see illustrations 3 and 4).

Illus. 2.



Illus. 3.



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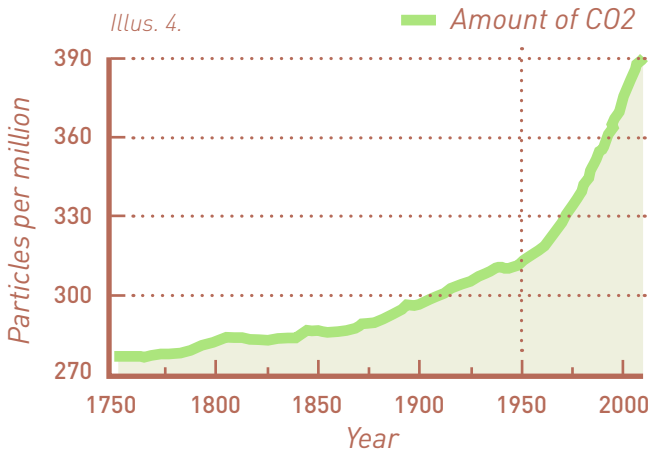


In the 2016 WWF study, *Living Planet Report 2016: Risk and resilience in a new era*, there were overwhelming results regarding the great loss of animals by species. One of the data that draws attention is how the **population of species** belonging to tropical forests has **decreased by 41%** since 1970.

One of the main causes of this phenomenon is the abrupt loss of habitat and the degradation of ecosystems, largely due to unsustainable agriculture and **growth of urbanized areas.** In this report, a study was conducted on the amount of forest area lost since 1990, which resulted in a figure of 239 million hectares of natural forests, where the development of cities has been one of the main reasons (WWF, 2016).

Human consumption by year 2020 exceeded by 56% the Earth's regenerative biocapacity (WWF, 2020). This leads to talk about the *"Overshoot Day"*, which is the moment in the year when humanity exceeds the regenerative capacity of the planet and begins to consume more of what nature can provide for the support of all living beings (WWF, 2016).

For the year 2021, the **Overshoot Day was the 29th of July**. This means that from that moment on, the human being is indebted to the environment for all the resources consumed during the following five months. In order to start solving this problem there have been some efforts to allow future generations to enjoy a sufficient amount of resources to meet their needs, but it has not been enough. This "charge date" for natural resources with each passing year moves closer to the month of June (Earth Overshoot Day Organization, 2021).

Illus. 5.

Illus. 5.

Illus. 6.

The situation is that alarming that even a biodiverse country and with such a great amount of natural resources like Colombia is not exempt from the problem, as a study on resource consumption revealed that **if everyone consumed the way Colombia does**, by 2021 Overshoot Day would be **November 2nd** (Earth Overshoot Day Organization, 2021).

By the time the overshoot is in June, humanity will be 50% in debt each year. Having this data, pitifully the good intentions of sustainable design for saving resources seems not to be enough. As we saw with Cole (2012), sustainable design has focused just on finding alternatives to reduce the negative impacts when implementing an architectural project.

These efforts have undoubtedly achieved technological advances to improve efficiency and natural resource savings in architectural projects. It has even been achieved that buildings are completely energy self-sufficient, so that the management of resources is cyclical. This means that the building itself produces all the energy resources it consumes, without the need for external support to the project, as will be seen later in the case studies.

The only way to recover a debt is with a positive balance. This is one of the premises of the theory of Colombian architect *Andrés Ibáñez*. Given that what is needed now is an environmentally positive development to recover the debt, the strategy through architecture can no longer be the search for making the negative impact less serious. Thus ***Eco-productivity*** becomes a viable alternative to overcome the parameters of green design. This design philosophy proposes the **capacity of architecture to generate ecosystem services** in an integral way and that allows the implementation of an architectural project to finally be a **positive impact** for the environment, and not a "less bad" impact (Ibáñez, 2017).

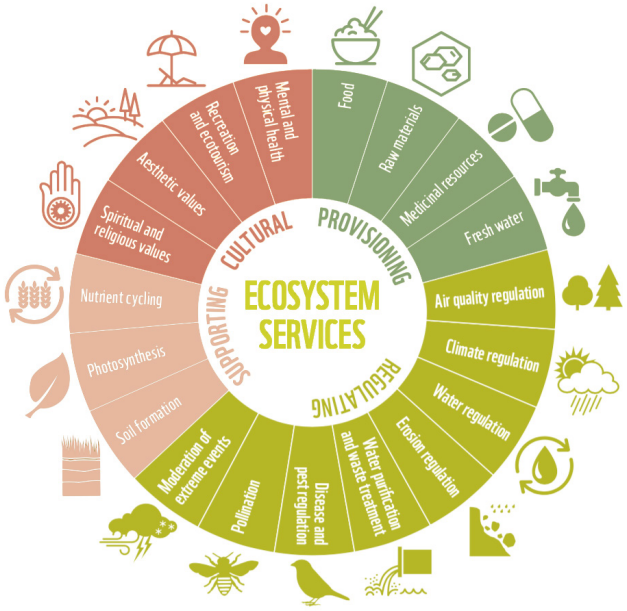
Taking again as a reference the *Living Planet Report* (WWF) of 2016, the Earth is capable of generating provisioning, regulating, supporting and cultural ecosystem services (see illustration 7). These services are what allow all living creatures to subsist. These services are the basis for the search for the positive impact of architecture, to the extent that it is capable of generating environmental value (Ibáñez, 2017).

Then **Eco-productive architecture** is that which is capable of **generating ecosystem services** of four types. Thus, a building could contribute to CO2 capture, oxygen production, increase the permeability and infiltration of water into the soil, increase biodiversity, clean water, cool the environment, promote food production, etc. (Ibáñez, 2017).

However, this approach does not mean that all green design strategies should be discarded or that they are not positive. On the contrary, they are a **technological starting point** for further refinement to ensure that a built environment generates ecosystem services.

For an evaluation that demonstrates that an architectural project is eco-productive, it becomes necessary to make a comparison between the quantity and quality of ecosystem services generated by the property (or place of implantation) prior to the realization of the building, in contrast to the quantity of services after it has been implanted. As a result, in order to be eco-productive, the quantity of environmental services produced by the architectural project must be greater (Ibáñez, 2018).

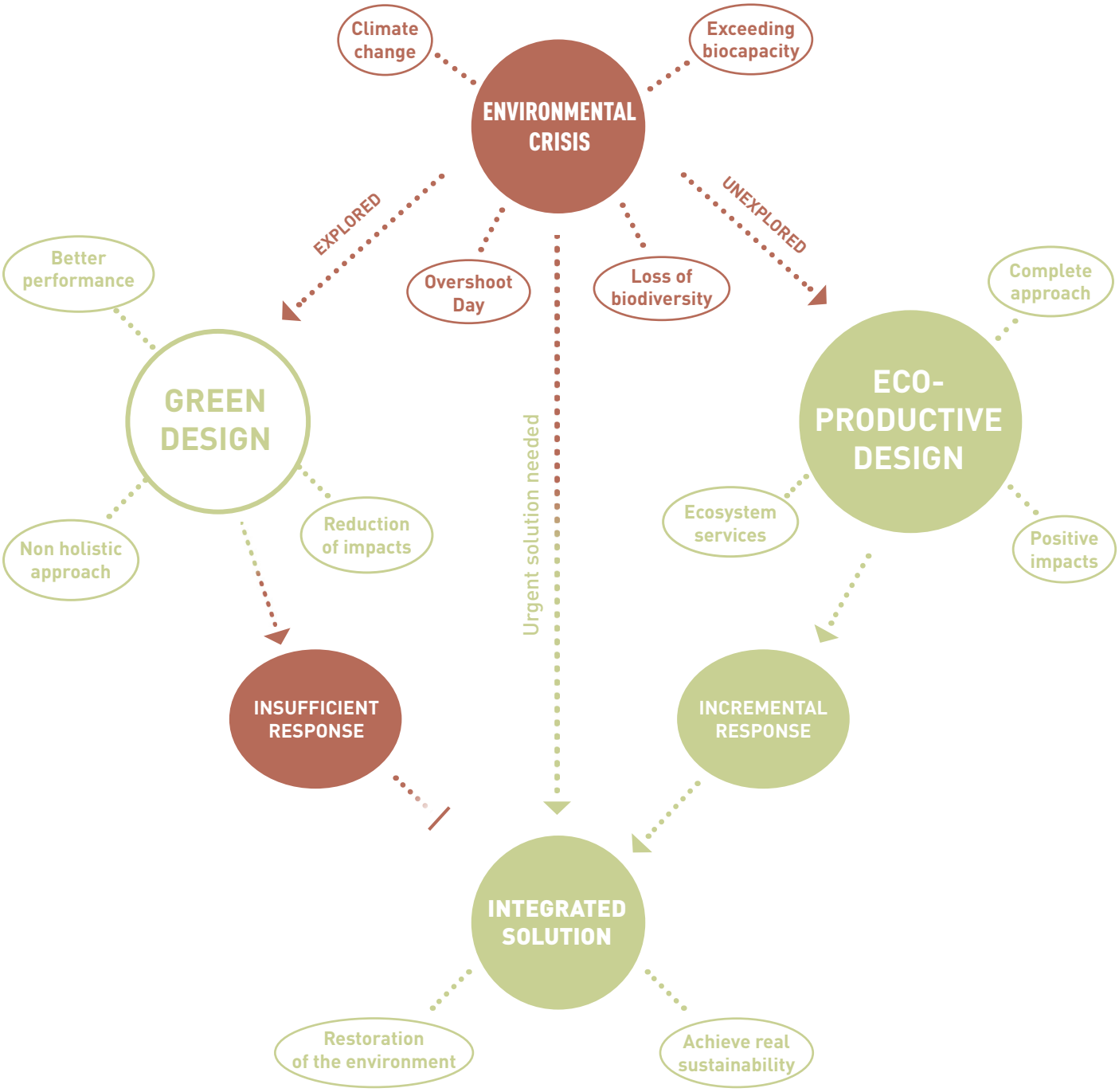
In conclusion, the environmental conditions of planet Earth show that design strategies that aim to reduce the negative impacts of architecture are no longer sufficient. This is why it is of great importance to seek that **architecture can generate ecosystem services** and make a positive impact on the environment, in order to reverse the alarming conditions of the Earth.



Illus. 7. Ecosystem services, WWF.

2012 ***Raymond J. Cole*** *stated:*

> *While the technical* ***strategies of green design will remain valid,*** *the intention and language of* ***regenerative design*** *and development particularly for the partnering and* ***coexistence*** *of human and natural systems, offers considerable potency for a* ***broadly-based environmental approach.*** (p.48)



Illus. 8. Global problem concept map, own elaboration.

2018 ***Andrés Ibáñez*** *stated:*

> *"**The next generation** of green architecture will not only reduce negative impacts and burdens on the environment, but will also **produce social** and **environmental value** in our cities by **generating eco-services.**"*

03

CONCEPTUAL FRAMEWORK

BEYOND "GR

ECO-PRODUCTIVITY

"Architectural design philosophy that elaborates urban elements that have the capacity to **generate ecosystem services**, create environmental value and thus have a **positive impact** on the environment" (Ibáñez, 2018).

+

SOCIAL

"The totality of potential or actu possession of a durable networ relations of mutual knowledge another way, it is the totality of **a group**" (Bourdieu, 2000, p. 14

Green infrastructure

"Strategically planned **network of high quality natural and semi-natural areas** with other environmental elements, designed and managed to provide a wide range of ecosystem services and protect the biodiversity of both rural and urban settlements." (European Commission, 2014).

Biotectonics

"It is the practice of building spaces with living plant material instead of using conventional inert materials. In other words, the **technological application of natural principles** and materials to architectural design." (Ibáñez, 2011).

Biomimicry

"It is the science that studies the principles present in nature for the solution of technological problems, through the realization of a **functional and formal abstraction of a system**." (Benyus, 1997).

Individual social capital

"All those structural and non-co individuals that make it possible to **necessary to solve the proble** different areas: labor, residential, etc." (Mayorga, 2012, p.23)

Collective social capital

"All those structural and non-co individuals that make it possible (organizationally and temporally **sufficient resources to achieve th** cultural, educational or recreation

Citizen social capital

"All those structural and not circu individuals that allow for the **forgi respect for social differences** an citizens, as a basis for acquiring a effective practice." (Mayorga, 2012

QUALITY

"An **individual's perception** of his or her place in existence, i she lives and in relation to his or her **expectations, norms ar** complex way by the subject's **physical health, psychological** or her **relationship with the essential elements of** his or her

Physical health

Psycholog

EEN DESIGN”

Core concepts

CAPITAL

ual resources associated with the
k of more or less institutionalized
e and recognition. Expressed in
resources based on belonging to
8).

+

URBAN FACILITIES

“Spaces and buildings for public or private use, whose function is to **offer services to meet and satisfy the needs for the provision of social services** (mainly educational, recreational, cultural, administrative, supply, security and health services).” (Mayorga, 2012, p.24)

Social capital promoters

“Social elements, which are constituted as referents of the daily life of spatially and temporally determined individuals and as **spaces for the production of social capital**, due to the interactions that take place within them.” (Mayorga, 2012, p.24)

Collective life contribuiters

“Urban facilities are spaces that fulfill a double function since, in addition to providing essential services, they **contribute to the construction and strengthening of collective life**.” (Franco et al, 2012, p.12)

Right to the city consolidators

“Facilities have a **direct influence on the consolidation of the right to the city**, to the extent that they are distributed equitably throughout the territory (...), and that they provide the services for which they were created with quality and responsibility through the construction of buildings that allow and promote it.” (Franco et al, 2012, p.19)

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njunctural relationships with other
acquire the skills and information
ms of daily life development in
educational, cultural, recreational,

l

njunctural relationships with other
to **create stable interest groups**
), with the capacity to mobilize
eir goals, be they of a neighborhood,
nal nature.” (Mayorga, 2012, p.23)

umstantial relations with other
ing of values around equality,
d, therefore, rights and duties as
attitudes around democracy and its
2, p.24)

Y OF LIFE

in the context of the culture and value system in which he or
nd concerns. It is a very broad concept that is influenced in a
state, level of independence, social relations, as well as his
environment.” (World Health Organization, 1996).

ical state

Social relations

Referent cases

GARDENS BY THE BAY

Information

Location: Singapore.

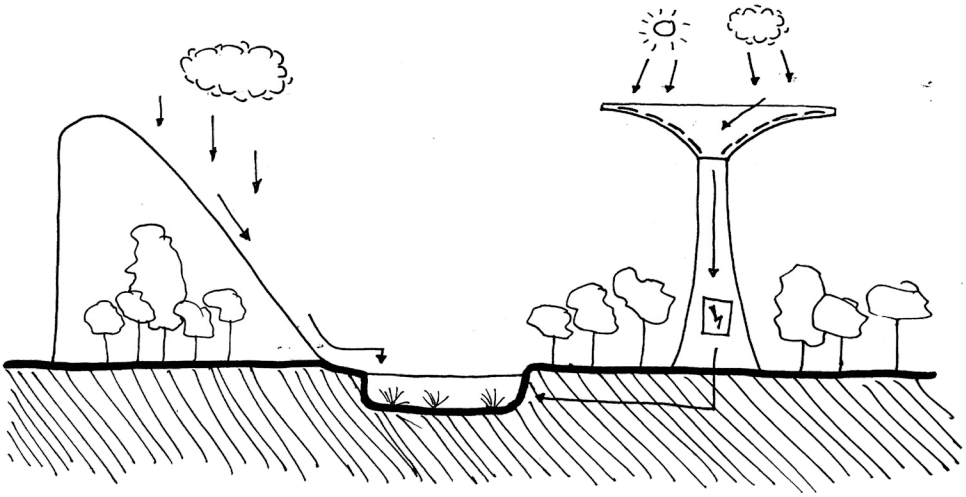
Designers: Wilkinson Eyre Arch., Grant Associates

Year: 2010

Stage: Completed

Description

Is a nature park of 101 hectareas located in the heart of Singapore. The gardens hold the world's largest glass greenhouse, which is called the Flower Dome. The park is an icon of the city's transformation on the search of evolving from a "Garden City" into a "City in a Garden".



Illus. 9.

Ecotectural contributions

- The whole masterplan created sustainable water cycles.
- The creation of the "SuperTrees" provides several environmental functions, such as water harvesting, solar energy harvesting, supporting biodiversity, etc.
- Achieved a holistic approach thanks to the different environmental strategies that were mixed.

Social contributions

- Created one of the most important landmarks, enhancing people's appropriation.
- Strengthened the horticulture and biodiversity appreciation in the society.
- Promoted the development of sustainable technology and environmental knowledge.

Illus. 10.

1000 TREES

Information

Location: Shangai, China.

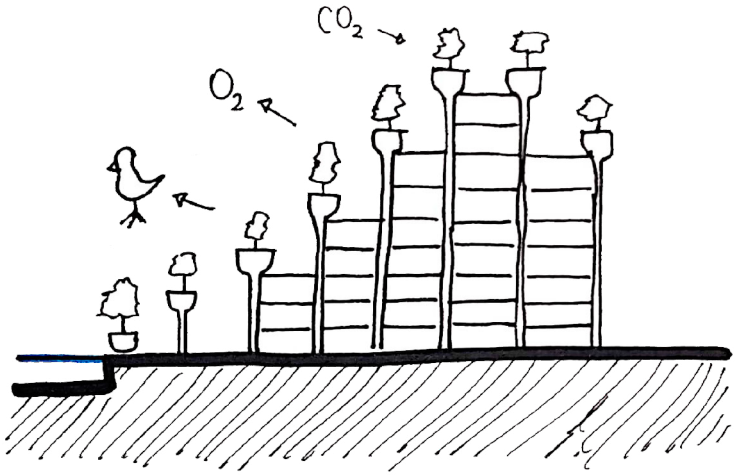
Designers: Heatherwick Studio

Year: 2021

Stage: Completed

Description

It is a multi-use complex near to Shangai's art district, including offices, shops, cafes, everyday stores, new public spaces and promenades. The main idea was to consider the human scale in the building's volumetric design and to advantage of the large number of columns that the project needed by planting on them.



Illus. 11.

Ecotectural contributions

- Large increasement of biodiversity on the site, by the creation of a tree covered built mountain.
- Considerable environmental cooling on the site and the surroundings.
- Considerable oxigen production and carbon dioxide capture.

Social contributions

- Creation of a landmark that mixes different types of activities such as commerce and arts with nature.
- A human scale approach that let people interact easily witht the large building that was requested.
- Harmonious integration with the context, giving space for street art present in the surroundings and enhancing the park's nature.

Illus. 12.

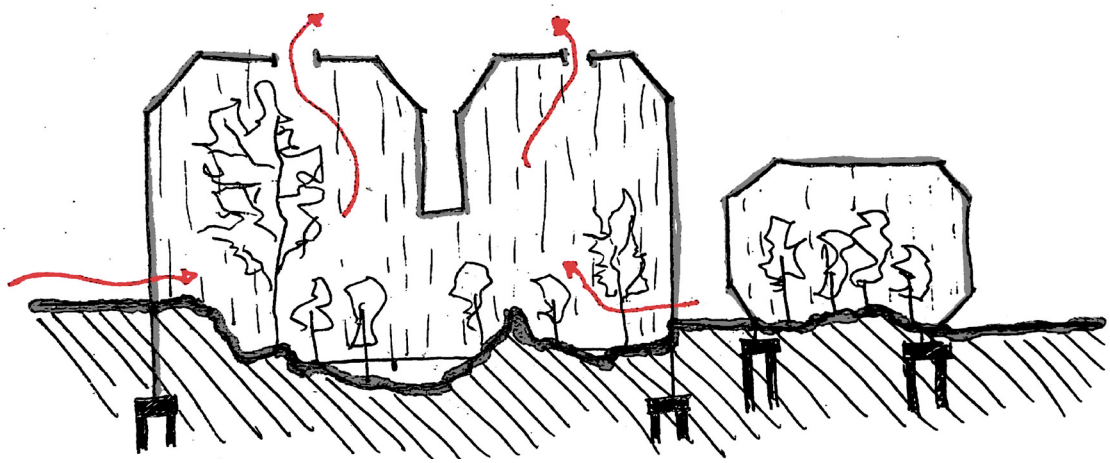
“TROPICARIO” of Bogotá’s Botanical Garden

Information

Location: Bogotá, Colombia.
Designers: DARP
Year: 2021
Stage: Completed

Description

Is the main infrastructure of a plan for protecting and valuing some of the most threatened ecosystems in the Colombian territory. The project is part of the Botanical Garden’s main path so it was very important to consider its strong educational and vocational outreach.



Illus. 13.

Ecotectural contributions

- Achieved the conservation of the surrounding nature and promotes conservation and recreation of different ecosystems in its interior.
- Achieved a fully natural ventilation system, that doesn’t require any mechanical support.

Social contributions

- Created a significant landmark in one of the city’s most important natural space.
- Promotes the valuation of the national ecosystems and raises awareness on their importance.
- Promotes and supports educational programs and environmental research.

Illus. 14.

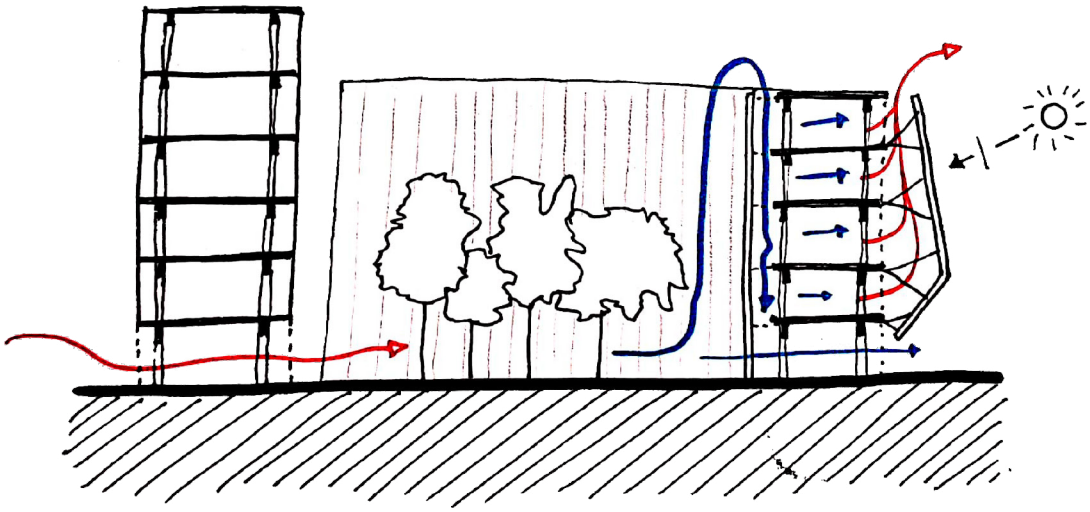
RUTA N

Information

Location: Medellín, Colombia.
Designers: AE + V Arquitectos
Year: 2012
Stage: Completed

Description

Is a center for innovation and business, were the city finds spaces that can promote entrepreneurship and foster technological and business development. It is a public initiative of the city's mayor's office, which was committed to improving technological innovation accessible to everyone.



Illus. 15.

Ecotectural contributions

- Reduced energy costs by 34% thanks to efficient ventilation and lighting systems.
- Stands out for not creating light pollution and cooling its urban context.
- Reused close to 90% of its landfill waste during construction

Social contributions

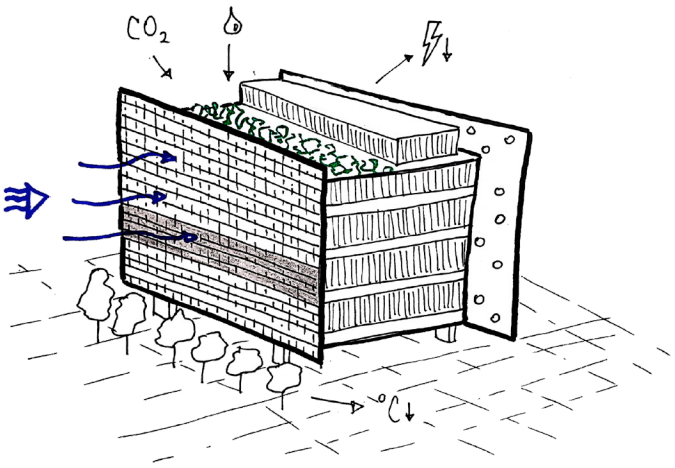
- Enhanced the technological education and development in the business and entrepreneurship fields.
- Created spaces for startups accessible to everyone.
- Became an important landmark accepted by the people in the immediate context.

Illus. 16.

CENTRO ARGOS para la innovación

Information

Location: Medellín, Colombia.
Designers: Castro Arquitectos
Year: 2015
Stage: Completed



Illus. 17.

Description

Is a building located in a university that promotes the research on new cements and concrete with better qualities, and supports the technological and sustainable development of concrete industry. It offers laboratories and office spaces for researchers, students and proffessors on the field.

Ecotectural contributions

- Achieved a 44% reduction in energy consumption in the building
- 45% of the roof area is vegetated, which reduces the heat island effect and promotes biodiversity.
- Environmental strategies reduced the building's water consumption by 72%.

Social contributions

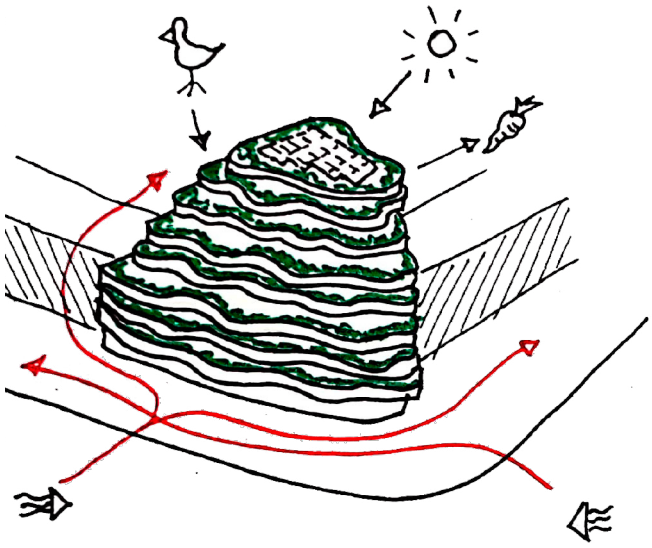
- Enhances the collaboration between a private company and the academy researchers, making the two fields to get in touch.
- Supports the development of research activities and promotes the knowledge development on sustainable practices.

Illus. 18.

ARBORICOLE

Information

Location: Angers, France.
Designers: Vincent Callebaut Architectures
Year: 2018
Stage: Competition project



Illus. 19.

Description

It is a mixed use building designed for a competition in the heart of the city. The project includes 50 experimental apartments, a hotel residence, a bar, a concert hall, and a restaurant. Its ambition was to create a biophilic focused smart building that combines plants and advanced renewable energies.

Ecotectural contributions

- It is a Low-Carbon project aiming for energy autonomy.
- It implements the water cycle through rain curtains and a filtering lagoon.
- It uses recycled and recyclable bio-based materials for a zero-waste circular economy
- Includes horticulture in a residential building.

Social contributions

- Innovation in the sustainable architecture field, empowering the importance of biodiversity and biophilic design.
- Proposal of future relations between residential activities and urban agriculture.

Illus. 20.

04

LOCAL PROBLEM

Specific problem

(A local concern)

A focus on *Latin America's situation*

Latin America is a region that is home to a large part of the world's natural resources, as it has some of the most biodiverse countries on the planet. Within its territory lies *22% of the planet's fresh water, 21% of the terrestrial ecoregions, 16% of the marine water resources and an immense amount of endemic animal and plant species* (CEPAL, 2015). Unfortunately, the most recent studies of its environmental conditions show that the immense natural wealth is at serious risk.

In the last decades, urban areas in Latin America have shown an accelerated growth where the number of people living in cities has almost doubled. In 1950, the percentage of the population living in cities was 41%, and by 2015 this percentage *had increased up to 80%*. This has brought about an enormous improvement in social and economic conditions in the region, but nevertheless it has also represented a large number of negative consequences on environmental conditions (CEPAL, 2015).

Some of the consequences on the environment have been changes in precipitation and temperature. Annual precipitation has increased in the southeastern part of South America and decreased in Central America, and temperature in the region increased by 0.7 to 1°C since the mid-1970s. Associated with this temperature change was the **loss of 20% to 50% of glacier area due to melting**, especially in Bolivia, Chile, Colombia, Ecuador, Peru and Venezuela (CEPAL, 2015).

On the other hand, the *Living Planet Report* (WWF) of 2020 found a **94% decline in the Living Planet Index** (LPI) for Latin America and the Caribbean, which is an indicator developed by WWF to monitor the population trends of species in the world. This tool is important for measuring the overall health of ecosystems, and Latin America showed the most impressive decline compared to other regions. The average rate of species population decline in the region has been due to the *transformation of grasslands, savannas, forests and wetlands, overexploitation of species, climate change and the introduction of non-native species* (WWF, 2020, p.22).

The measurements developed by the *Global Footprint Network* (2021) and published through their initiative *National Footprint and Biocapacity Accounts* (NFAs), show the total biocapacity per person available in each country (in gha) and subtract the ecological footprint per person (in gha) in the respective countries to determine whether the nation is in a 'deficit' or 'reserve' ecological condition. In the case of Latin America and the Caribbean several countries present deficit compared to their ecological footprint such as *Mexico (-1.5 gha), El Salvador (-1.4 gha), Dominican Republic (-1.2 gha) Costa Rica (-1.1 gha), Cuba (-1.0 gha), Chile (-0.9 gha), Guatemala (-0.8 gha)*, among others. Nevertheless this doesn't mean the other countries in the region have a sustainable footprint, in fact, the ecological footprint per person could be significantly greater but if the total biocapacity in the country is higher enough to compensate it could be shown as a reserve. This is the case of countries like *Brazil* where the *ecological footprint is 2.8 gha/person*, which for example is greater than the one in *Cuba of 1.8 gha/person*.

Despite the environmental problems mentioned above, if we look at the Latin American and Caribbean region in comparison with other regions of the world, it could be said that it has contributed less to climate change throughout history. However, it is considered one of the regions particularly vulnerable to its effects. This asymmetry is due to its socioeconomic and demographic condition, and its geographic and climatic position (ECLAC, 2015). This means that the urgency of seeking solutions to environmental problems in the region is evident.

2020 *Wetlands International:*

> *"Already, **more than 40%** of forests **in Latin America** and the **Caribbean** have been **completely deforested** or degraded."*

According to the Earth Overshoot Day Organization (2021) if everybody would consume as these countries in Latin America the overshoot day would be:

	1. Chile	May 17, 2021
	2. Argentina	June 26, 2021
	3. Paraguay	July 8, 2021
	4. Bolivia	July 9, 2021
	5. Brazil	July 27, 2021
	6. Mexico	August 11, 2021
	7. Costa Rica	August 16, 2021
	8. Venezuela	September 13, 2021
	9. Panama	September 14, 2021
	10. Peru	September 29, 2021
	11. El Salvador	October 21, 2021
*	**12. Colombia**	November 2, 2021
	13. Cuba	November 17, 2021
	14. Guatemala	November 24, 2021
	15. Dominican Rep.	November 29, 2021
	15. Nicaragua	December 2, 2021
	16. Ecuador	December 7, 2021

General *Colombia's situation*

In spite of Colombia's great biodiversity and ecological wealth, natural resources and the country's overall biocapacity are in threat as recent studies show. The nation's ecological footprint is a consequence of an accelerated growth of cities and due to their high density there is now a great environmental deterioration in the country's largest urban centers. The ecological conditions of the most developed urban centers are not the best and represent a risk to the health of their inhabitants.

According to the NFAs developed by the *Global Footprint Network* (2021) the biocapacity of the whole country has decreased drastically since the early 60s due to the ecological footprint per person, **dropping from offering near 10.6 to 3.6 gha/person** by 2017. The high density of the four largest cities in the country (which hold 30% of the total country's population) and the unsustainable urban development dynamics have led to consumption of a large part of the country's biocapacity. The NFAs also show that according to the ecological footprint of the country, if everyone would consume the way Colombia does **we would need 1.2 Earths** for supplying enough resources (Global Footprint Network, 2021).

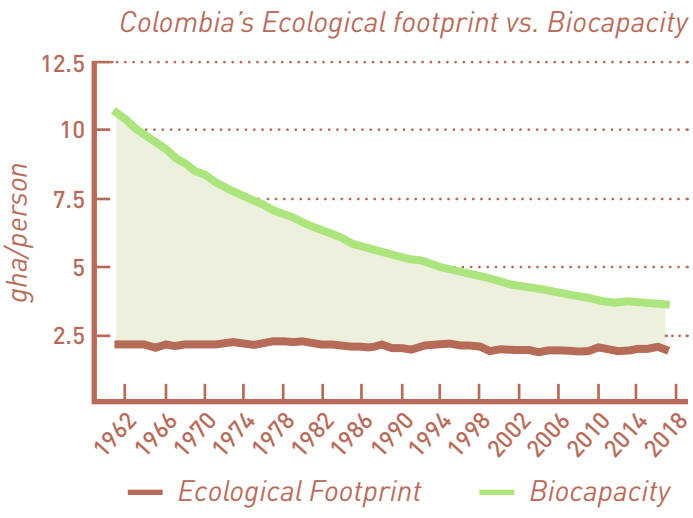
Studies and reports of the *Secretaría Distrital de Ambiente* (SDA) show that for the year 2017 the **most polluted cities** in the country were **Medellin** and **Bogotá**. These studies are focused mainly on diagnosing the quality of air that is breathed in the cities, since for several years, the amount of particulate matter in the atmosphere that citizens breathe has been monitored by the municipalities (Diario Semana, 2016).

Republic of Colombia

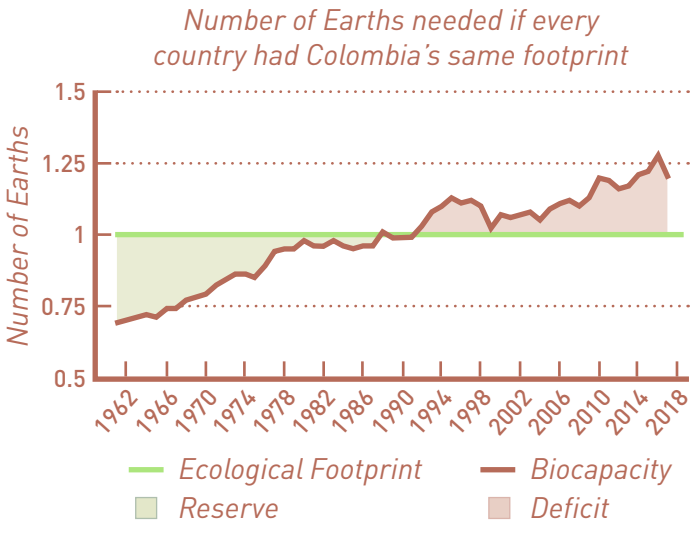
- 75% of individuals live in cities
- 30% of population in the 4 largest cities

Biodiversity:

- One of the 17 megadiverse countries in the world
- Hosts the 10% of Earth's whole biodiversity
- Country with the world's greatest birds biodiversity



Illus. 21.



Illus. 22.

Illus. 23. Nevado del Ruiz.

Illus. 24. Cerros de Mavecure.

Illus. 25. Bogotá D.C.

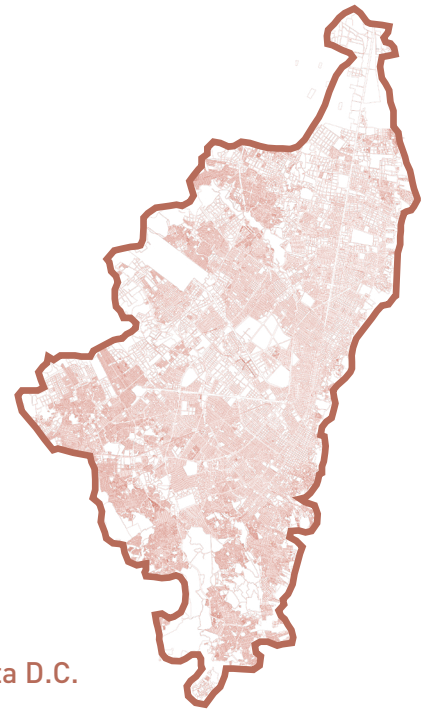
Observing *Bogota D.C.'s conditions*

The SDA within its environmental health studies has determined the rates of cases attended in room corresponding to Acute Respiratory Disease for the city of Bogota. There is evidence of a large increase in cases of patients ill with this condition compared to 2007 (SDA, 2017). For the year 2017 in Bogota, around 47,000 people were treated for acute respiratory disease, which raises alarms about the environmental conditions experienced in the capital (see illustration 26).

Another result of the SDA studies is the morbidity due to acute respiratory diseases in children under 5 years of age in Bogota, with a worrying increase since 2009 (SDA, 2017). The count for 2017 reached a total of 584,864 of morbidity in children for these diseases caused largely by particulate materials emitted by automobiles (see illustration 27).

Within the contamination reports, it is alarming how the national contamination diagnosis always refers to contamination in two specific localities of the country's capital. These are the localities called Kennedy and Fontibón, located in the west of Bogotá.

The SDA conducted a monitoring in 2010 of the levels of particulate matter in different areas of the city. The city was divided into northern zone, northwestern zone, central zone, southern zone, and southwestern zone (where Kennedy and Fontibón are located). The annual amount of PM10 was found to be 75.6 micrograms per cubic meter in the southwestern zone, being the most affected zone in Bogotá (Diario El Espectador, 2011).



Bogota D.C.

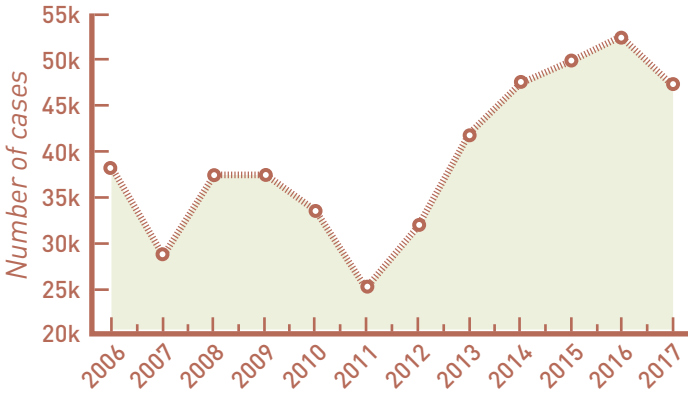
Population:

- Urban area: 7'743.955 people
- Metropolitan area: 10'331.626 people

Wetlands:

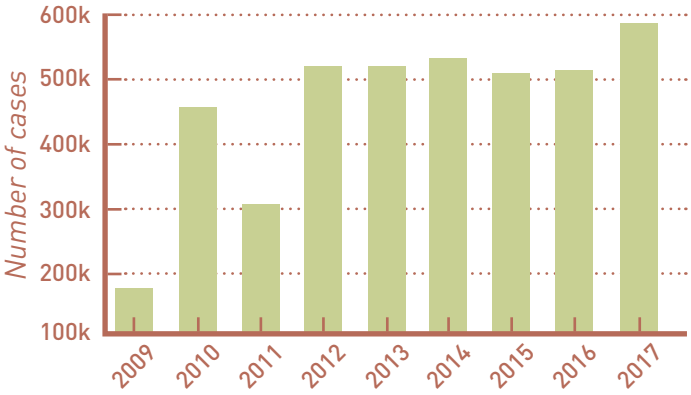
- **Recognized wetlands: 15**
- **Unrecognized wetlands: 24**
- Wetlands in schools & universities: 9
- Wetlands in parks: 10
- Wetlands in country clubs: 11

Cases attended in room corresponding to Acute Respiratory Disease



Illus. 26.

Morbidity due to acute respiratory diseases in children under 5 years old



Illus. 27.

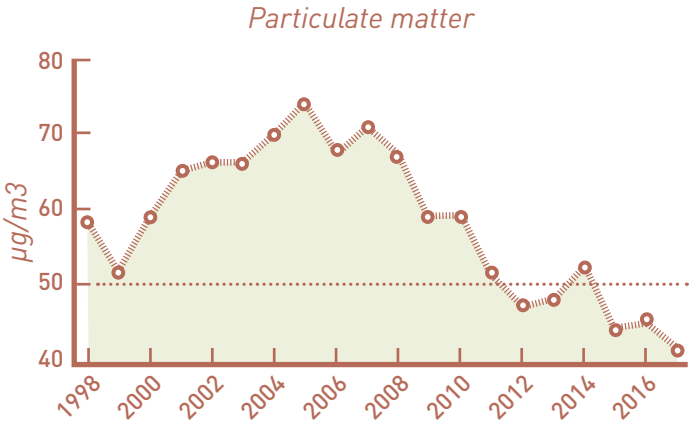
The *Institute of Hydrology, Meteorology and Environmental Studies* (IDEAM), in studies and reports conducted between 2011 and 2015, revealed that **the locality of Kennedy is the most polluted place in all of Colombia** (Pulzo virtual newspaper, 2016). This was diagnosed according to the study through the Air Quality Index that measures in real time the air quality, taking into account the amount of particulate matter that can enter the respiratory tract. This deterioration in air quality, which is also accompanied by an enormous amount of solid waste in the public space, is due to the concentration of industry and heavy traffic in this locality.

The concentration of particulate matter in the air in the city for 2016 achieved its lowest point since 1998 (SDA, 2017; see illustration 28). However, despite achieving an annual average of lower PM10 it still represents a deterioration and a risk for the inhabitants of the sector. According to the *World Health Organization* (WHO), air pollution increases the risk of respiratory diseases such as pneumonia and lung cancer, and cardiovascular diseases.

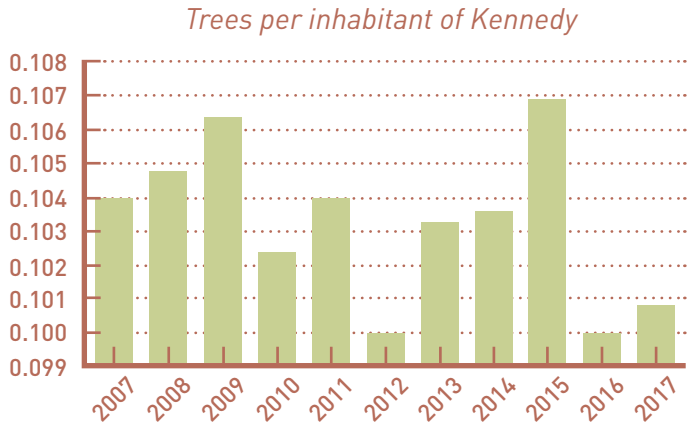
Air quality is not only affected by the high industrial activity in the sector, but also by the number of trees per inhabitant in the sector. This is an indicator that shows the impact on the quality of life of the inhabitants, since trees are the living beings that contribute the most to the capture of CO2 and harmful particulate materials, and have a great contribution to the cooling of the environment through the process of evapotranspiration. The latter process is the amount of water that returns to the atmosphere as a result of evaporation and transpiration of plants.

In the locality of Kennedy the number of trees per inhabitant from 2007 to 2017 has not exceeded the figure of 0.107 trees/person (SDA, 2017; see illustration 29).

On the other hand, studies by the SDA show that because there is such an important commercial and industrial activity in Kennedy, it also has the highest visual pollution indexes, accompanied by localities such as Suba, Ciudad Bolivar and Engativá. This is a result of the high population densities of these localities and the large presence of stratum three, which is the population sector that generates the highest visual pollution (Kien Y Ke virtual newspaper, 2013).

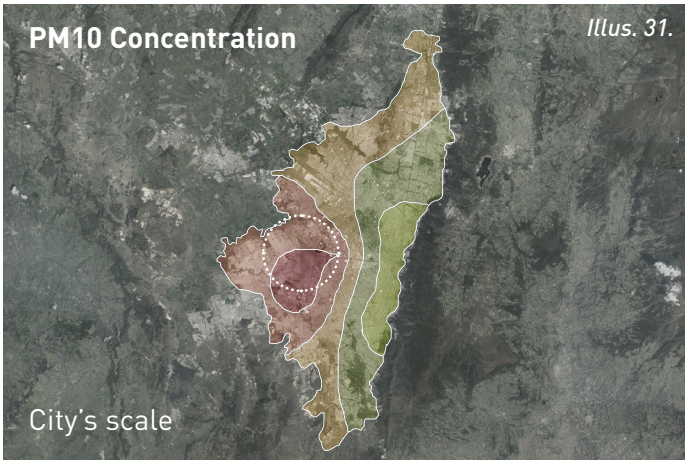


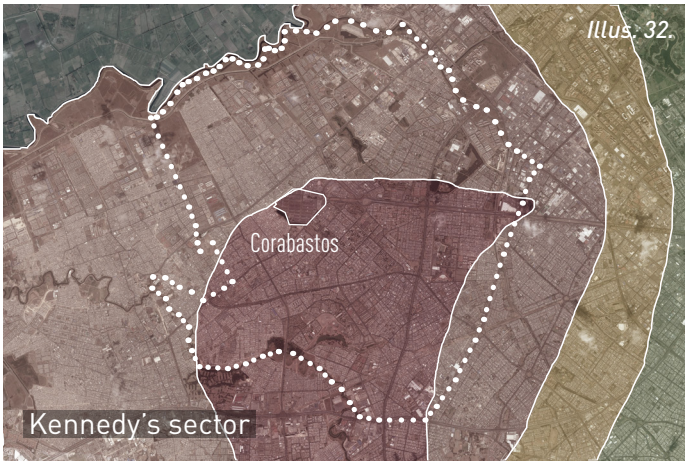
Illus. 28.

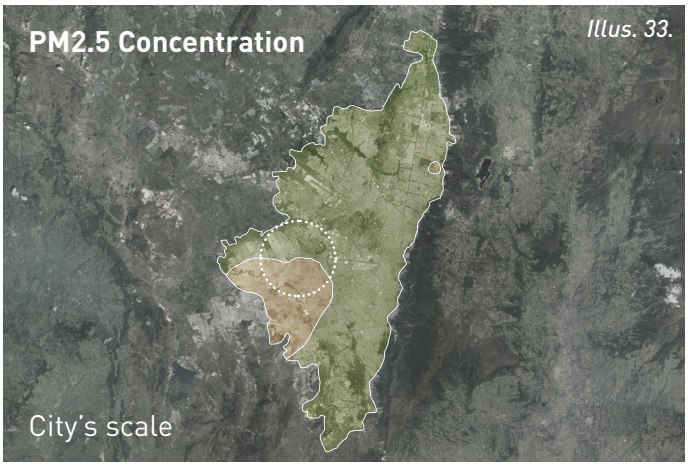


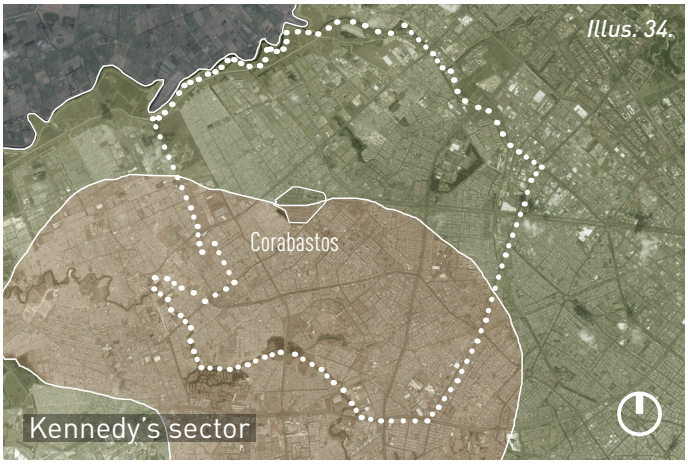
Illus. 29.

Illus. 30. Traffic jam in Bogotá.









Further insight into *Kennedy's problem*

Seen from an architectural perspective, it is evident that most of the environmental problems in Kennedy are caused by the concentration of the industrial sector in the urban structure. Industry in the city of Bogota has repercussions on the urban space and consequently on the environmental qualities of the surroundings. The effects on public space include large amounts of solid waste in the public space, air pollution, and heavy traffic, etc. When these types of buildings are not well developed, they bring with them problems that are expressed in the environmental pollution indexes explained previously and negatively affect the quality of life of citizens.

In addition to the industrial sector that negatively affects environmental conditions, there is also a problem corresponding to the amount of solid waste in public spaces and the **contamination of wetlands** belonging to the locality. One of the main culprits of this condition is the *Corporación de Abastos de Bogotá S.A.* (Corabastos), which is located in the sector adjacent to the "Monumento a las banderas", in Kennedy.

Corabastos is the most important wholesale center in Bogotá and is located within the urban structure in a sector that is mixed between industry and housing, as is a large part of the locality. The presence of an urban event of this magnitude has generated an impact on public space and mobility infrastructure in the surrounding sector, which has deteriorated over time the quality of life of the inhabitants. Currently, the central supply center **wastes around 4.5 tons of food every day**, which end up in the public space of the surrounding neighborhoods and the La Vaca wetland (Diario El Espectador, 2016).

The deficient management of Corabastos' waste has brought repercussions in the contamination of public space and of one of the main elements of the main ecological structure, as is the neighboring wetland. It has deteriorated the spatial conditions of the María Paz neighborhood, decreasing the amount of effective public space, generating bad odors, affecting the mobility infrastructure and generating garbage in public areas (Rojas et al., 2017, p. 132). This phenomenon is also a product of the relationship that the central supply center has with the surrounding neighborhoods, since the spatial relationship consists on a wall of approximately 10 meters high, without any type of landscaping or urbanistic treatment.

Illus. 35. Corabastos and Kennedy's Ecological Structure


Illus. 36. Corabastos' border.

Waste from the central supply center is collected by people who take advantage of it to sell it in the streets of the María Paz neighborhood, reducing the perception of **effective public space**, which is already insufficient being **0.45 m2/person** (Rojas et al., 2017, p. 132). Among the main consequences of the second life given to food on the outskirts of Corabastos are the following:

1. ***Commercial irruption*** that occupies public space and increases the deficit of public space.
2. ***Environmental contamination*** and detriment of spatial quality.
3. ***Increased insecurity*** in the sector and alienation of the child population.
4. ***Interruption*** of the bicycle routes, the road and pedestrian circulation.
5. ***Detriment*** of the commercial dynamics of the sector and attraction of homelessness.

In addition to the social and urban repercussions of the problem, it has also had negative consequences on one of the most important natural spaces in the main ecological structure; the La Vaca wetland in the northern sector. This wetland is adjacent to the southern side of Corabastos. Throughout history it has suffered from illegal urbanization that has affected the environmental conditions and the extension of the wetland.


Illus. 37. Maria Paz neighborhood.

In Kennedy there is a concentration of wetlands, strongly affected by contamination and encroachment of the wetlands. These are the "Humedal de la Vaca" northern sector, "Humedal de la Vaca" southern sector, "Humedal El Burro" and "Humedal de Techo". These natural areas are of great biological, **social and cultural importance**. According to *Fundación Humedales de Bogotá* (2011) the most important services they provide are the following:

1. ***Regulation of the water cycle:*** They prevent flooding, retain sediments and nutrients, contribute to the discharge and recharge of aquifers, and function as water reservoirs.

2. ***Improvement of air quality:*** They are CO2 sinks, retain dust, regulate temperature, generate microclimates, produce oxygen.

3. ***Biophysical conservation areas of the region:*** Refuge of endemic biodiversity, essential habitat for various resident and migratory species.

4. ***Pedagogical spaces:*** They invite contemplation, reflection and calm; they are living classrooms for learning, passive recreation areas, generators of knowledge and research.

Illus. 38. Location of the wetlands in Kennedy.

2022 ***Wetlands International:***

"***Wetlands*** *cover a small percentage of the earth's surface, yet they are* ***essential systems*** *– they are the* ***arteries and veins*** *of the landscape. They are* ***rich in nature*** *and* ***vital to human life****."*

Illus. 39. Wetland "El Burro".

One of the wetlands in the **most critical** situations according to the *Fundación Humedales de Bogotá* (2011) is the one called "**Humedal de Techo**". Due to the uncontrolled urban development of the city in the 80s and 90s, this wetland suffered great damage. The most important damage was the illegal settlement of the "Lagos de Castilla" neighborhood within the buffer zone, that started in the year 1994.

In addition to this, the strong urbanization process around the wetland has pressured its reduction in area, which has led to the loss of its ecosystemic potential. According to SDA studies, of the legally recognized wetlands, the Techo wetland is currently the one with the **lowest habitat supply** and the **least potential for rehabilitation** due to its critical condition. However, despite its condition, it is the one with the greatest biotic potential thanks to its diversity of vegetation cover and species (SDA, 2008).

On the other hand, within the action plan of the locality of Kennedy for the years 2017 - 2020, in the section of the *"Transversal axis: Environmental sustainability based on energy efficiency"* there were specific actions for the improvement of environmental conditions in the sector. Only three are named; plant and/or intervene 1,000 trees, intervene 2 hectares of public space with renaturalization and/or ecourbanism actions, and intervene 8,000 square meters of public space with gardening, green walls and/or landscaping actions (Alcaldía Mayor de Bogotá, 2017, p. 2).

As can be seen, Kennedy's environmental plan focuses mainly on improving the number of trees per person in the locality and the intervention of public space to renaturalize it. These are completely necessary measures in the sector, however, considering nowadays environmental emergencies these actions **are not sufficient** to reverse the current environmental conditions.

06	Eje transversal Sostenibilidad ambiental basada en la eficiencia energética
38	Recuperación y manejo de la Estructura Ecológica Principal
1361	Sostenibilidad ambiental basada en la eficiencia energética
1	Sembrar Y/O Intervenir 1000 Arboles Para Mejorar Las Condiciones Ambientales Locales
2	Intervenir 2 Hectareas De Espacio Público Con Acciones De Renaturalización Y/O Ecourbanismo
3	Intervenir 8000 M2 De Espacio Público Con Acciones De Jardinería, Muros Verdes Y/O Paisajismo

Illus. 40. Environmental action plan by the municipality.

Illus. 41. Legal area of the Wetland of Techo.

2008 ***Secreatría Distrital de Ambiente:***

*"The wetlands with the **lowest current habitat supply** are **Techo** and **La Vaca**, which have undergone **infill and drainage subdivision** in the last years."*

The *Secretaría Distrital de Ambiente* (SDA) presented in 2008 a **protocol for the ecological rehabilitation of wetlands** in urban centers, with valuable information on these ecosystems. It contains a detailed study of the general characteristics, their current status, strategies for their rehabilitation, recovery experiences in Bogotá, and areas of interest for research.

This last chapter makes explicit the **existing information gaps in the research of wetlands in Bogotá**, in areas of knowledge such as limnology, water dynamics, vegetation and soil ecology, and strategies for the conservation of vegetation and fauna (SDA, 2008). This makes evident the need to implement a project that strengthens the development of knowledge about these ecosystems.

The latest *Land Management Plan* (abbreviated in Spanish as POT) for the city was launched in 2021 and targets a transformation of the city between 2022 and 2035. According to the Alcaldía Mayor de Bogotá (2021) the "POT" aims to **guide urban development in order to green the city**, giving special importance to the ecological structure as the city's main territory planner. The main long-term objectives are:

1. ***To protect the main ecological structure*** and Bogotá's landscapes and generate the conditions for a more harmonious and sustainable relationship of the city with its rural environment.
2. ***To increase the resilience*** of the territory in the face of disasters and those derived from climate variability and climate change.
3. ***Improve the urban environment*** and rural settlements.
4. ***Revitalize the city*** through quality interventions and projects.
5. ***Promote dynamism***, economic reactivation and job creation.
6. ***Reduce imbalances and inequalities*** for a more supportive and caring territory.
7. ***To achieve sustainable*** rural development.

Keeping this in mind, it becomes evident how the development of a **Wetlands Research Center** aligns perfectly with local needs and concerns. This is because the project would foster the **development of knowledge** about the city's main ecological structure, provide education and **research services**, **reestablish a harmonious relationship** between wetlands and citizens, and **reinforce environmental rehabilitation** of Bogotá.

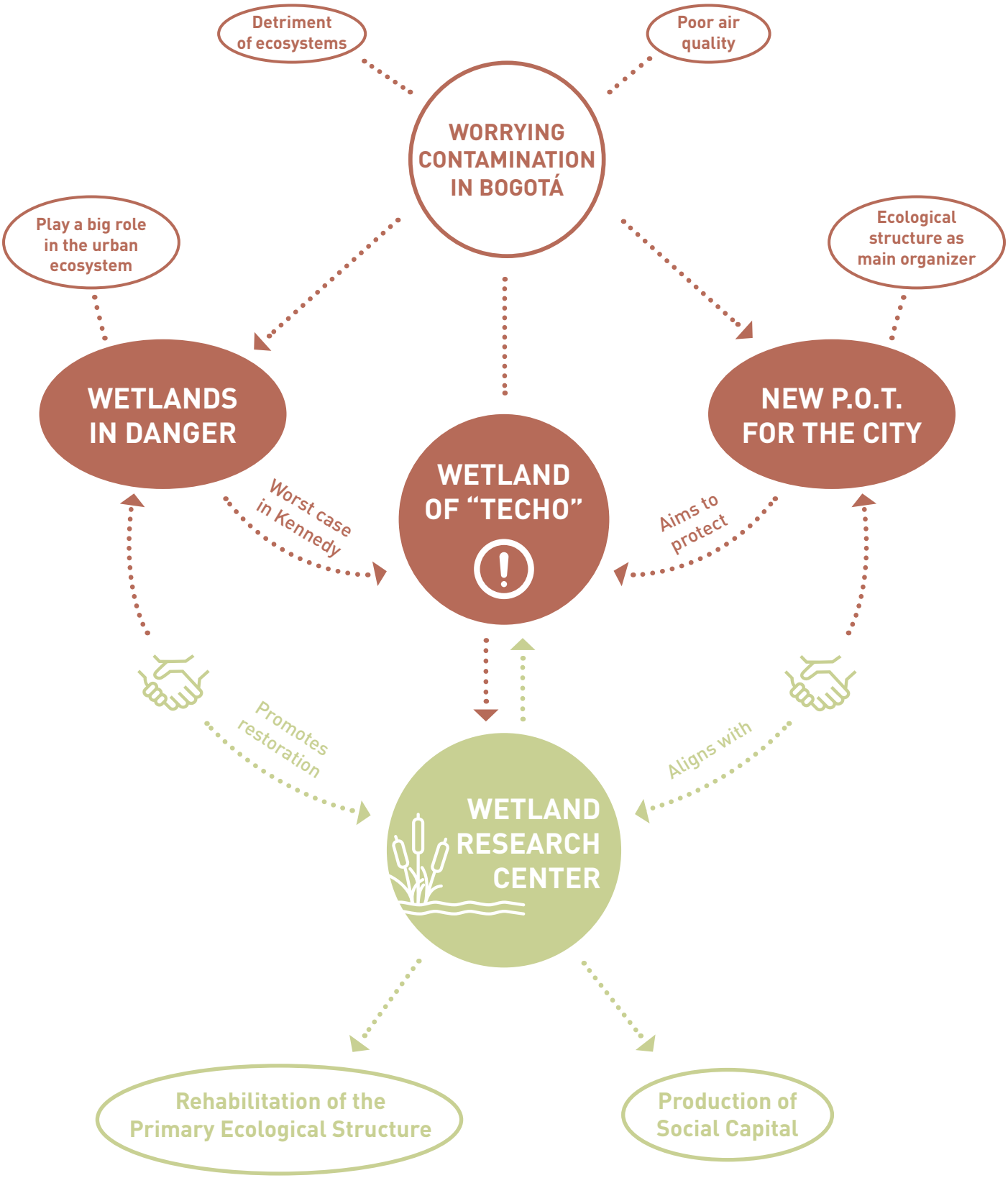
According to sociologist Mayorga (2012), an urban facility of this type would not only be a structuring element of the city but would also become a **consolidator of collective life**, due to the social interactions that occur within it and that become **generators of social capital**.

To conclude, the area of Kennedy and specifically around the **Techo Wetland** has environmental conditions strongly affected by the industrial sector and the uncontrolled urban development, which in turn becomes a **constant threat to its population and the city's ecological structure**. The municipality is turning its sights on an environmentally friendly transformation of the city, were an architectural **intervention is urgently needed** and would contribute to the environmental rehabilitation.

Illus. 42. New "POT" approved for the city.

2012 ***José Mario Mayorga:***

"***Social interactions*** *in educational, recreational and cultural* ***collective facilities*** *are the guarantors of the production of* ***social capital*** *and, therefore, the ones that make it possible to* ***achieve optimal quality of life*** *indexes and* ***overcome poverty.*** (p. 23)"



Illus. 43. Local problem concept map, own elaboration.

05

PROJECT

"WHAT IF A **BUILDING** WERE MORE LIKE A **NEST**?

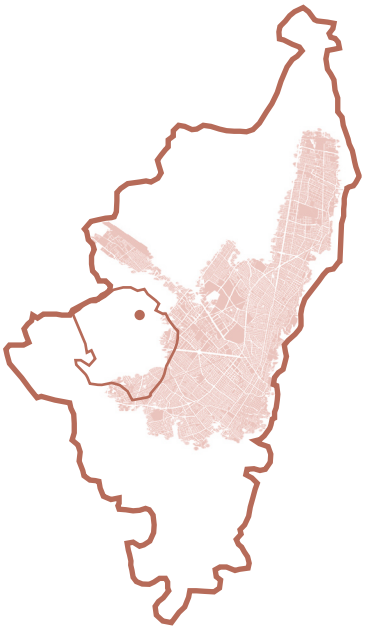
IF IT WERE, IT WOULD BE **MADE OUT** OF **LOCAL, ABUNDANT MATERIALS.**
IT WOULD BE **SPECIFIC** TO ITS **SITE** AND **CLIMATE.**
IT WOULD USE **MINIMAL ENERGY** BUT MANTAIN **COMFORT.**
IT WOULD **LAST** JUST **LONG ENOUGH** AND THEN WOULD LEAVE **NO TRACE.**
IT WOULD BE JUST WHAT IT **NEEDED TO BE.**"

JENNE GANG

Project site analysis

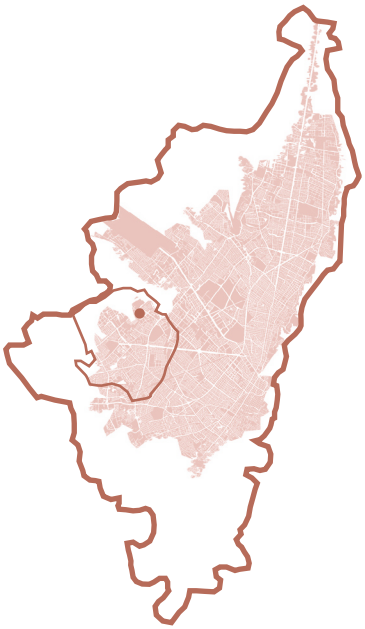
Schematic timeline

— *Kennedy area*
● *Wetland of Techo*



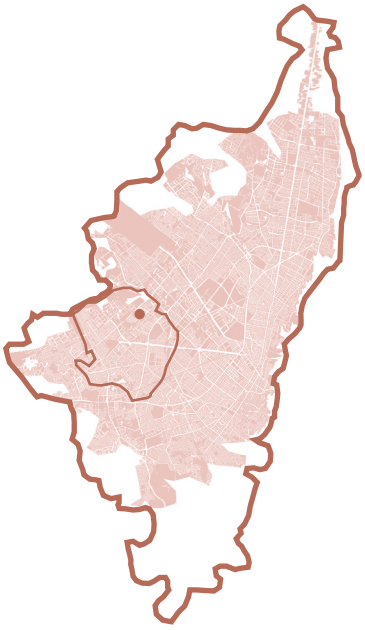
1940s - 1950s

By this time the city was celebrating 400 years of its foundation and infrastructure projects and new constructions were carried out. During this period the population grew from 333,312 inhabitants to nearly 700,000. By the end of the 40s the "Bogotazo" revolt took place, which destroyed the center and started a very long period of violence in the country. By that time the wetland terrain was untouched by the city.



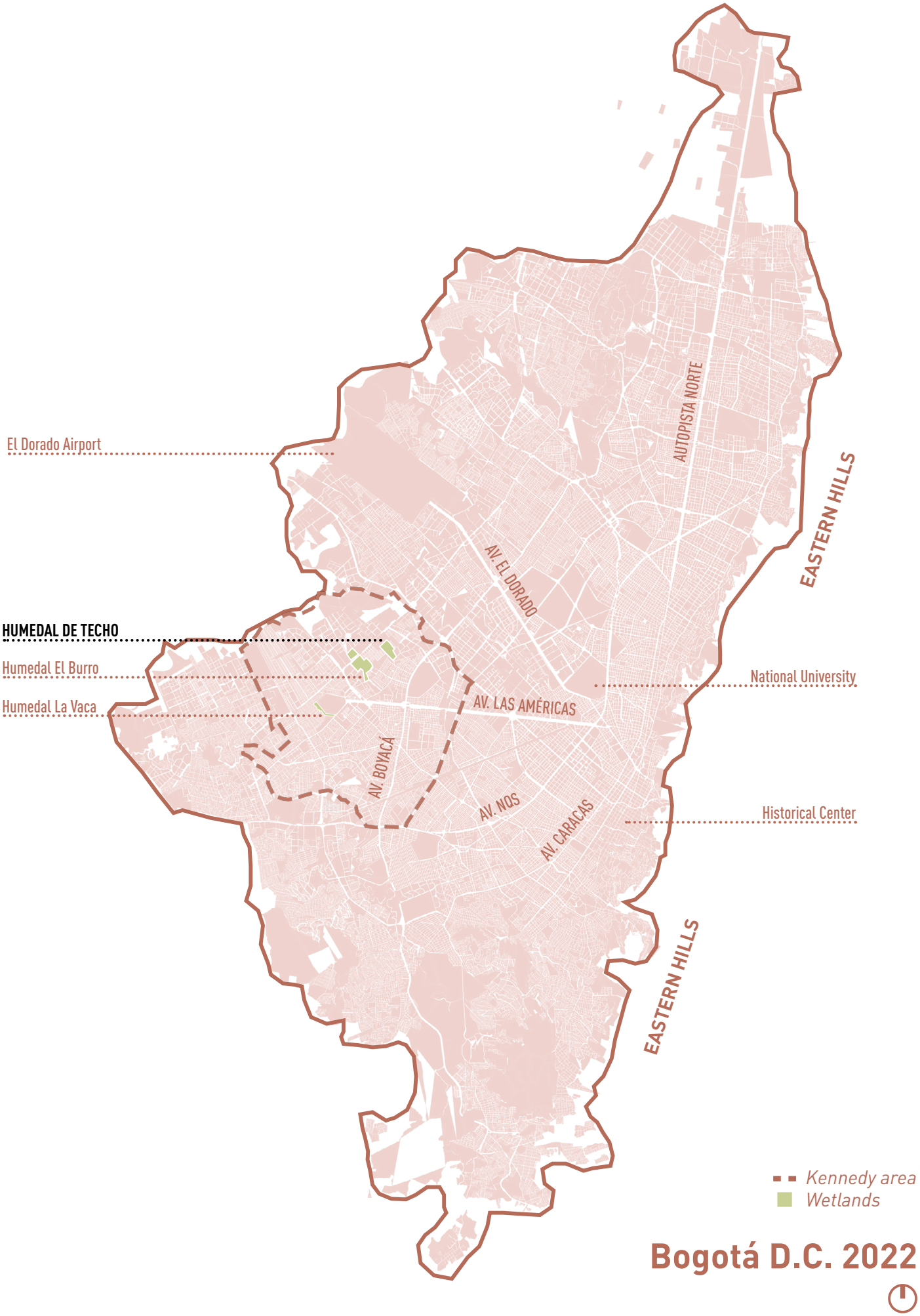
1960s - 1970s

The violence in the country generated an enormous forced immigration of peasants and landowners seeking better living conditions. This caused the population to grow exponentially to 1,600,000 in 1964 and 2,500,000 in 1973. John F. Kennedy's visit in 1961 marked the beginning of the mega urban project "Ciudad Techo", which later changed its name to Kennedy after the president's death.



1980s - 1990s

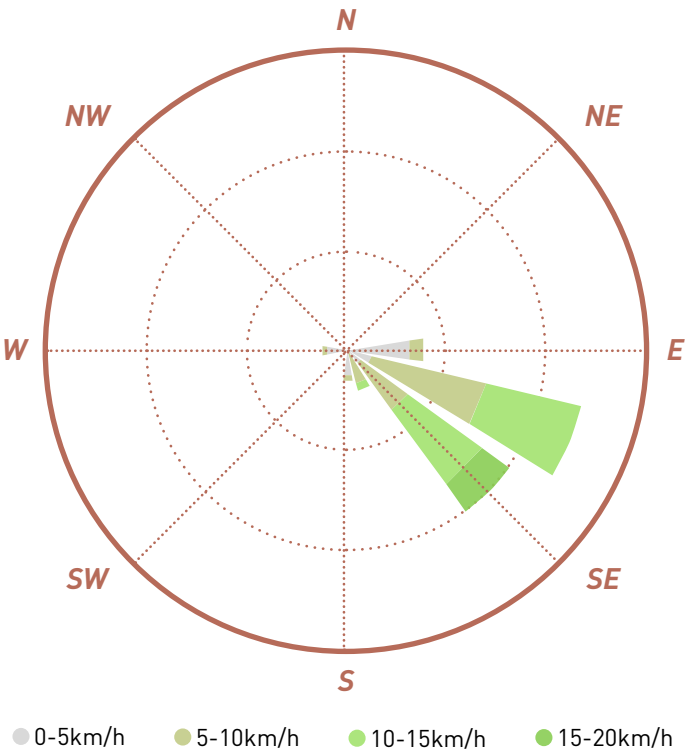
The population of the capital continued to increase and by 1985 was close to 4,100,000 and in 1993 it reached almost 6,000,000. By this time, urban growth was abrupt and informal, due to the need for shelter for people that the municipality could not satisfy. This led to an uncontrolled growth that affected the main ecological structure.


El Dorado Airport
HUMEDAL DE TECHO
Humedal El Burro
Humedal La Vaca
National University
Historical Center
AUTOPISTA NORTE
EASTERN HILLS
AV. EL DORADO
AV. LAS AMÉRICAS
AV. BOYACÁ
AV. NQS
AV. CARACAS
EASTERN HILLS
Kennedy area
Wetlands
Bogotá D.C. 2022

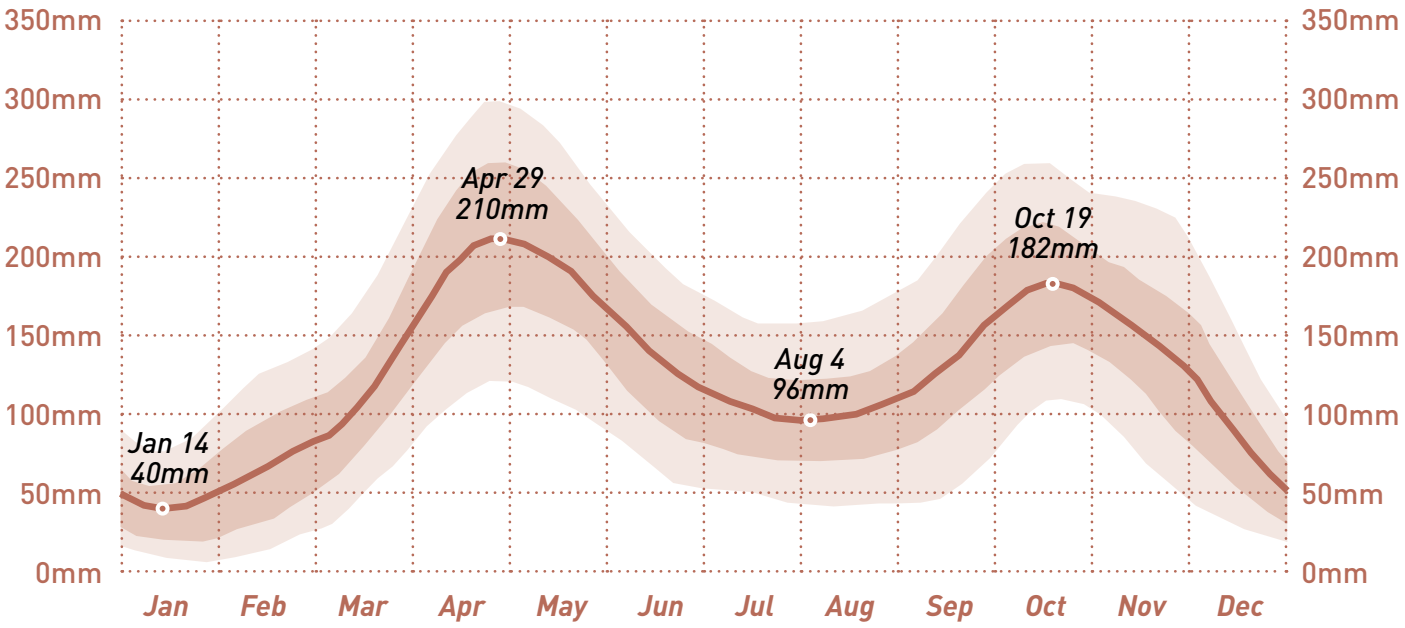
Bogotá's weather conditions

Bogota is a high Andean city located in the Cundinamarca-Boyacá highlands, approximately 2,600 meters above sea level. Being located at a high altitude, the average annual temperature is 14°C, where the average high temperature is 18°C and low temperature is 9°C. Given its geographical position, the city has a climate that does not vary much throughout the year.

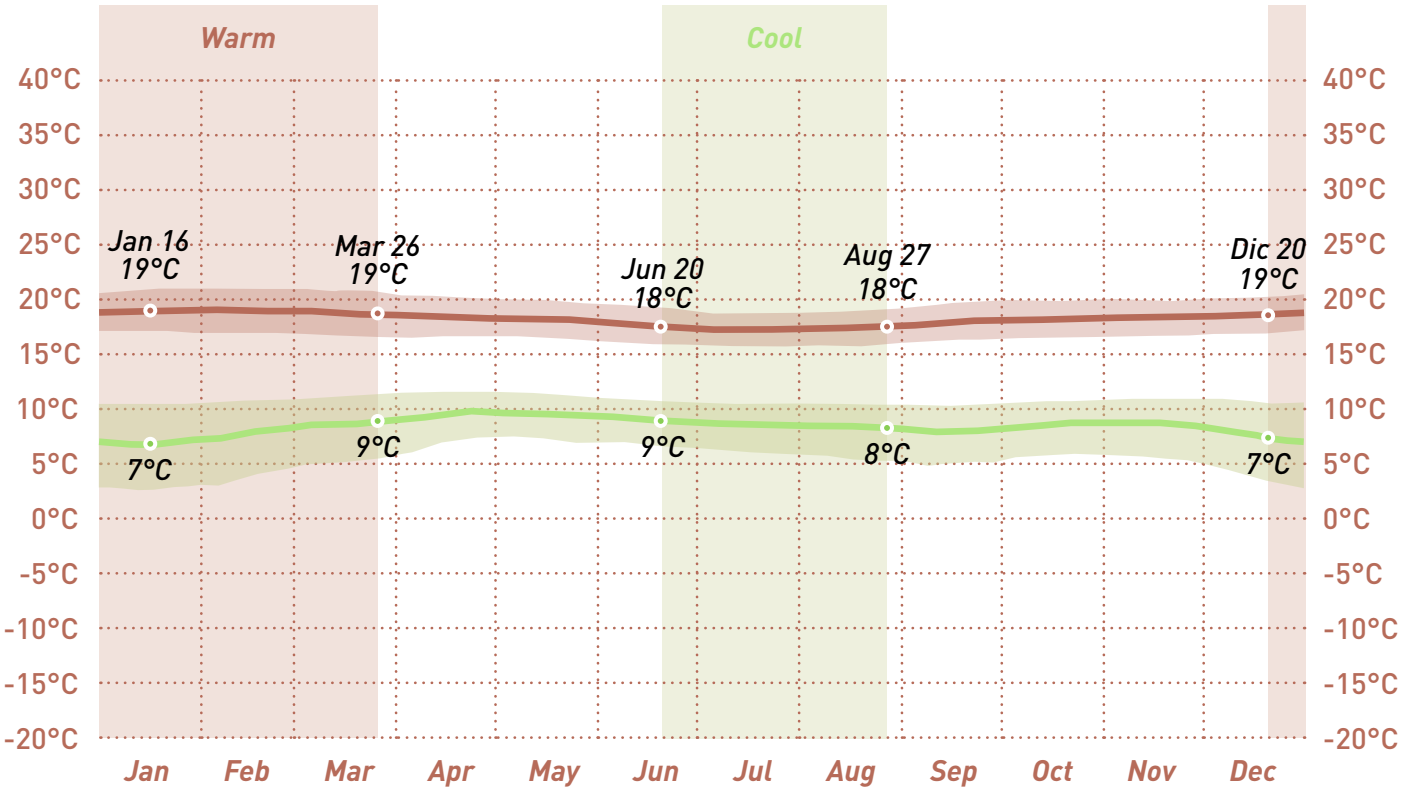
Due to its location the average annual rainfall is 1,312 mm. Rainfall varies according to two seasons, the wet season which is in the months of April, May, September, October and November, and a dry season in the months of January, February, March and December. It can be seen in the illustrations that the variation in the number of daylight hours throughout the year is practically negligible, with an average of 12 hours. Winds in Bogota are mainly from the east.



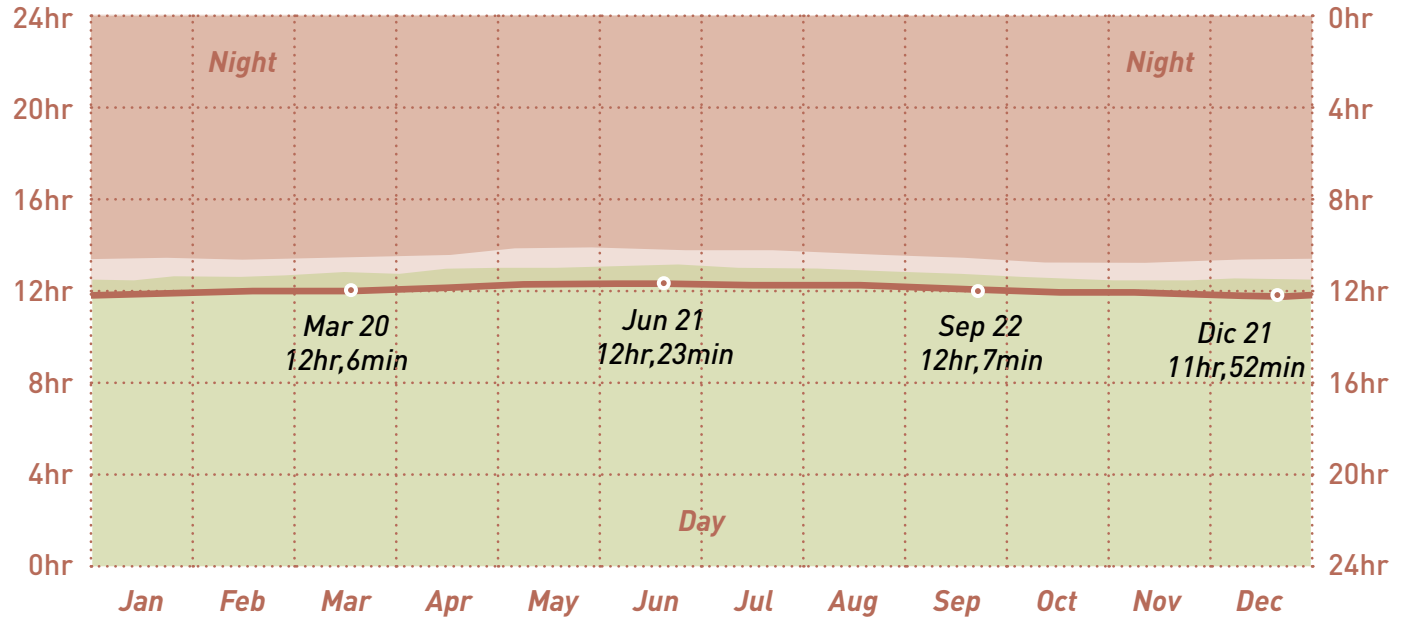
Wind Rose



Average Monthly Rainfall



Average High and Low Temperature



Hours of Daylight and Twilight

Wetland of Techo timeline

Illus. 44.

1938

Wetland area extends to the current Ciudad de Cali avenue and the predominant use in the adjacent area is pastureland.

Illus. 45.

1956

The appearance of new channels and noticeable changes in the textures of the coverings can be observed.

Illus. 48.

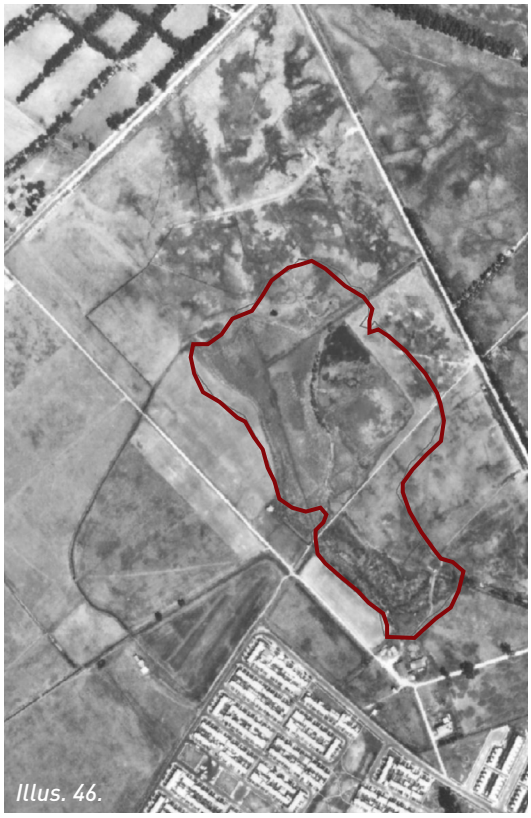
2001

Illegal urbanization "Lagos de Castilla" is subdivided and houses are built within the legal area of the wetland.

Illus. 49.

2009

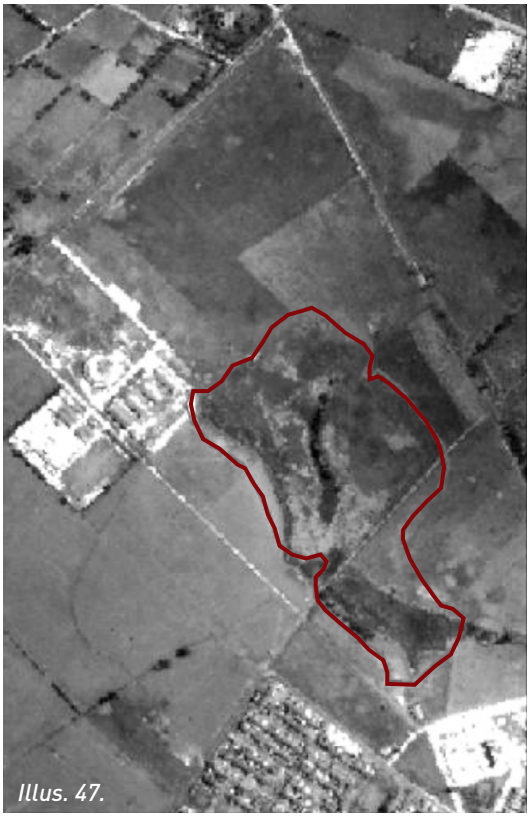
Urbanization pressure continues. By this period, near 100 constructions could be identified within the legal area.



Illus. 46.

1973

Appearance of "Castilla Real" urbanization, which brought with it water works that affected the wetland definetly.



Illus. 47.

1985

Urbanization process in the area of influence accelerates and the first informal developments appear towards the west.

Illus. 50.

2012

Almost all of the 466 lots have been built, of which only 67 are legalized and 399 are within the legal area of the wetland.

Illus. 51.

2022

Residential buildings are being constructed in the surroundings, and there are several parking lots for heavy vehicles.

Ecological structure

- *Rivers and water canals*
- *Wetlands and parks*
- *Project area limit*

Illus. 52. Wetland of Techo.

Illus. 53.

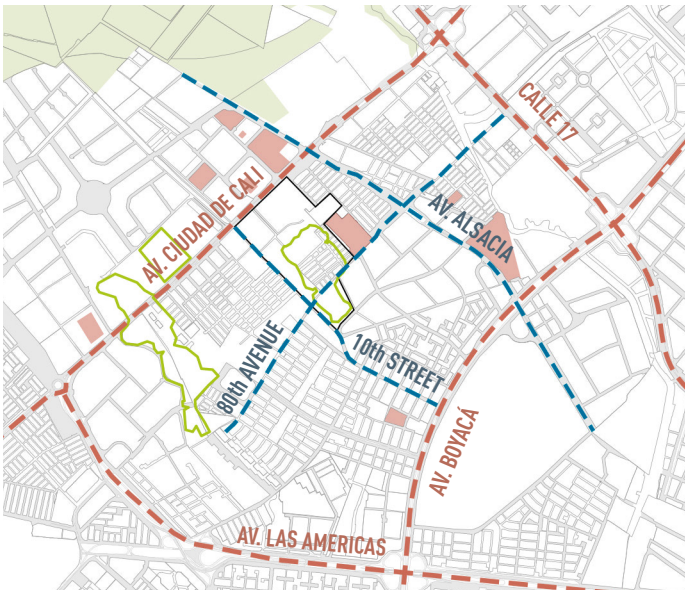
Illus. 54.

Illus. 55.

Illus. 56.

Illus. 57. Wetland "El Burro."

Illus. 58. "Fucha" River.



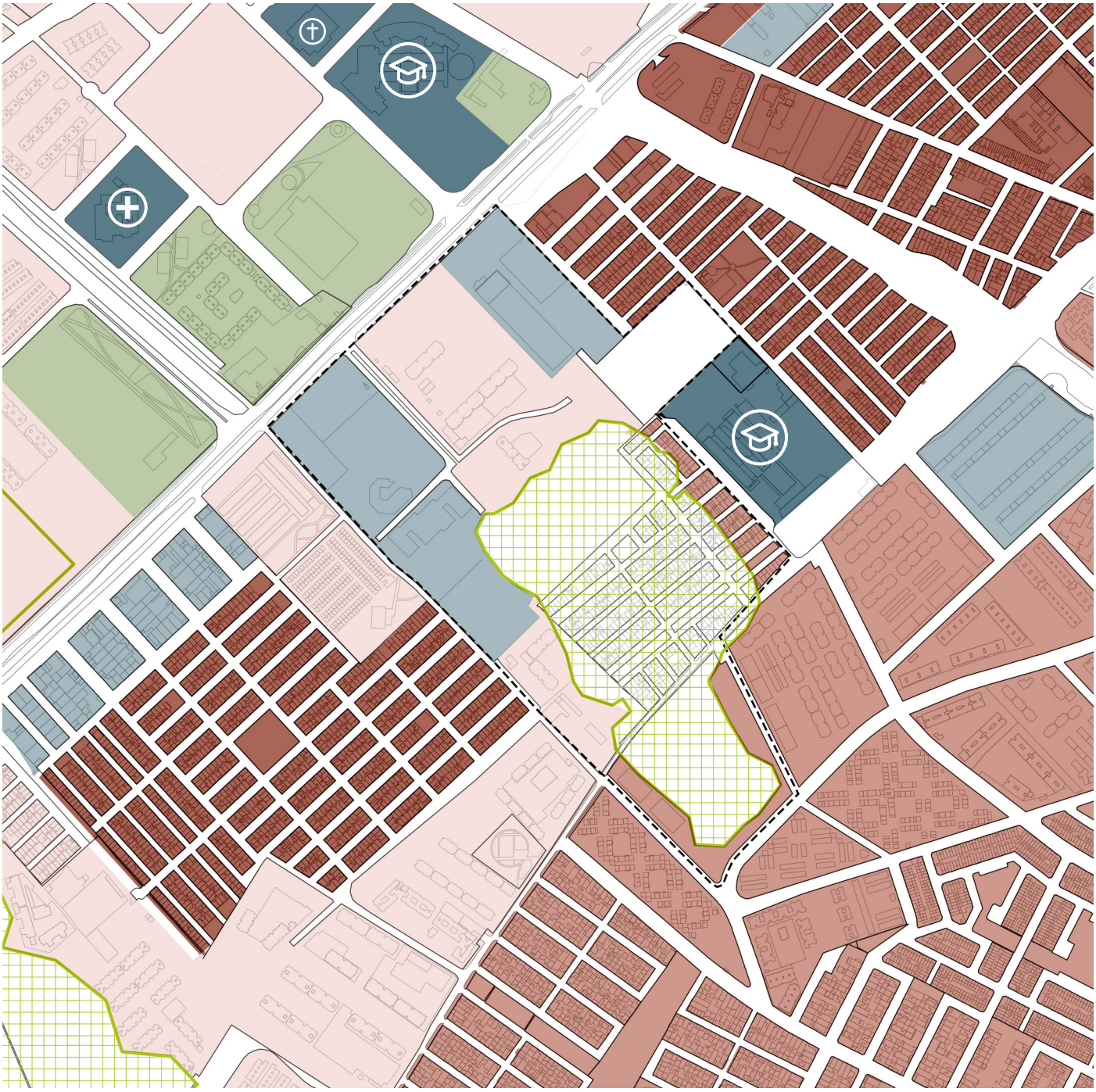
Mobility and Urban landmarks

- *Principal road mesh*
- *Secondary road mesh*
- *Landmarks*
- *Wetlands*

Illus. 59. Avenue "Ciudad de Cali".

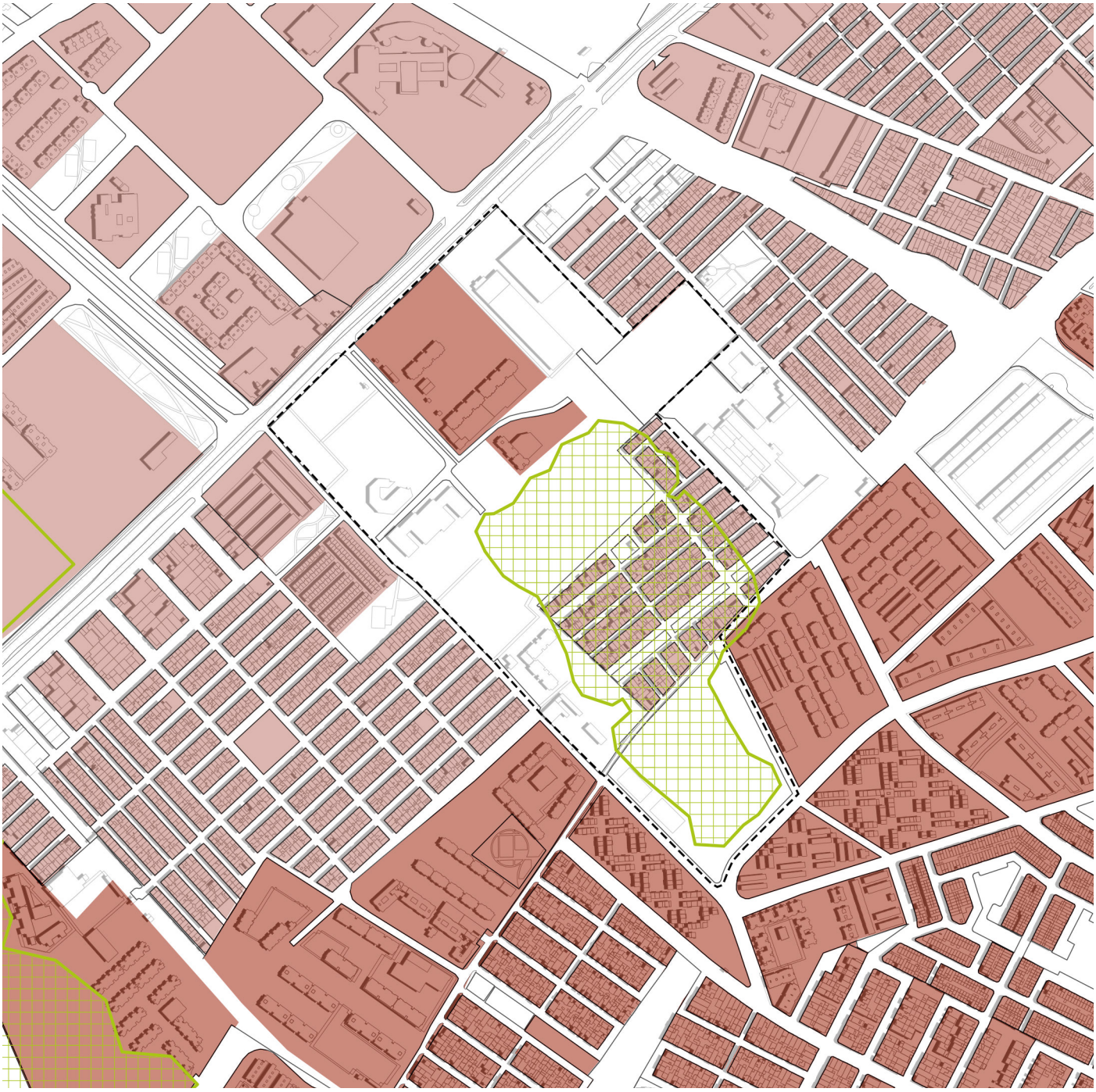
Illus. 60. 10th Street.

Illus. 61. 80th Avenue.



Land uses

- *Residential*
- *Residential with comerce*
- *Residential with economic activity*
- *Multiple zone*
- *Industrial zone*
- *Urban facilities*
- *Aglomerate comerce*
- *Basic urban services*



Socioeconomic stratification

- *No stratum*
- *Stratum 1*
- *Stratum 2*
- *Stratum 3*
- *Stratum 4*

Is the mechanism used by the municipality to classify the population into different strata with similar socioeconomic characteristics, by examining the physical characteristics of their homes and their urban context.

Volumes and voids

The map shows the differences in building densities in the neighborhoods surrounding the work site. The amount of construction within the wetland is evident, as well as the large areas wasted in parking lots for cargo vehicles within the project area.

Permeability

The map shows that the project area borders one of the city's arterial roads, and there is a contrast between the urban fabric of working-class neighborhoods and industrial warehousing.

Population density

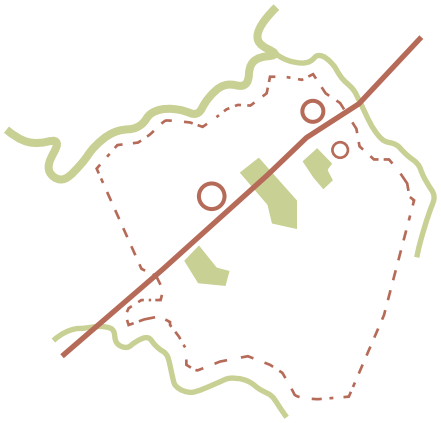
- *0 - 100*
- *101 - 200*
- *201 - 500*
- *501 - 1.000*
- *1.001 - 2.948*

S.W.O.T.

(Site diagnose)

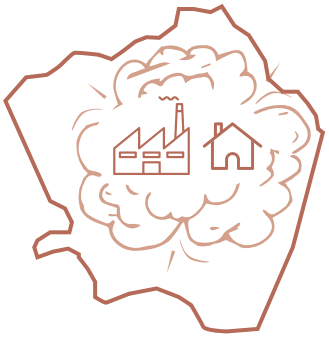
STRENGTHS

- Presence of elements of the main ecological structure: 3 wetlands and 2 boundary rivers.
- Proximity to one of the city's arterial roads.
- Presence of 2 educational facilities in the immediate area of the wetland and a public district library.



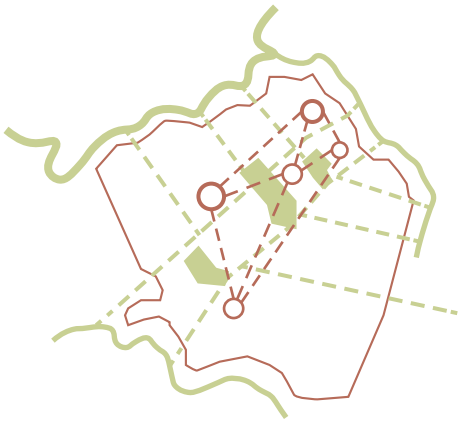
WEAKNESSES

- Presence of land uses that are not compatible with housing, such as industry and parking for cargo vehicles.
- Pollution of the sector and presence of debris in the streets due to nearby industry.
- Large areas lost to accommodate freight vehicle parking.
- Road infrastructure is absent or in a precarious state.
- Area far from the city's main services.
- Detriment of the natural habitat in the sector.
- Construction of a neighborhood within the legal area of the wetland.



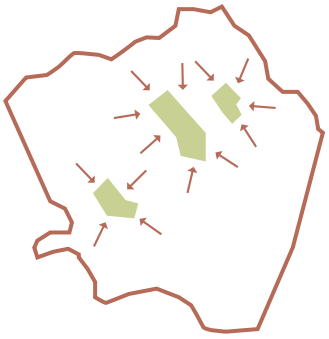
OPPORTUNITIES

- Opportunity to create a networked environmental and park system.
- Opportunity to strengthen a networked system of public facilities.
- Opportunity to reinforce and complement the social fabric, promoting its relationship with natural spaces.
- Opportunity to environmentally restore the sector by establishing green infrastructure.



THREATS

- Increasing construction of high-rise residential buildings around the wetland.
- Presence of cargo vehicles in the sector.
- Weak urban relations due to the enclosures of private residential complexes and wetlands.
- High urban pressure around the wetland and high population density within the legal area of the wetland.
- Affectation and alienation of the Techo wetland, thus deteriorating current and future environmental conditions.




DETRITMENT OF NATURE
POLLUTION AND DEBRIS
FAR FROM SERVICES
INDUSTRY
FAR FROM SERVICES
3 NEARBY RIVERS
2 EDUCATION FACILITIES
PRECARIOUS ROADS
3 WETLANDS
HIGH RISE HOUSING
POLLUTION AND DEBRIS
HIGH RISE HOUSING
DETRITMENT OF NATURE
PRECARIOUS ROADS
3 NEARBY RIVERS
2 EDUCATION FACILITIES
INDUSTRY
3 WETLANDS
INDUSTRY
HIGH RISE HOUSING
POLLUTION AND DEBRIS
2 EDUCATION FACILITIES
URBAN PRESSURE
PRECARIOUS ROADS
DETRITMENT OF NATURE
FAR FROM SERVICES
3 NEARBY RIVERS
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URBAN PRESSURE
3 WETLANDS
INDUSTRY
POLLUTION AND DEBRIS
INDUSTRY
PRECARIOUS ROADS
DETRITMENT OF NATURE
URBAN PRESSURE
INDUSTRY

Project concept
(Multi-scale proposal)

Project aims

1. Promote the ecological and social restoration of the area surrounding the Techo wetland.

2. Promote people's contact with the city's wetlands.

3. Experiment with design strategies to achieve eco-productivity in the project.

4. Strengthen the social capital network and thus improve people's quality of life.

5. Apply a multi-scale project to ensure its effectiveness.

Concept synopsis

The current ecological situation requires that architecture and urban planning seek strategies that allow them to have a positive impact on the environment, since according to the theory of eco-productivity it is not enough to simply reduce negative impacts. Kennedy is a sector of Bogota that has alarming pollution rates, yet there are elements of the **main ecological structure** that **could occupy an essential place** in the social and environmental **restoration of the area**.

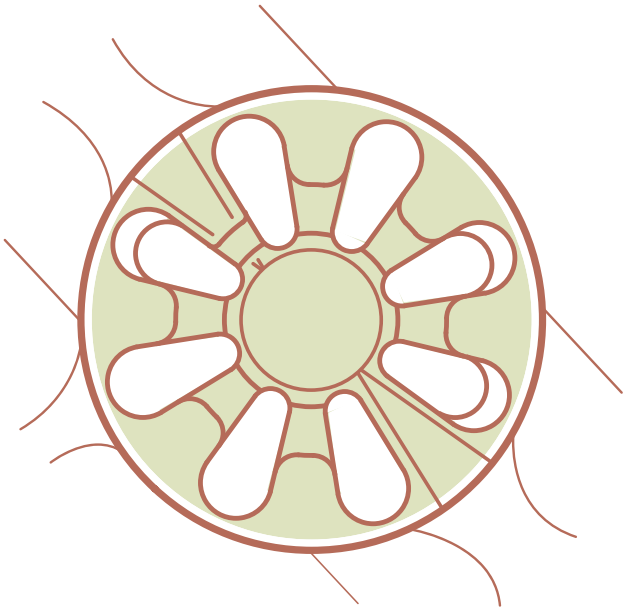
Through a **multiscale project**, the aim is to provide the city with a space for research and environmental education (a wetland's research center), improve the inhabitants' relationship with the wetlands, combat climate change through eco-productive strategies, and strengthen the network of relationships between people. To achieve this goal, the project is based on two main concepts: **eco-productivity** and **social capital**. The first pillar seeks to turn architecture and cities from being one of the main destroyers of the environment into a real alternative for the restoration of ecological conditions and the fight against climate change. The second is a network of relationships of mutual recognition among people that allows overcoming poverty, where public facilities play an important role in their development.

2022 *Stefano Boeri stated:*

> *By now it is* ***no longer possible*** *and much* ***less acceptable*** *at this present time to* ***shrug off responsibility*** *for not having had the tremendous foresight to* ***restore balance*** *where we have brought* ***imbalance****, to* ***restore co-habitation*** *and awareness where we have brought* ***conflict*** *and* ***destruction****. (p.59)*

Kennedy's scale

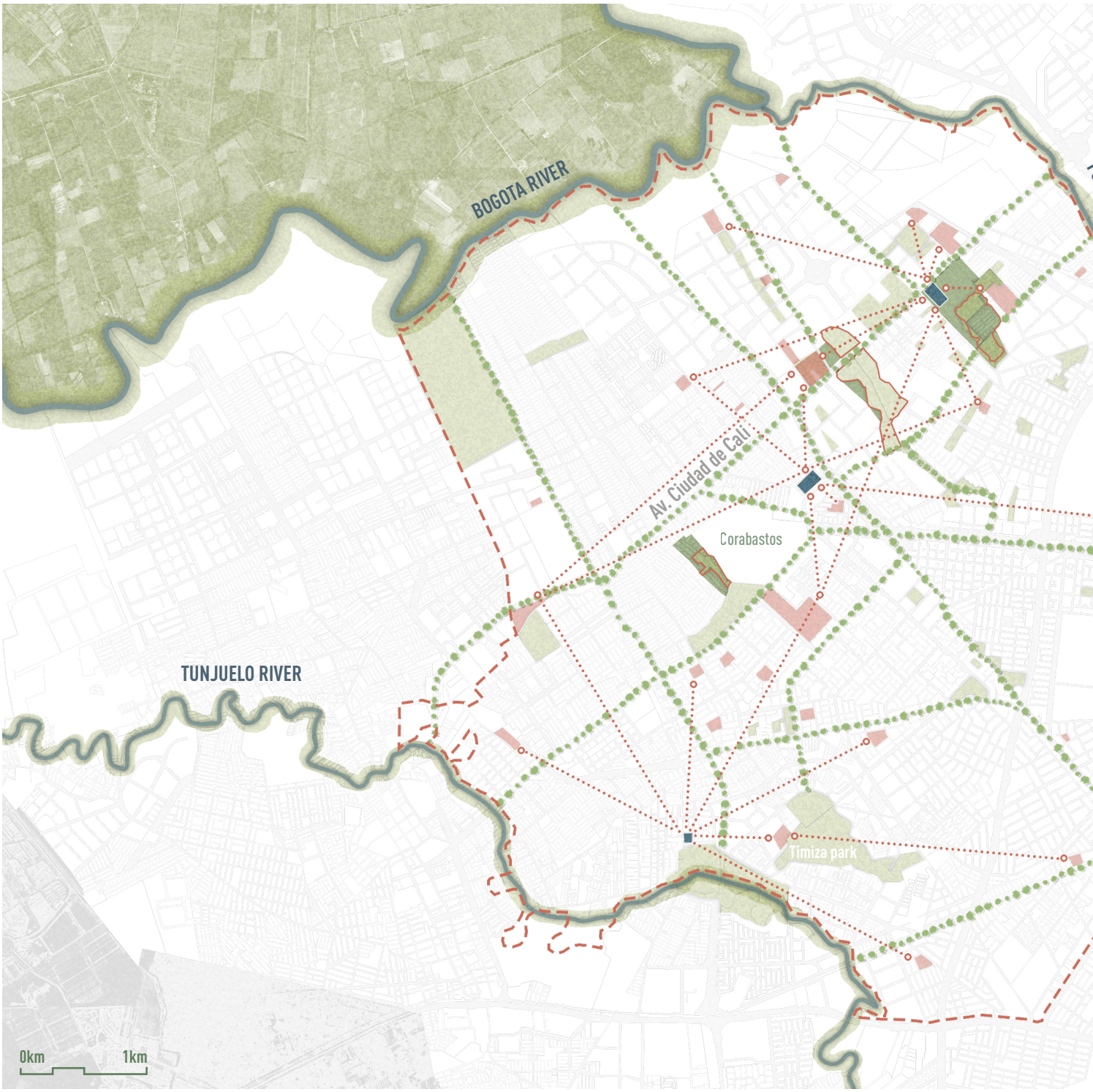
Wetland's scale



Building's scale

Kennedy's Masterplan

(Establishing the network)



Strategies

1. Establish a networked environmental and park system to generate ecological corridors that support biodiversity and connect the sector's main natural areas.

2. Restoration of the wetlands present in the sector through an intervention proposal that reestablishes a beneficial relationship between citizens and the natural spaces of the sector.

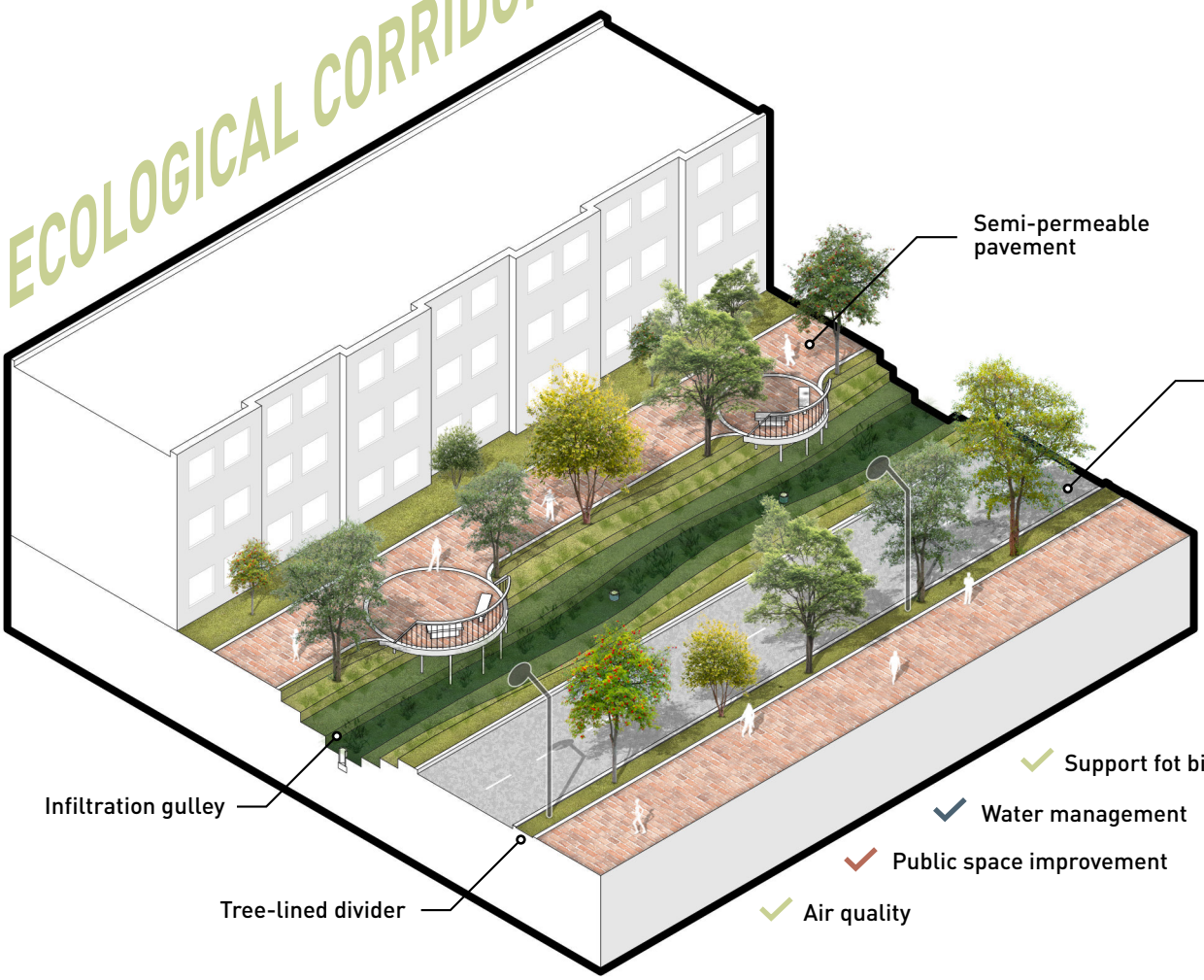
Environmental and public space system

Educational and research facilities system

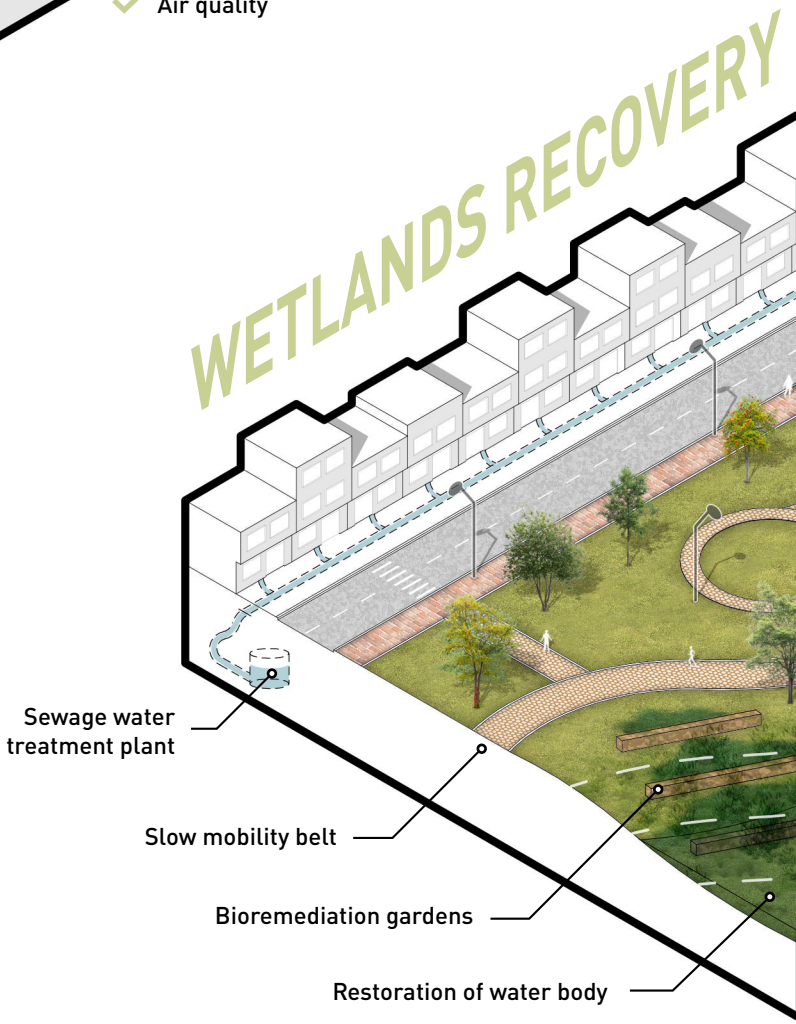
- *Public facilities network*
- *Proposed ecological corridors network*
- *Actual educational facilities*
- *Proposed research facilities*
- *Wetlands*
- *Proposed wetlands treatment*
- *Actual public parks*

3. Strengthen the network system of public educational facilities, generating synergies between schools and universities with new environmental research centers. Relying on ecological corridors to promote their connection.

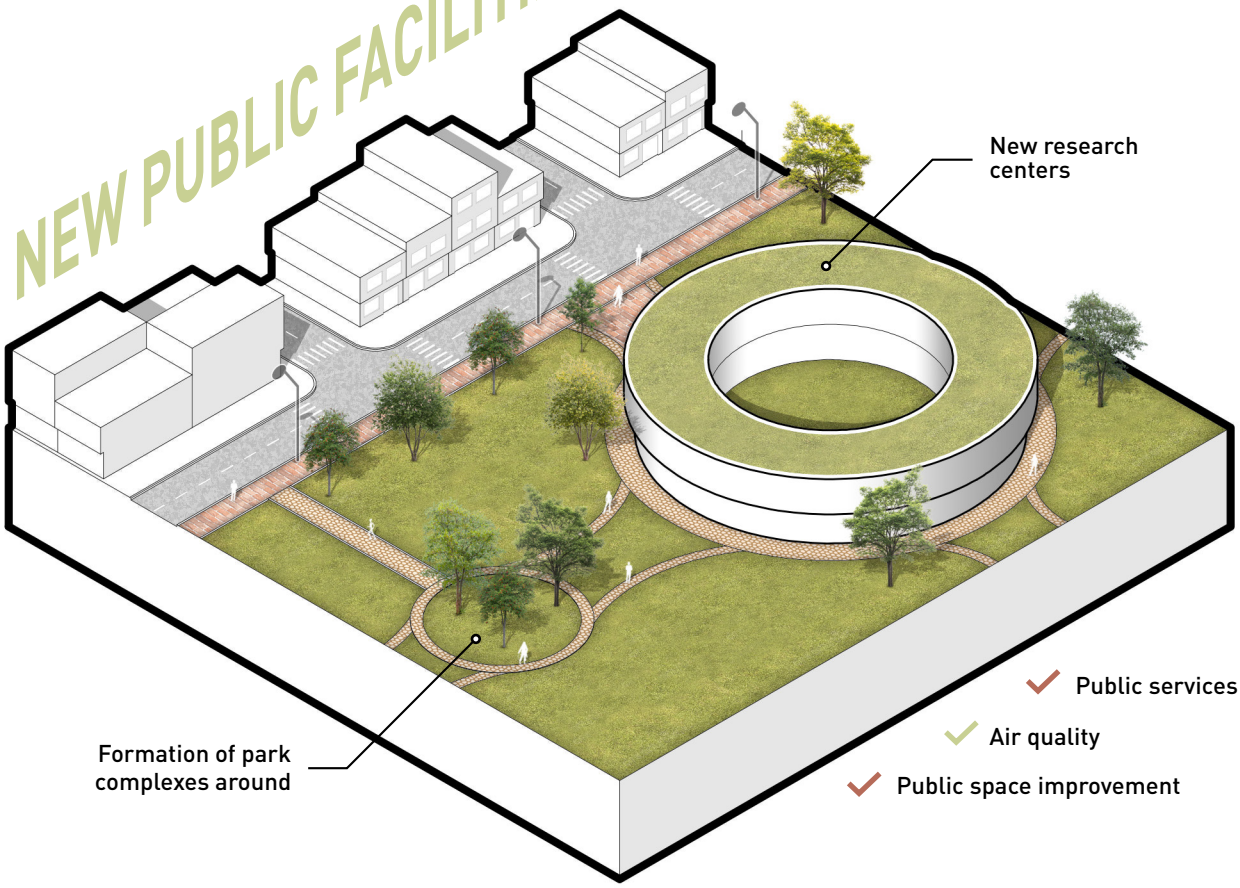
ECOLOGICAL CORRIDORS

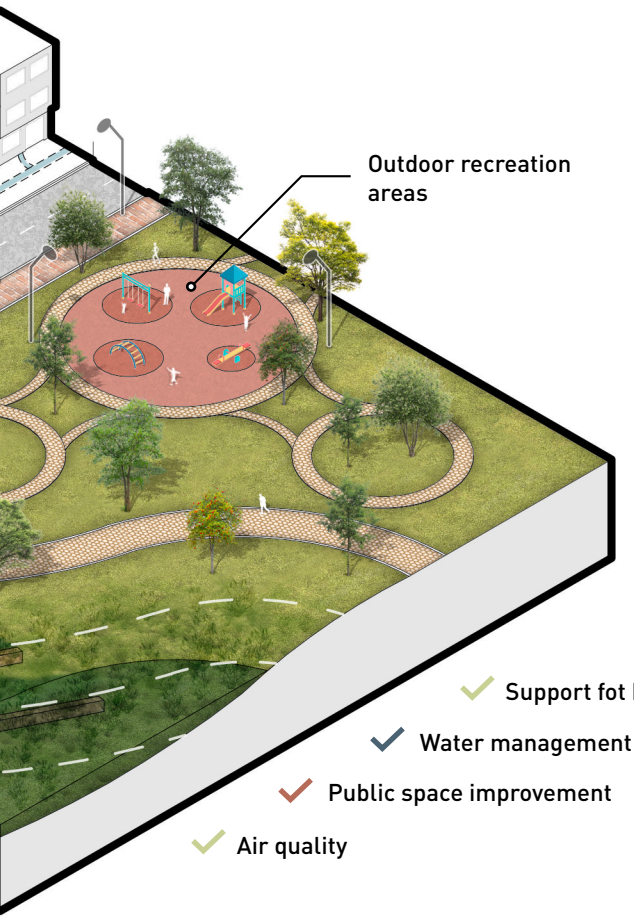


WETLANDS RECOVERY



NEW PUBLIC FACILITIES

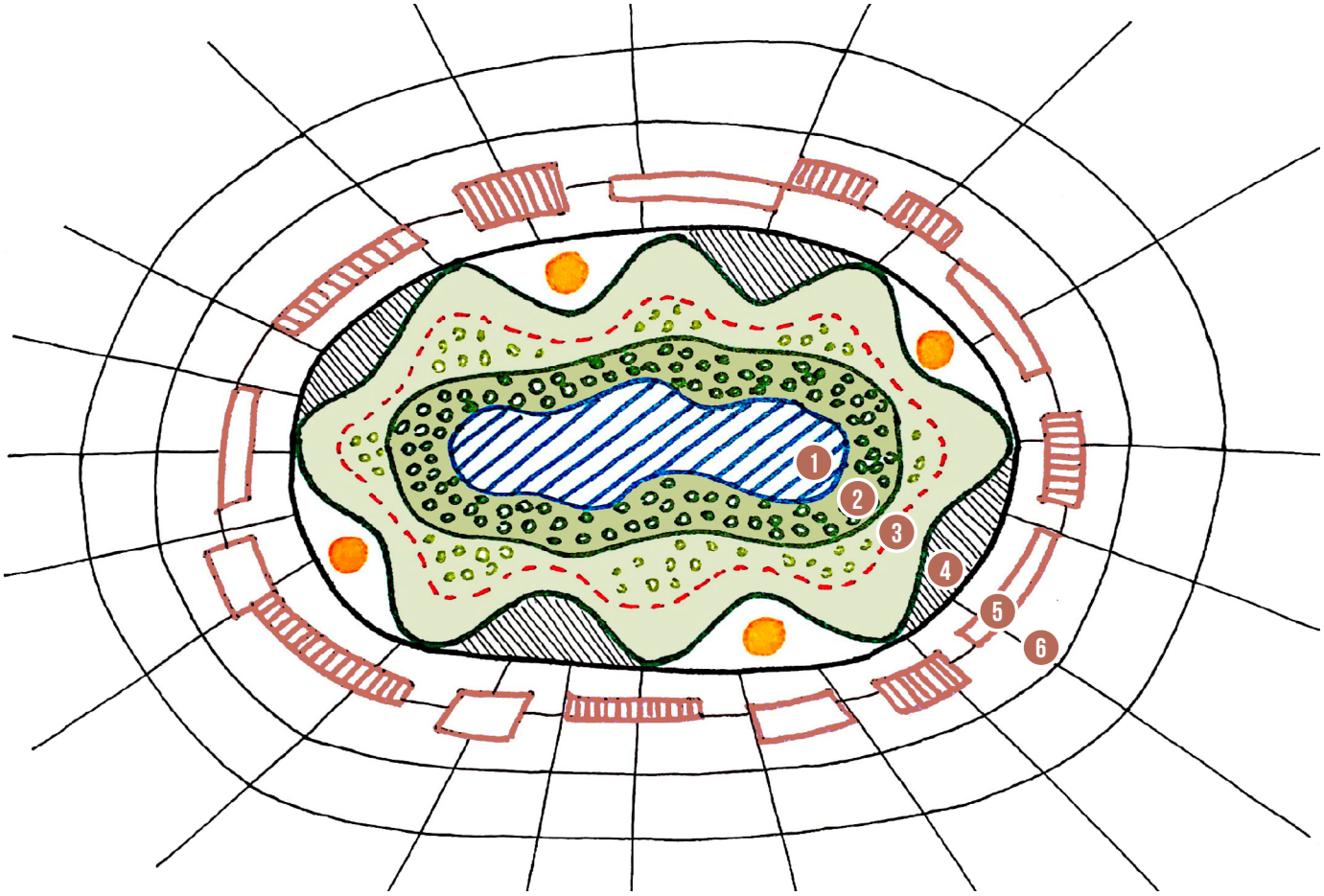




A model for intervention

(For wetland's restoration)

A model for the recovery of wetlands in the urban environment is proposed, based on a strip operation with different land uses. The first strips are intended to **protect the natural space** without any type of human encroachment; then, the first ring of **passive mobility** is the limit of barrier-free interaction with citizens; then, a **passive recreation** area that intersperses children's areas with areas for outdoor exercise; and finally, an urban edge with **collective facilities** to ensure vitality in the adjacent public space. It is also proposed the possibility of its application not only to the wetlands of the city, but in general to the elements of the main ecological structure of Bogota, aiming to strengthen it and **restore its relationship** with the population.



1. Water

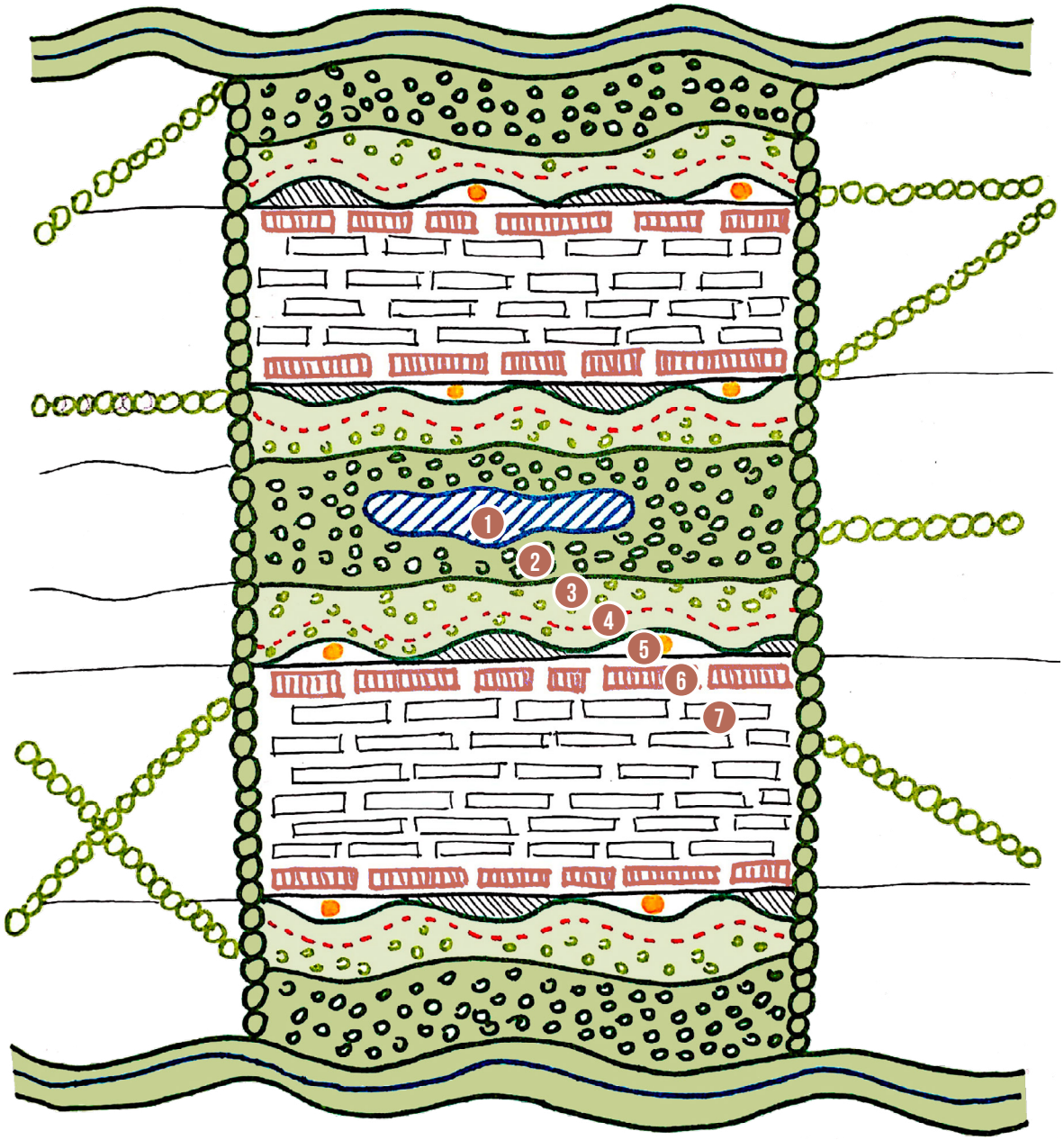
2. Protection zone without intervention

3. Slow mobility belt (Control of the affectations)

4. Outdoor recreation areas (Sports and children's recreation)

5. Urban edge of collective facilities

6. Urban environment



1. Natural spaces (Rivers and wetlands)

2. Protection zone without intervention

3. Conformation of environmental network

4. Slow mobility belt (Control of the affectations)

5. Outdoor recreation areas (Sports and children's recreation)

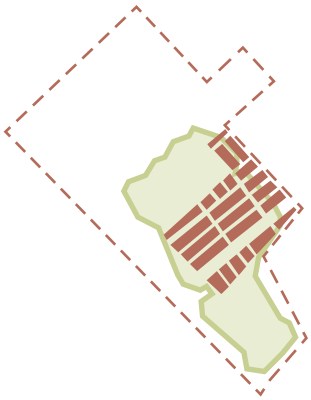
6. Urban edge of collective facilities

7. Urban environment

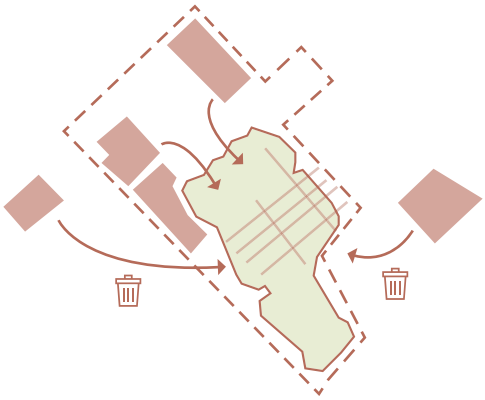
Techo's Masterplan
(Applying the model)

Problems to solve

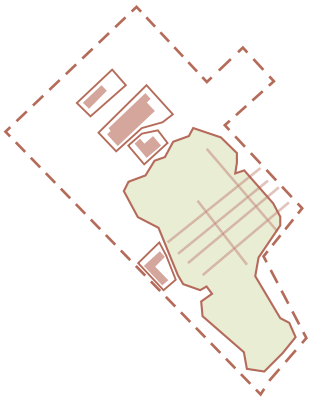
Invasion of the legal area of the wetland by the informal neighborhood Lagos de Castilla. The presence of the settlement does not allow the recovery of the wetland ecosystem and its location continues to be an obstacle to its legalization.



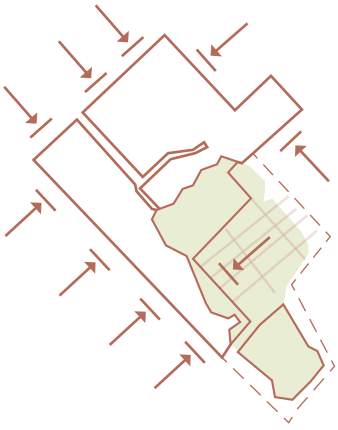
Contamination of the wetland due to the presence of industry and parking lots for cargo vehicles in the immediate area of the natural area. This has led to a reduction in the wetland's biocapacity and biodiversity.



Continuous increase in urbanization and construction of high-rise residential buildings in the immediate context of the wetland. This phenomenon generates more barriers to urban life due to the enclosures and walls that this type of housing creates, in addition to not allowing the implementation of public spaces or facilities with collective services.

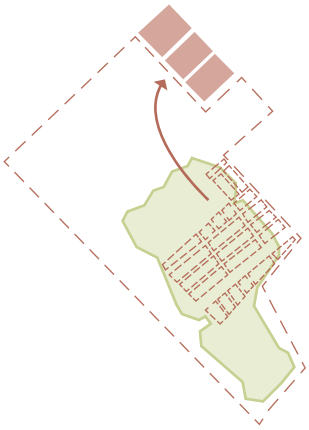


Very low permeability for pedestrians in the area around the wetland, which generates alienation of the natural space. The various enclosures and walls in the area around the wetland create many barriers to an active urban life and to the relationship between citizens and the natural space.

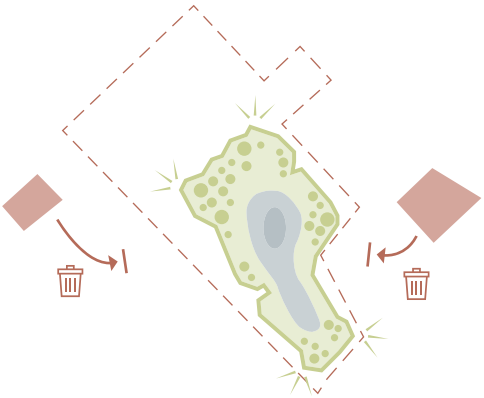


Solution strategies

Relocation of the people present in the Lagos de Castilla neighborhood, who must be evacuated for the recovery of the wetland, within the same area of the city. For this purpose, a social housing offer is proposed in the immediate context of the project.

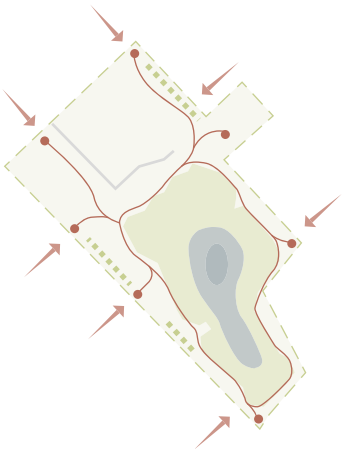


Ecological recovery of the wetland, taking into account the city's protocol for the recovery of these spaces. In this way, the ecological capacity of the wetland will be rebuilt and its restoration will reinforce the main ecological structure of the city.

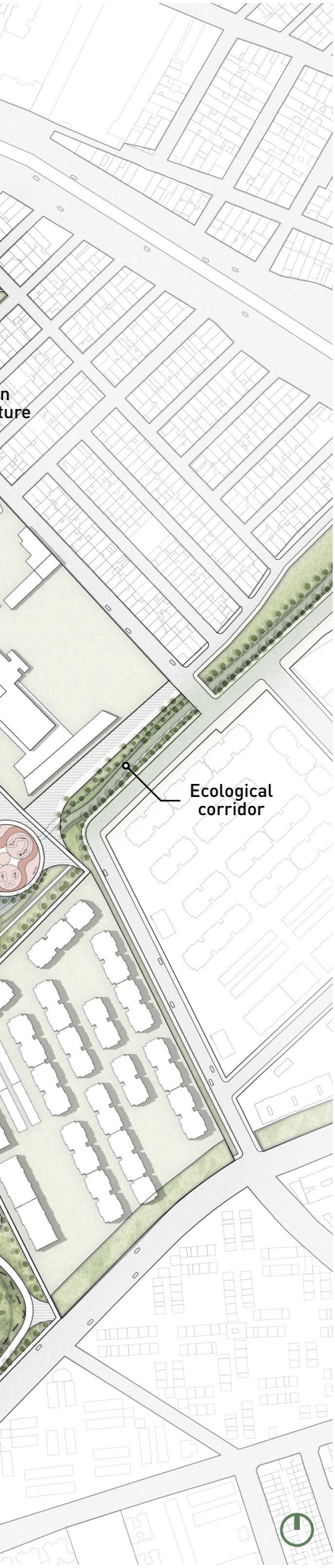


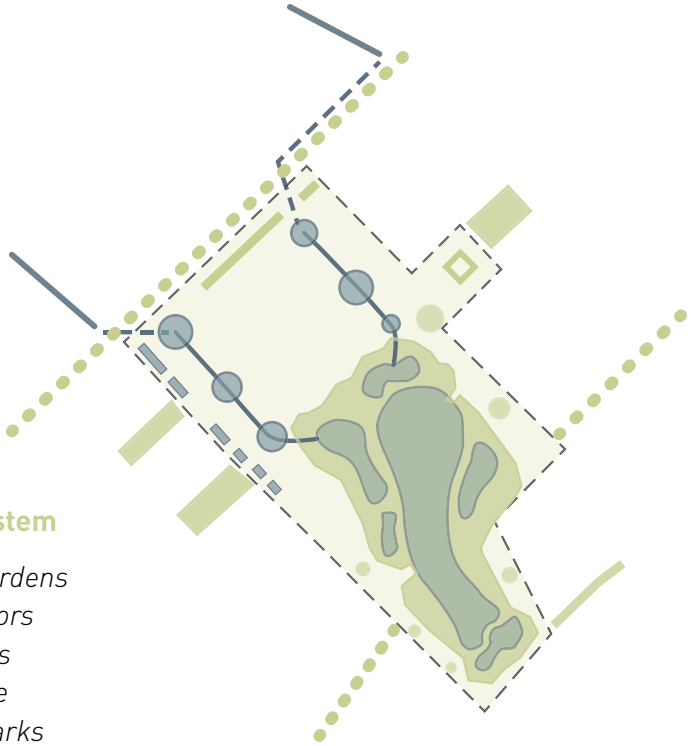
Apply the proposed urban wetlands treatment model, which will make it possible to create a mixed research complex with activities in the public space that will set an example for the restoration of these spaces of great value to the city.

Creation of controlled openings for pedestrians to a park around the wetland, which will strengthen the contact with the natural space, improve the quality of life of citizens and allow the reconstruction of a beneficial relationship between urban life and nature.



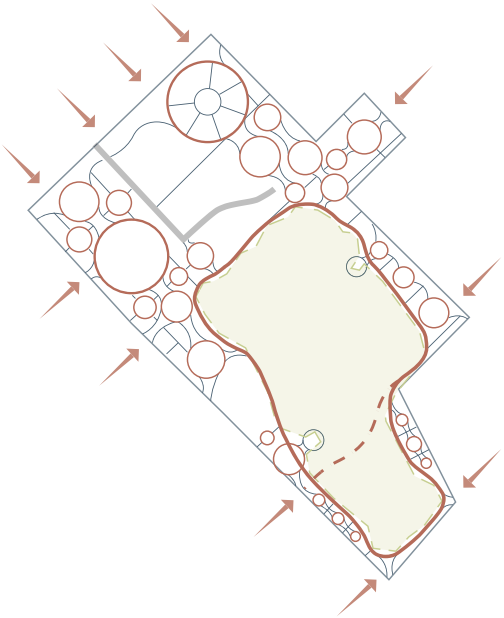

Social housing
Sports area
Ecological corridor
Urba
Agricult
Artificial wetlands
Public car park
Wetland's research center
Conservation greenhouse
Wetland of Techo
Outdoor recreation zones
Slow mobility belt
0m
100m





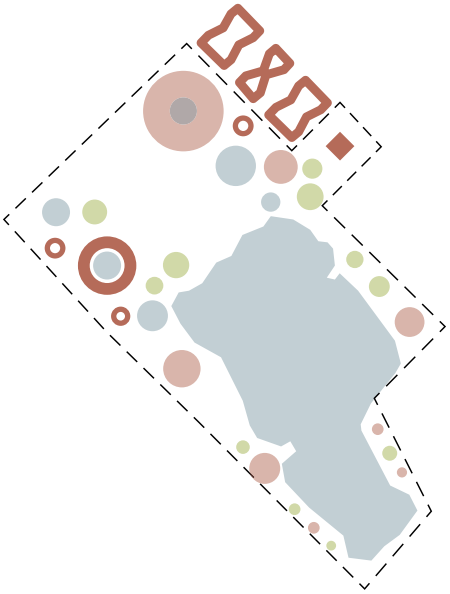
Environmental and public space system

- *SUDS and raingardens*
- *Ecological corridors*
- *Artificial wetlands*
- *Urban agriculture*
- *Existing public parks*



Circulation system

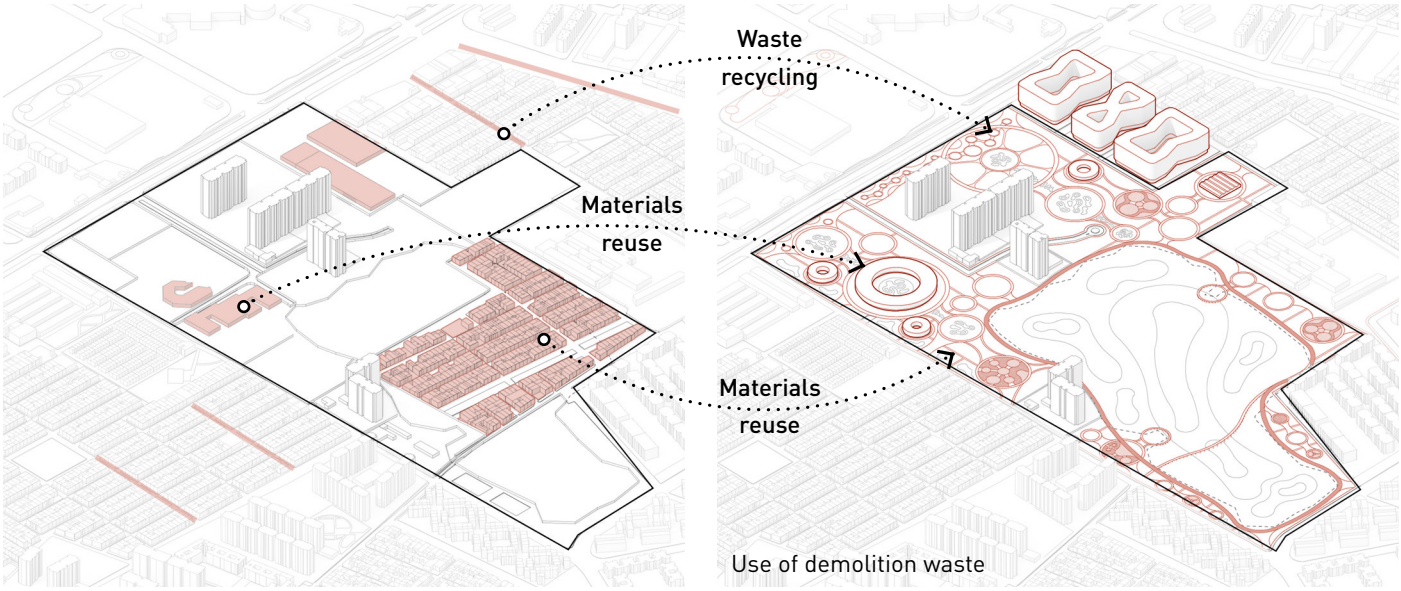
- *Main circulation ring*
- *Main access*
- *Main circulation circuits*
- *Secondary paths*



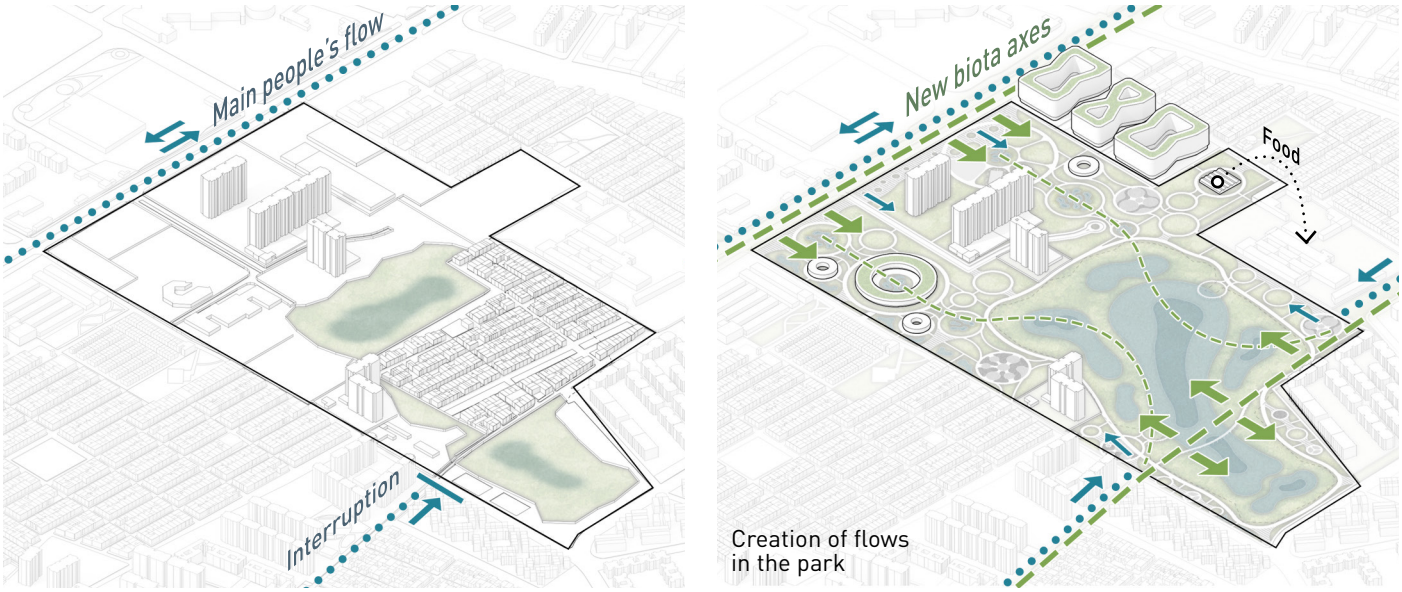
Spatial system

- *Proposed buildings*
- *Recreation & sport zone*
- *Wetland zone*
- *Gardens*

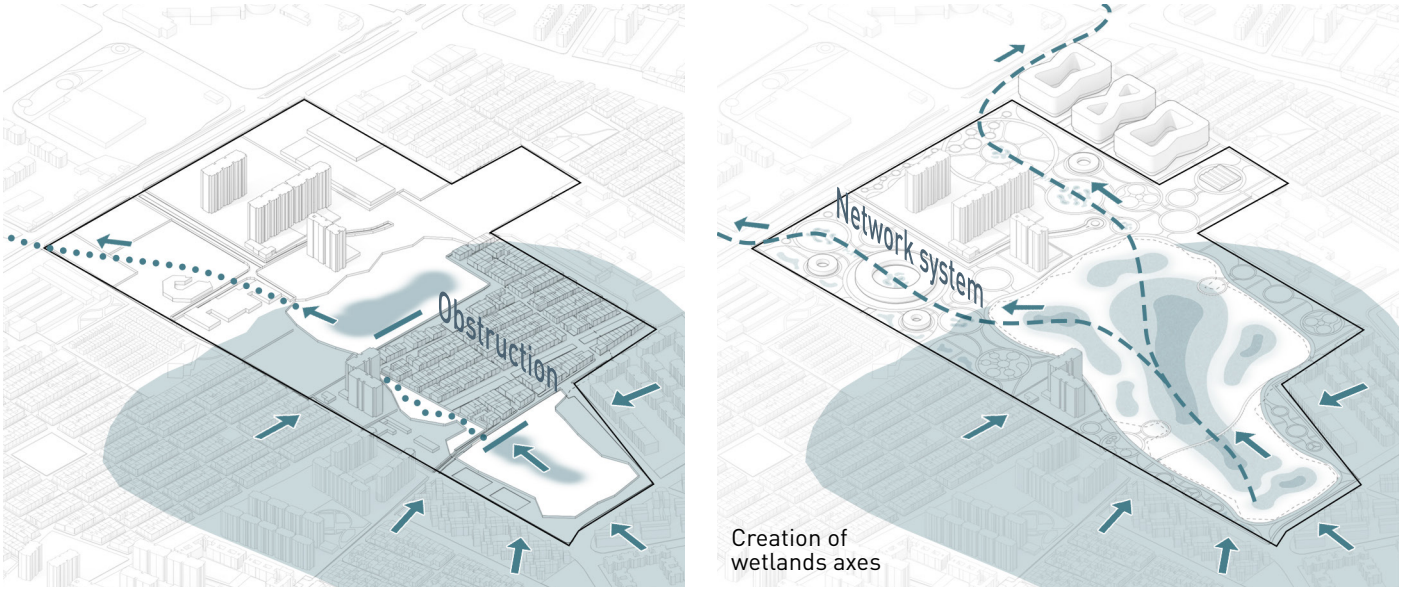
Materials & Waste flows

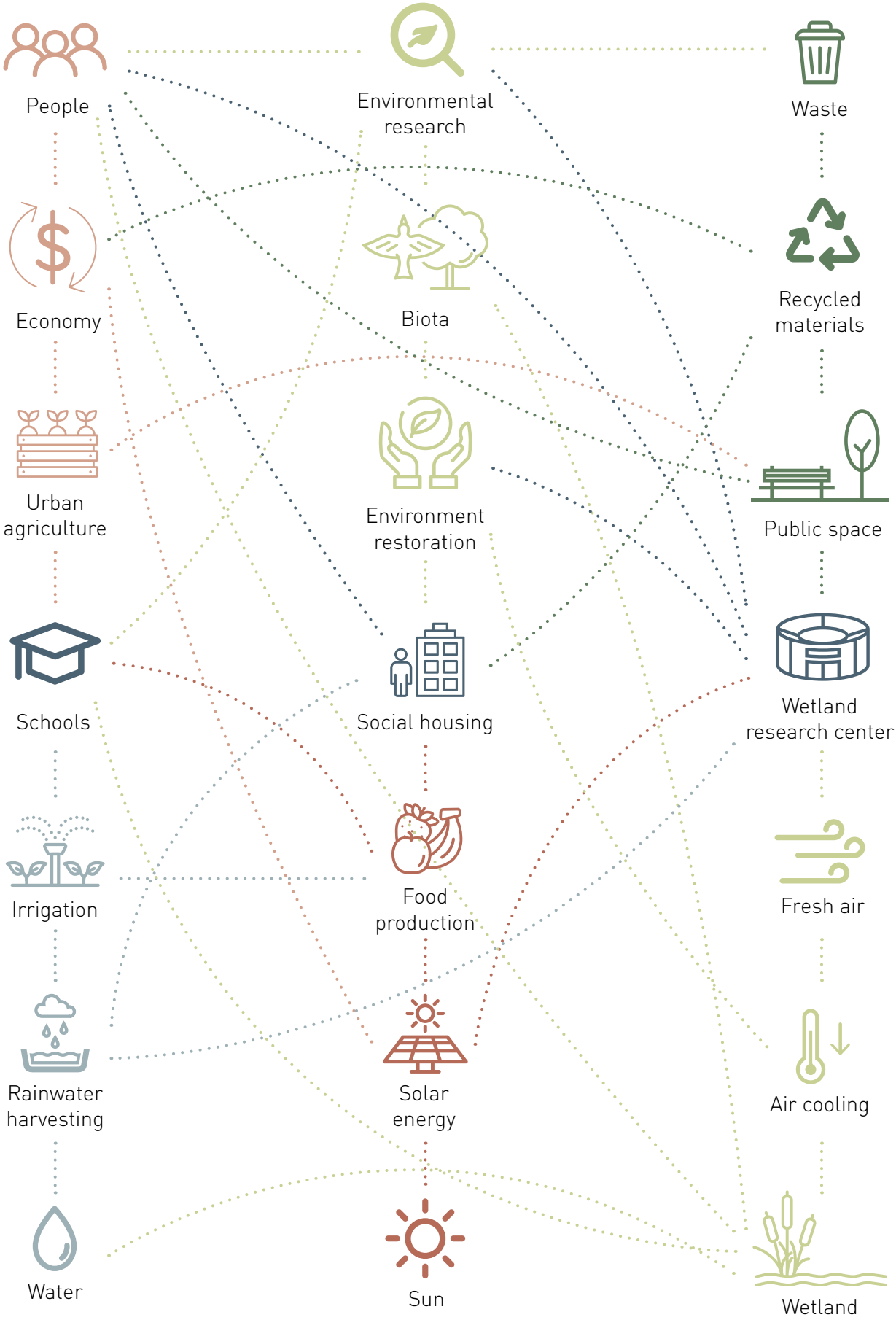


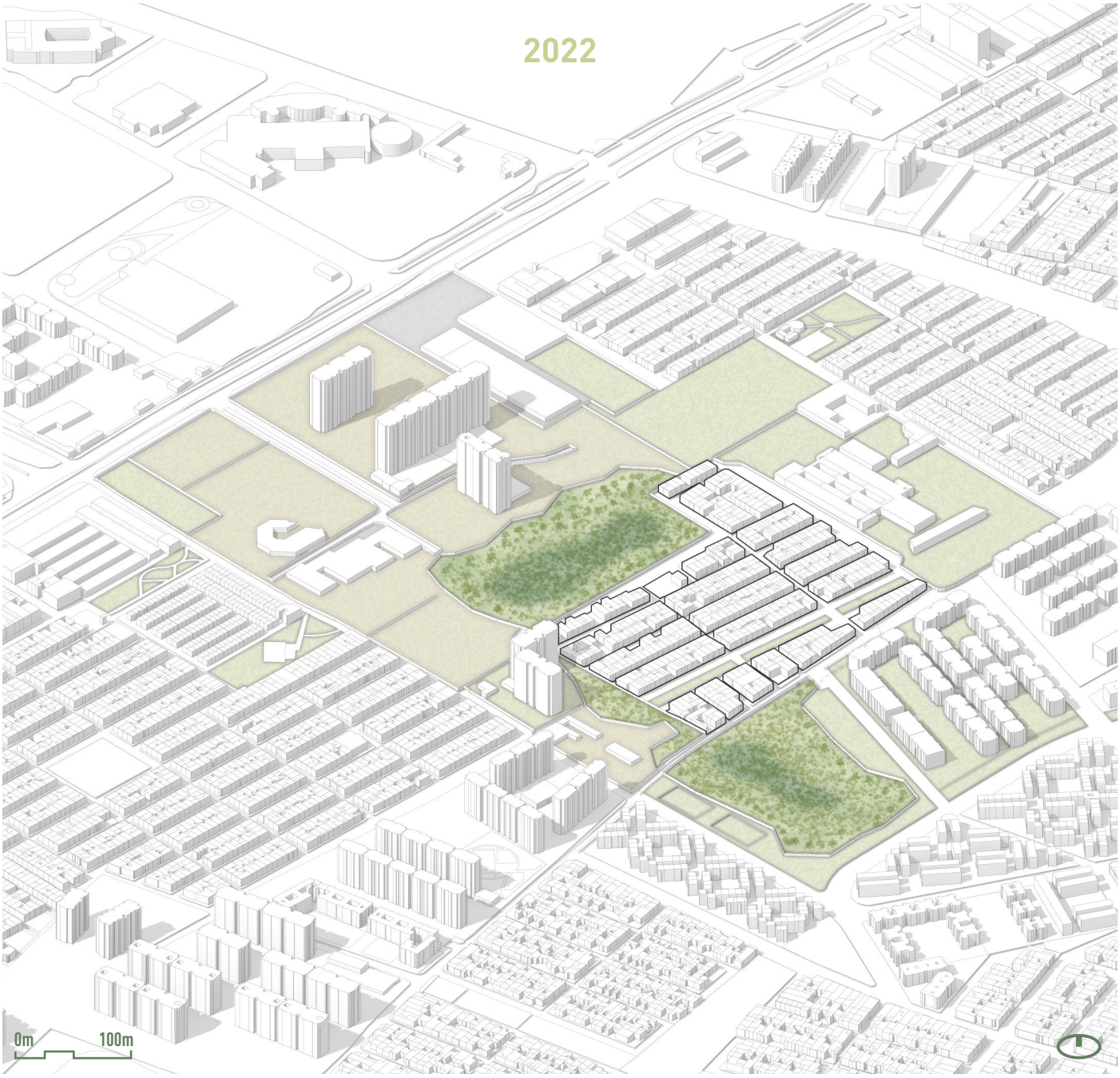
People & Biota flows



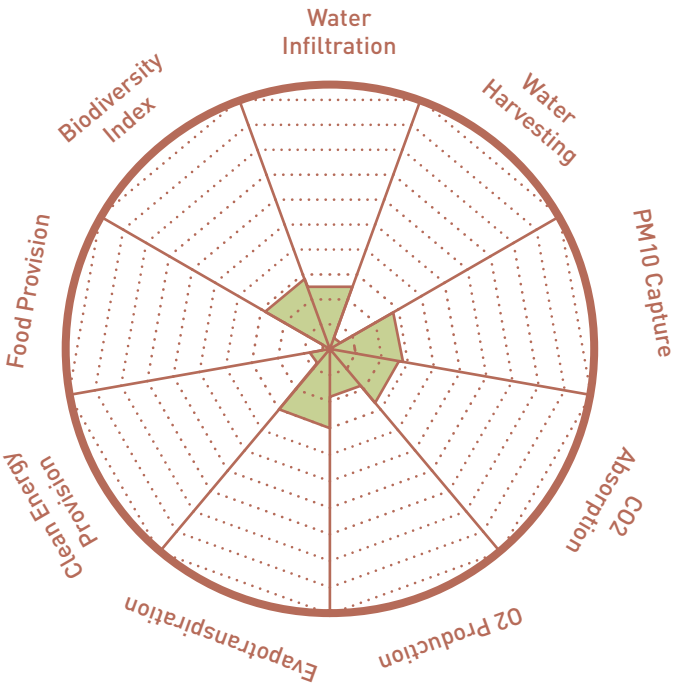
Water flows




People
Environmental research
Waste
Economy
Biota
Recycled materials
Urban agriculture
Environment restoration
Public space
Schools
Social housing
Wetland research center
Irrigation
Food production
Fresh air
Rainwater harvesting
Solar energy
Air cooling
Water
Sun
Wetland

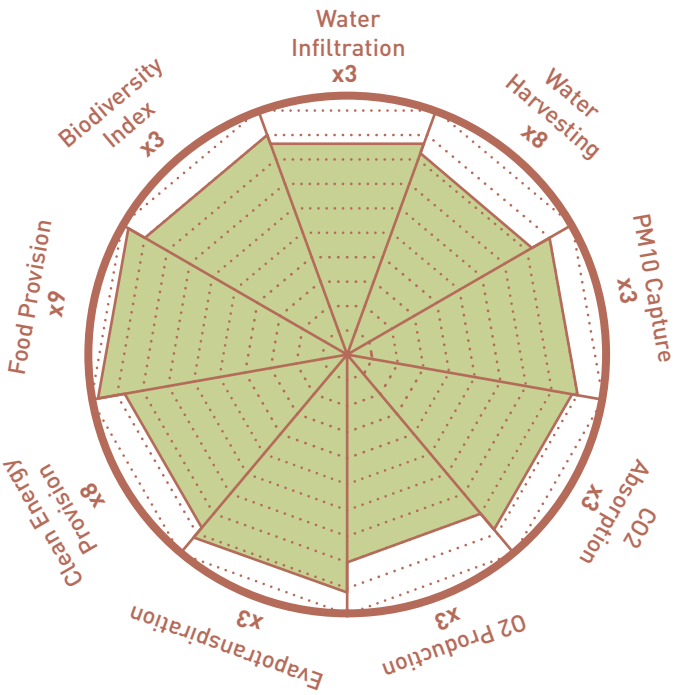

2022
0m
100m

Before


Water Infiltration
Water Harvesting
PM10 Capture
CO2 Absorption
O2 Production
Evapotranspiration
Clean Energy Provision
Food Provision
Biodiversity Index

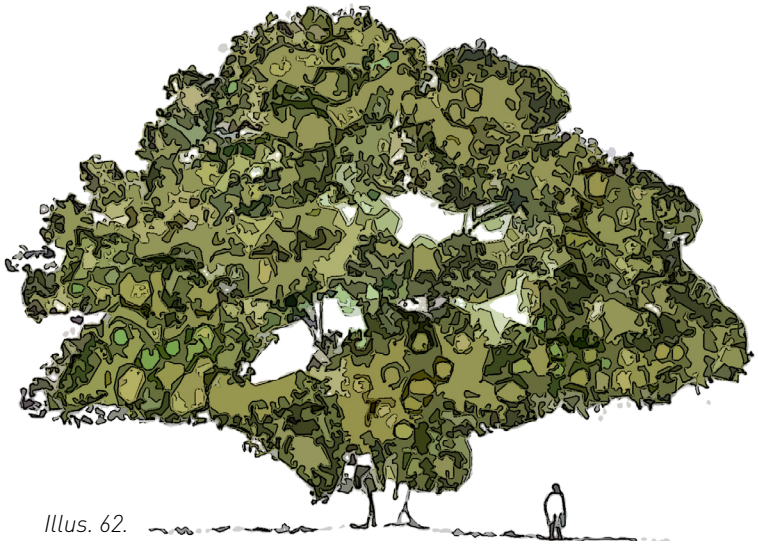

2028
0m
100m

After


Water Infiltration x3
Water Harvesting x8
PM10 Capture x3
Algae CO2 Absorption x3
O2 Production x3
Evapotranspiration x3
Clean Energy Provision x8
Food Provision x9
Biodiversity Index x3

Project's vegetation

The main reference for choosing the species for the trees in the project was the preliminary design of the Green Manual for Bogota, developed by landscape architect Diana Wiesner in collaboration with the José Celestino Mutis Botanical Garden. The manual describes the different species present in the Bogotá savanna, taking into account their ecological, biological and functional characteristics. Taking into account the low air quality in the work sector, the species with the best performance in carbon dioxide capture, oxygen production and habitat provision were selected for the project.



Illus. 62.

CAUCHO SABANERO

CO2 uptake: Good
Capture of particles in suspension: Good
Productivity (timber, food): Regular
Climate regulation: Good
Provision of habitat: Good

NATIVE

Illus. 63.

SANGREGAO

CO2 uptake: Good
Capture of particles in suspension: Good
Productivity (timber, food): Good
Climate regulation: Good
Provision of habitat: Good

NATIVE

CAUCHO TEQUENDAMA

CO2 uptake: Good
Capture of particles in suspension: Good
Productivity (timber, food): Regular
Climate regulation: Good
Provision of habitat: Good

NATIVE

Illus. 64.

ROBLE

CO2 uptake: Good
Capture of particles in suspension: Good
Productivity (timber, food): Good
Climate regulation: Good
Provision of habitat: Good

NATIVE

Illus. 65.

URAPÁN

CO2 uptake: Good
Capture of particles in suspension: Good
Productivity (timber, food): Good
Climate regulation: Good
Provision of habitat: Regular

NON-NATIVE

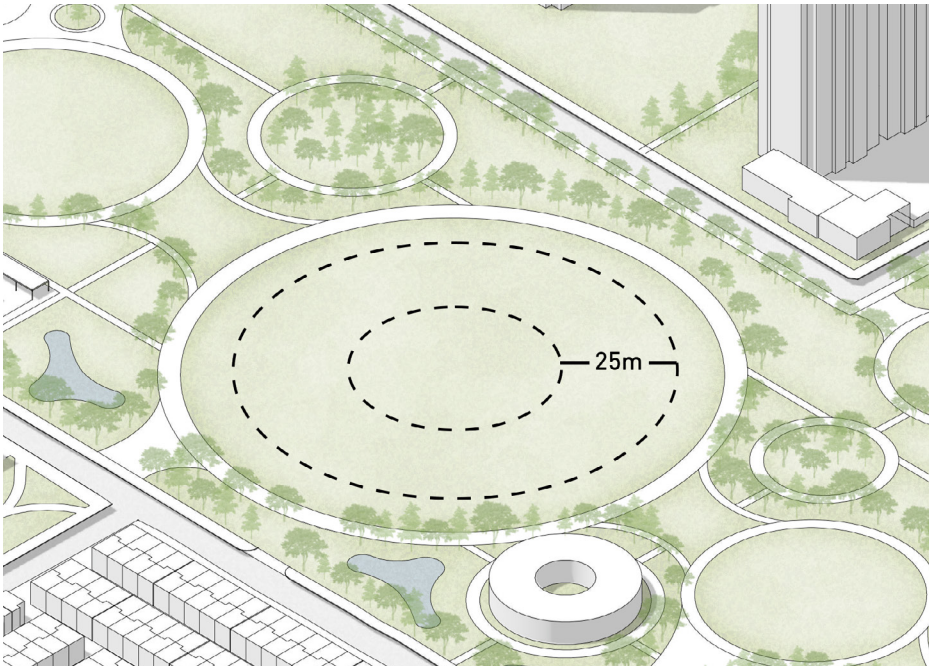
Illus. 66.

**Original sketches by Diana Wiesner*

THE GUARDIAN

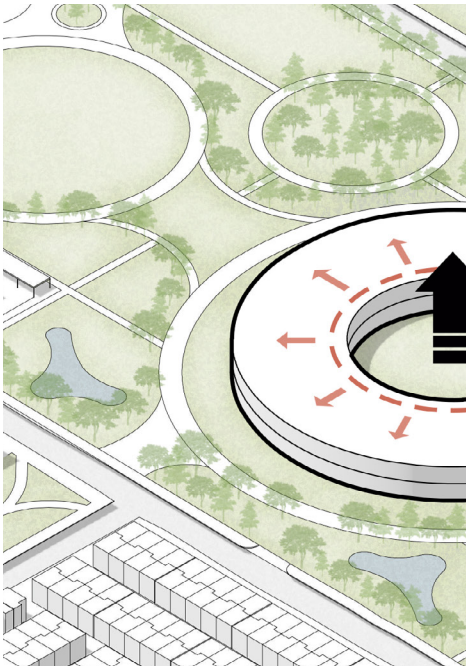
(The research center)

Form-finding diagrams



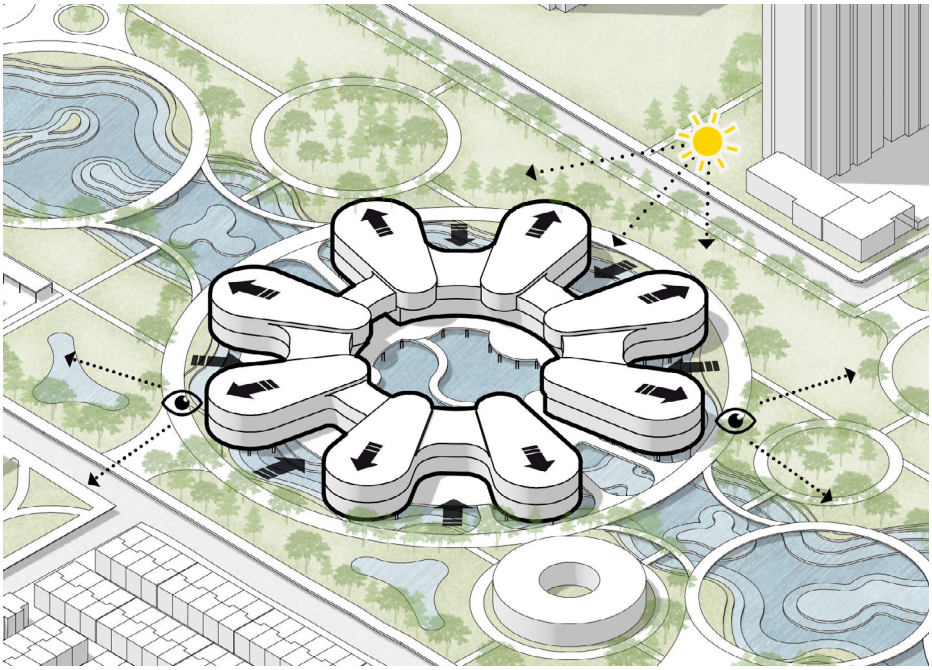
1. The site

The immediate context of the project is characterized by circular paths, organic circulations and by being surrounded by nature. Creating an offset of the context the result becomes a ring's silhouette.



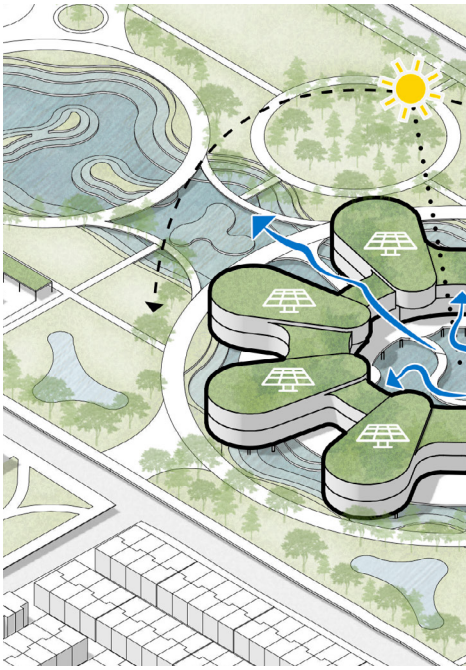
2. Efficient

A two stories building rises from the r
an efficient circulation system that c
spaces in a 360º facade.



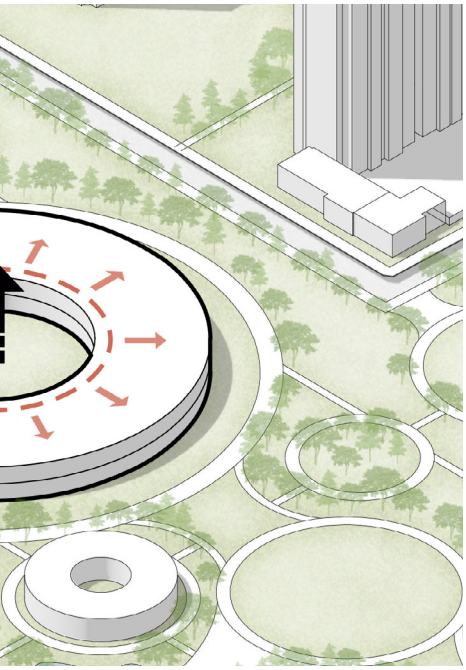
4. Facade maximization and views creation

The ring decomposes in 8 blocks in orther to optimize the natural lighting of the building, create views and have a clear organization of the project's specific program.



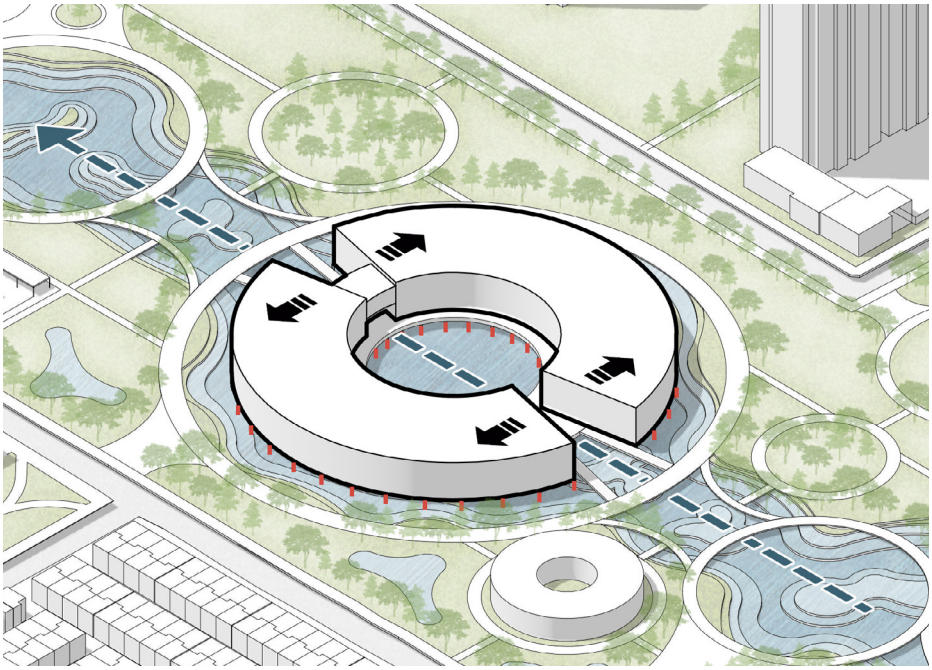
5. Roofing an

Due to Bogota's high radiation the pr
green roofs that capture energy th
naturally taking advantage of the cou



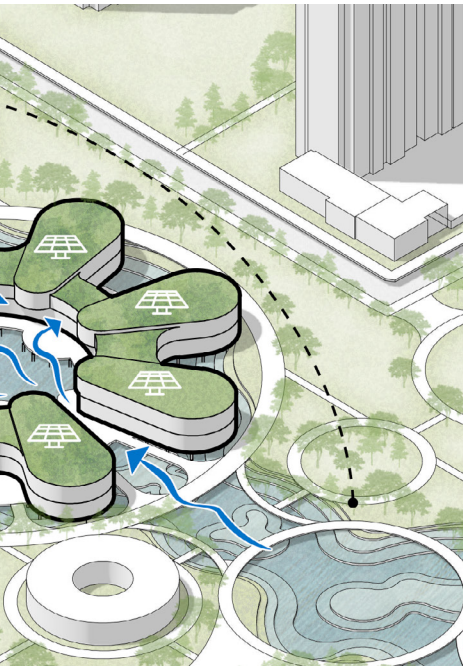
circulation

ring's silhouette in order to guarantee reates a courtyard and allows having



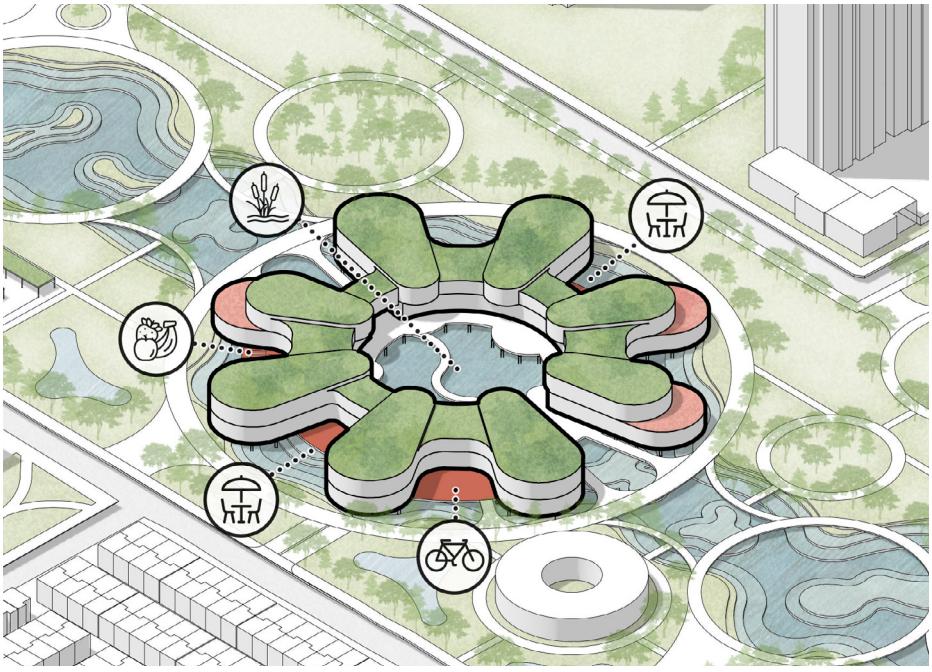
3. Bringing in the wetland

The ring gets crossed by an artificial wetland axis connecting the building with the surrounding nature, and to ensure ecological connectivity becomes a **palafitic structure**.



d ventilation

roject gets protection from extensive hrough panels, and ventilates itself urtyard.



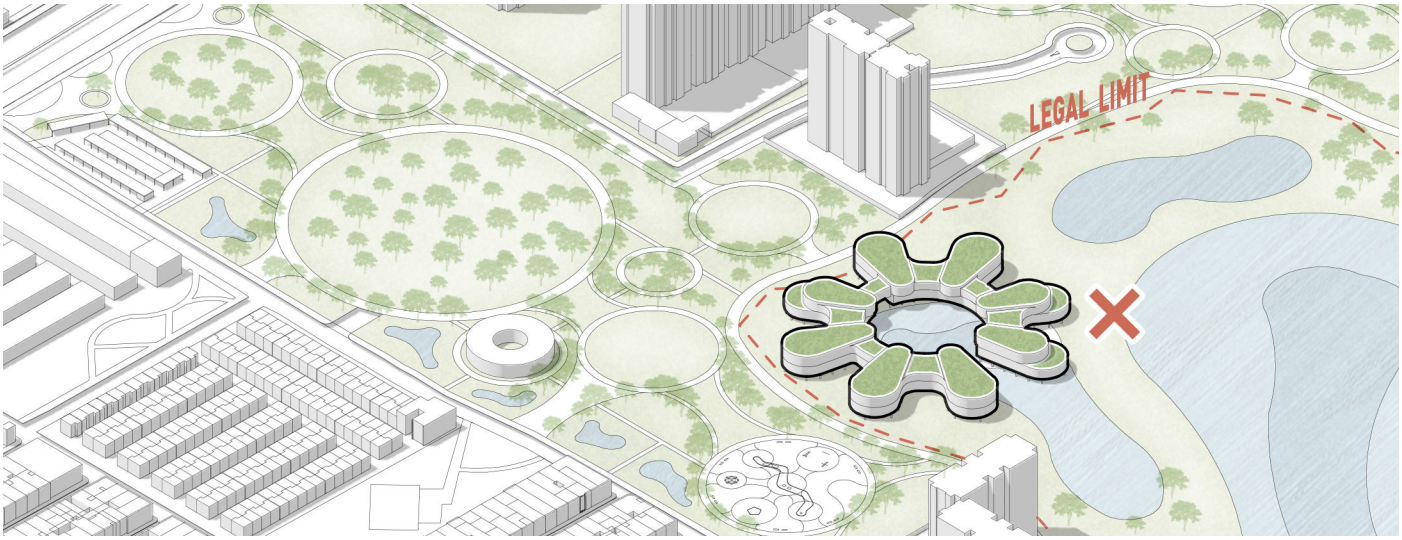
6. Terraces and in between decks

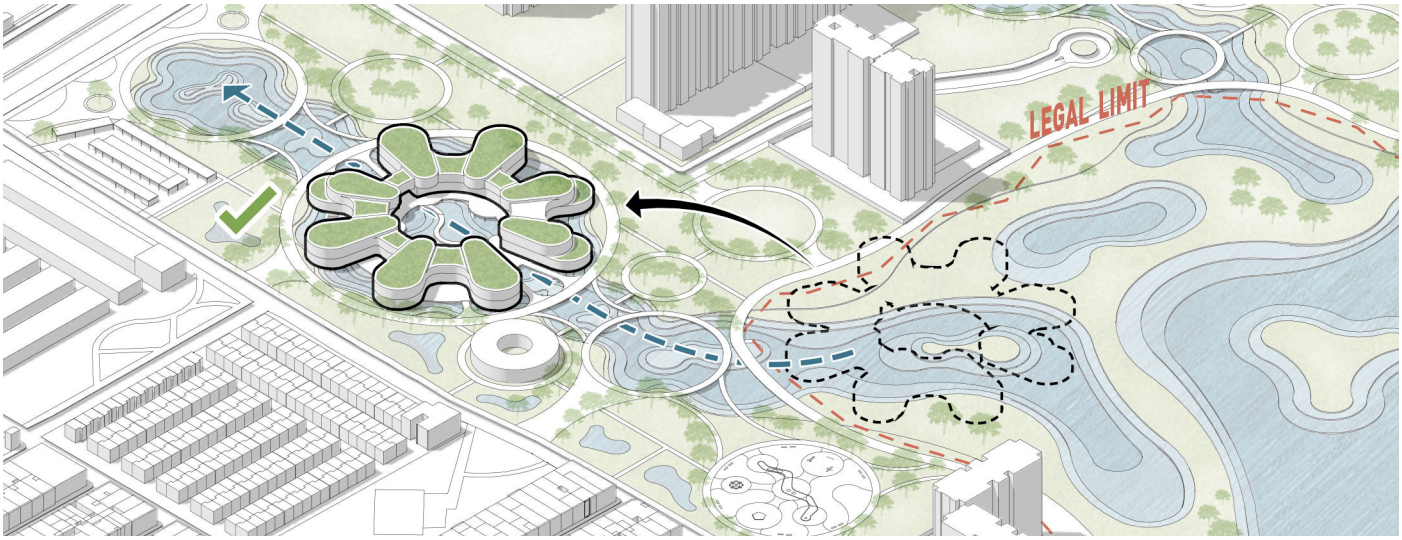
Creation of terraces adds value for the users comfort and takes advantage of views of the natural context, and the spaces between the blocks get different purposes.

General concept

The design of an environmental research center might automatically suggest a **direct relationship** with some **natural space** in its context. However, this relationship does not imply that its location has to be within the legal area of a protection zone for the relationship to be effective, since it would directly affect the relationships of the ecological system. This is why an **overflow of the wetland** is proposed to expand its territory in the park and bring it closer to the building project.

In this way, **instead of invading** the natural protection space with a building, it is intended to **bring the natural space towards the building**. This makes it possible to reinforce the main ecological system of the city, strengthening biodiversity and proposing new ways of interacting with the protection zones of the urban environment without having to invade or negatively affect them.

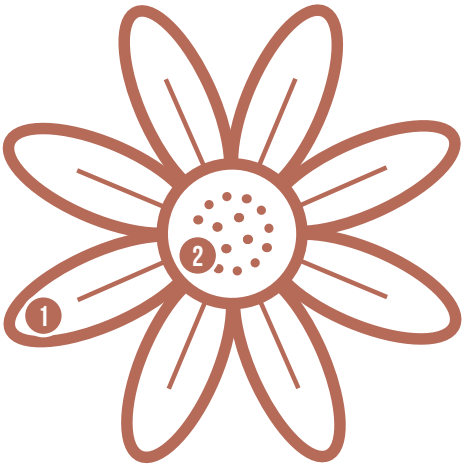




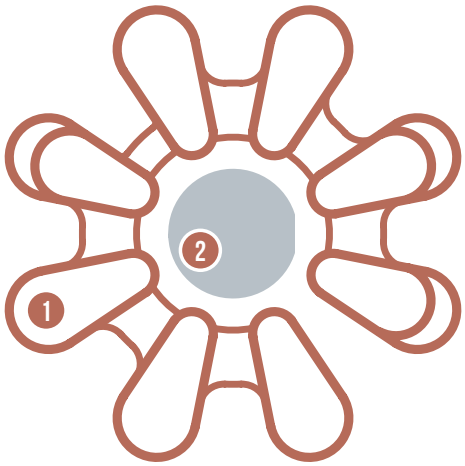
Form study

The formal experimentation for the project was based on the principle of **radial symmetry** to generate a volumetric disposition that would respond 360° to the immediate context, given that it is located in the middle of a park.

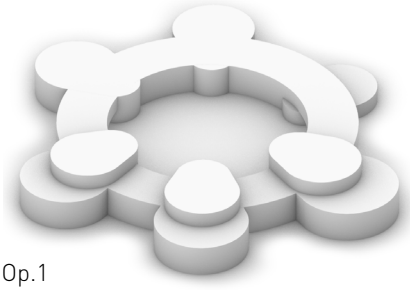
This led to the development of a bio-inspired formal study, since this system of organization is present in nature. **Biomorphism** refers to designs that visually resemble living elements, which can generate **well-being** in humans given the affinity we have for natural forms. This concept was applied in the project through the analogy of the functioning of a flower and the building.

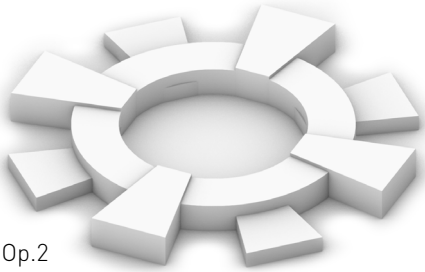


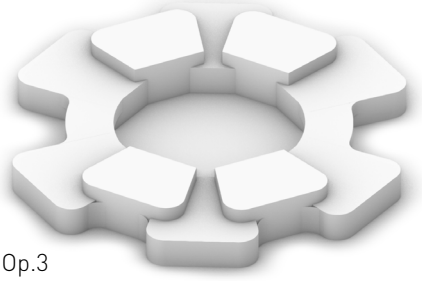
1. Corolla: Is composed by the petals, which have the function of attracting pollinators into the stames with their colors and aromas.
2. Receptacle: Is where the stamens and the pistil grow and where the polen is stored.



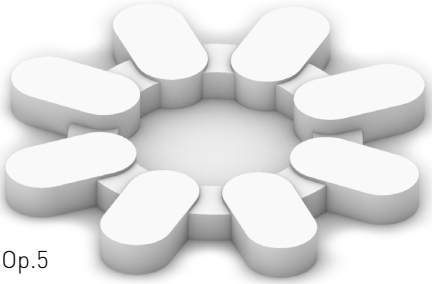
1. Petals: Blocks that organize the building's program and its outermost part has a special activity to catch people's attention.
2. Wetland "courtyard": Core of the building's disposition and main element of the distribution system, creating public space around it.


Op.1

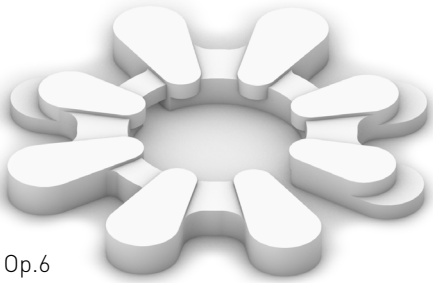

Op.2


Op.3


Op.4


Op.5

Chosen scheme

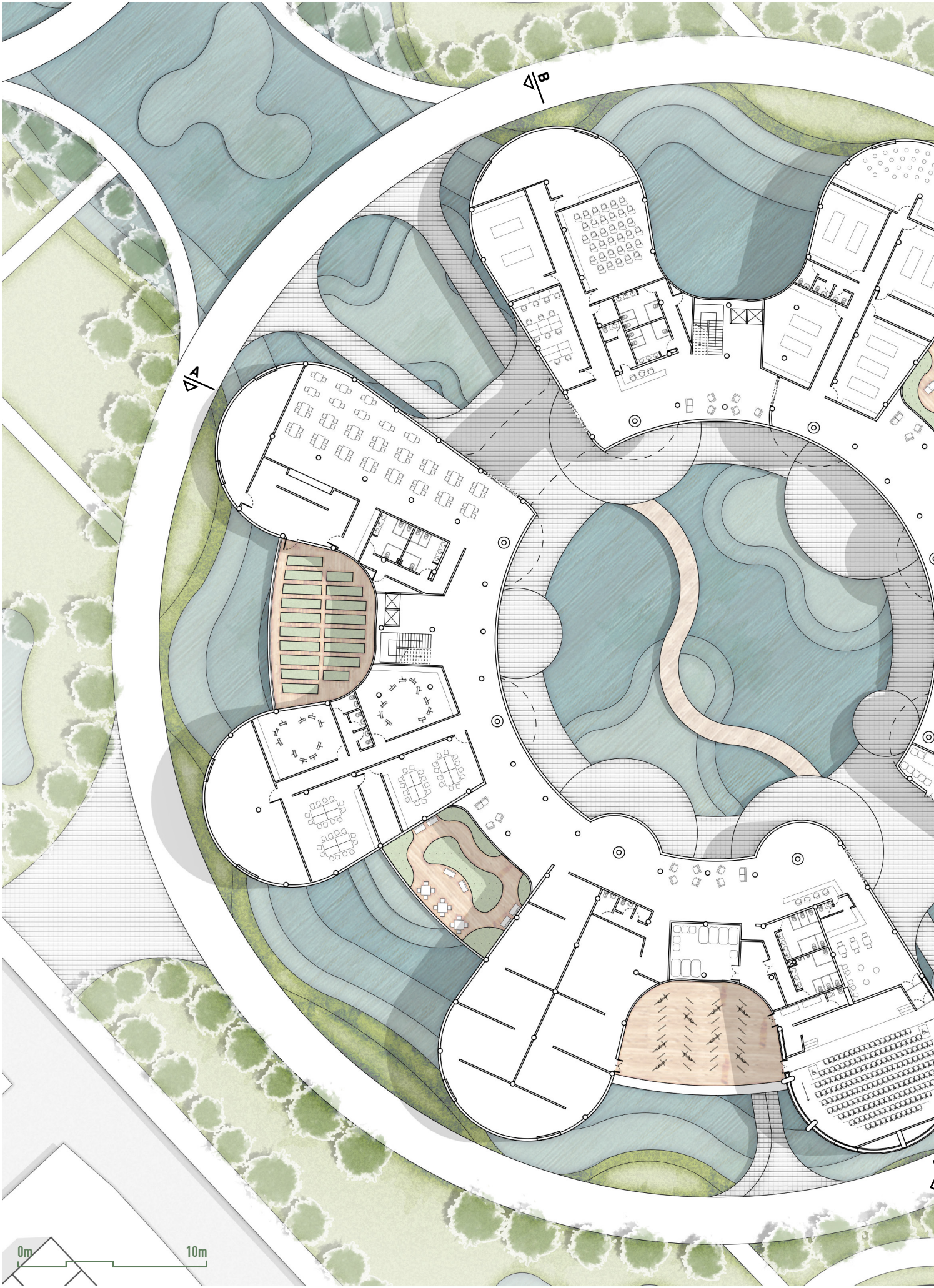

Op.6


0m
10m

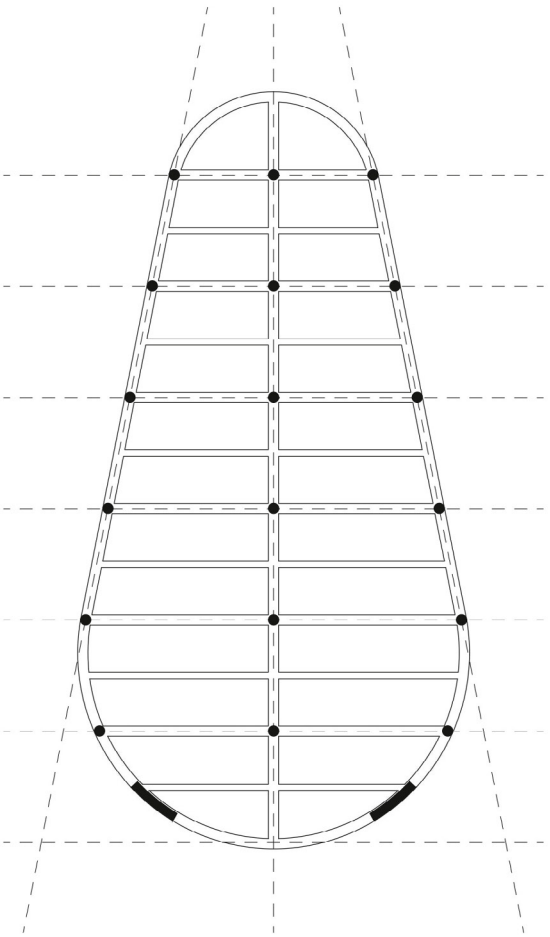
Site Plan

The project seeks to have a harmonious relationship with its surroundings, characterized by the presence of abundant greenery. To this end, its layout is **organic**, **permeable** and in direct relation to the nature of the wetland.

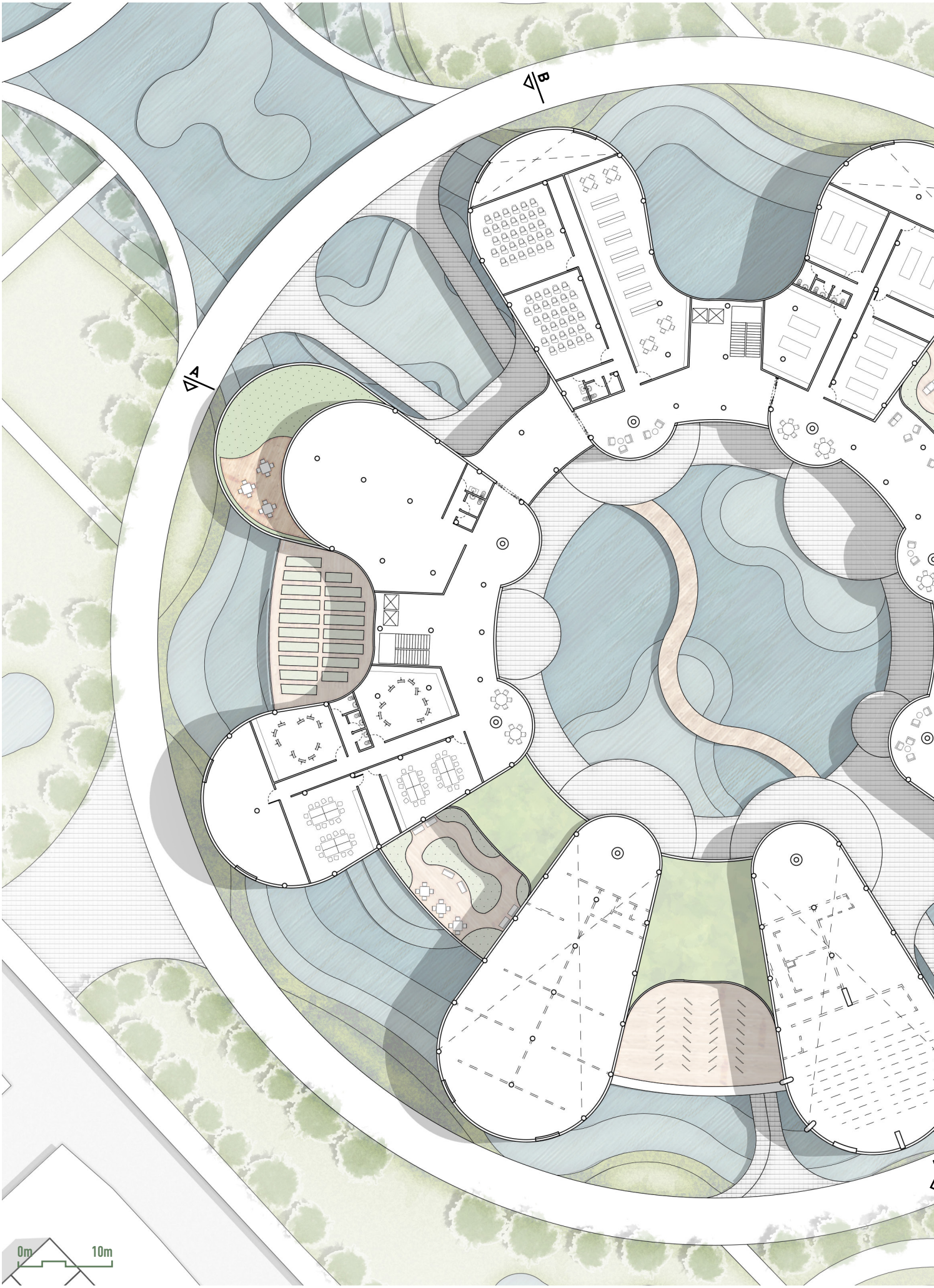
The building is arranged radially to favor its compatibility with the public space of the park, which is governed by the circumferences. Its relationship with the wetland is made evident by allowing its uninterrupted passage through the project site and by creating an internal courtyard for its contemplation.

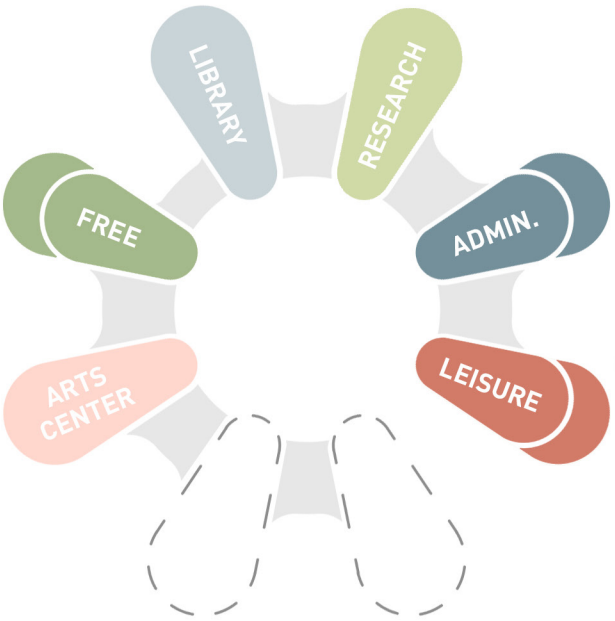

A
B
0m
10m

Groundfloor Plan



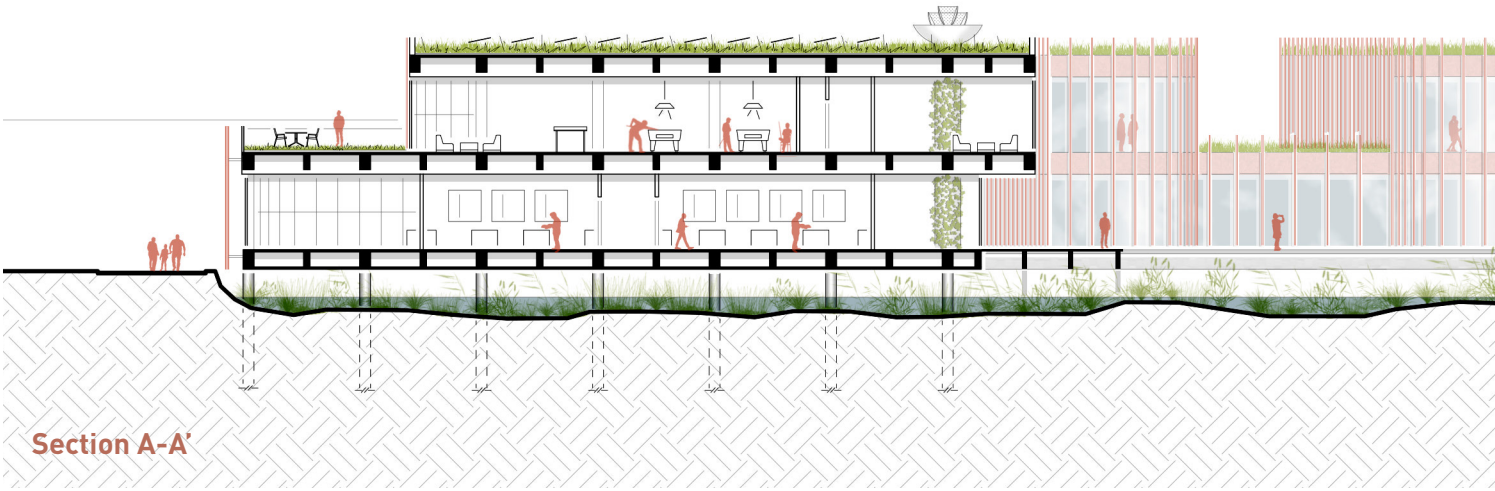
Structural system


A
B
0m
10m

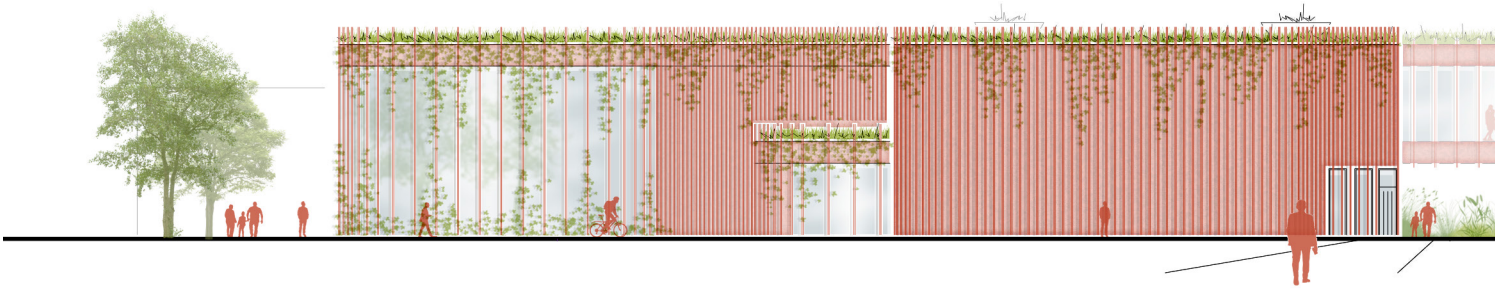


Second floor Plan

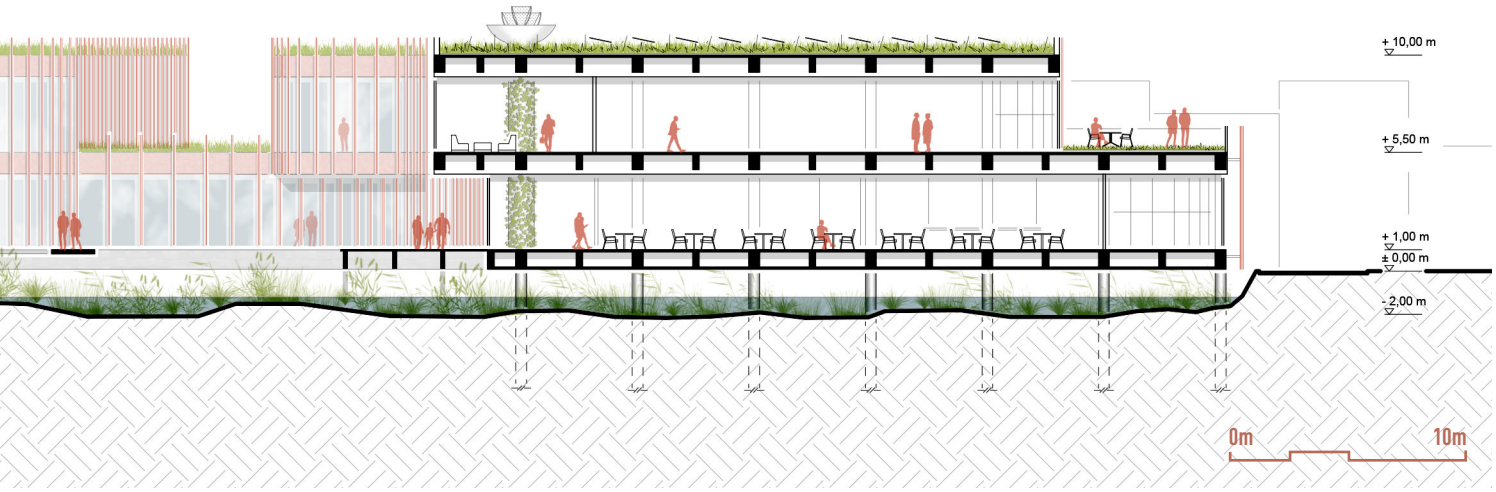
The building divides its program into different petals that communicate with each other through a wide and luminous corridor in constant relationship with the wetland. This creates the opportunity to have views to different areas of the natural environment, either inside the courtyard of the project or towards the exterior context. Along the corridor there are overhangs that form recreational spaces with a pleasant view of the natural environment. The internal arrangement of the petals favors the natural lighting and ventilation of all the spaces, reducing the energy impact of the project and creating a sense of wellbeing for the users. In addition, the presence of green terraces gives the opportunity for relaxation spaces during the day.



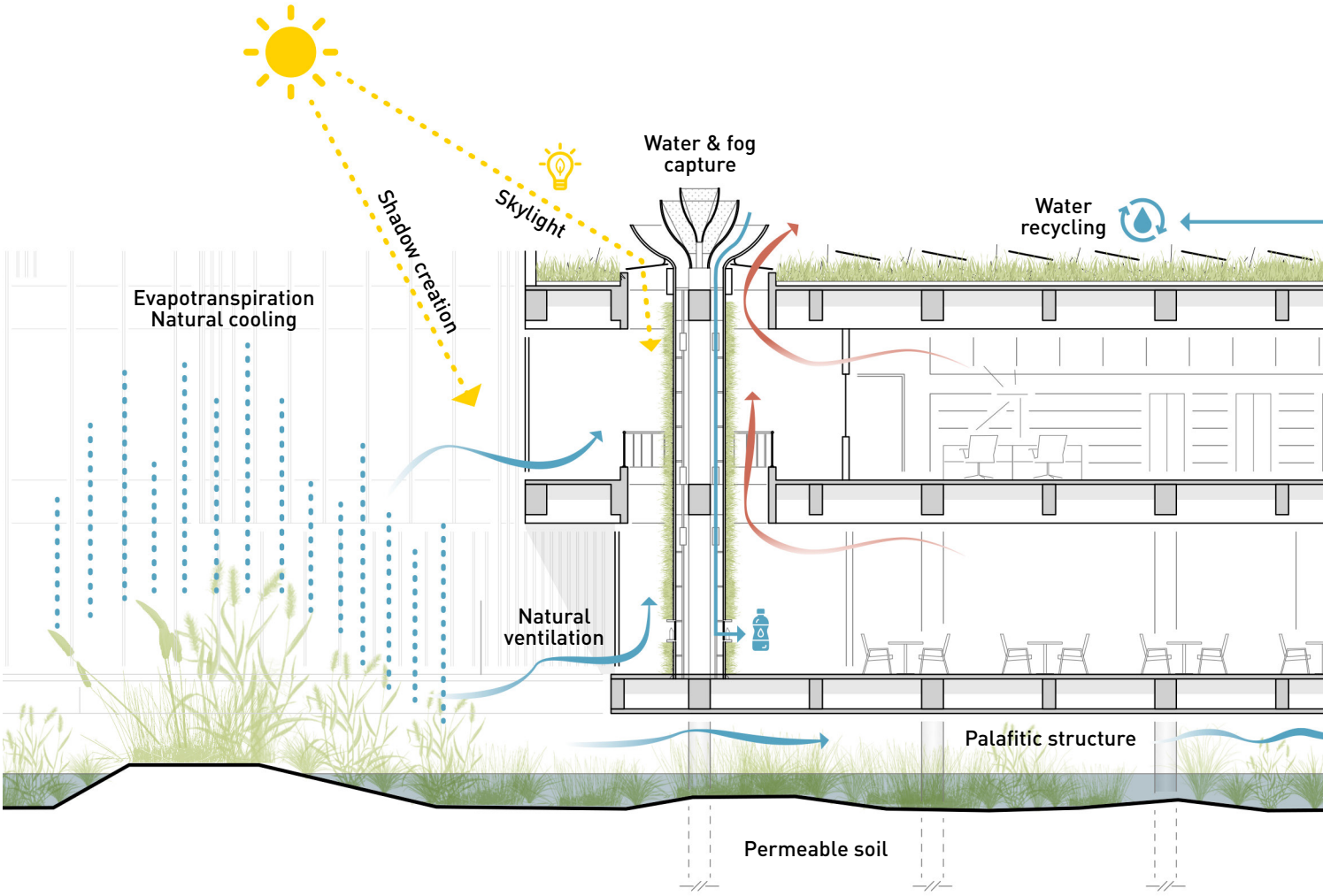
Section A-A'



Southeast elevation


+ 10,00 m
+ 5,50 m
+ 1,00 m
± 0,00 m
- 2,00 m
0m
10m

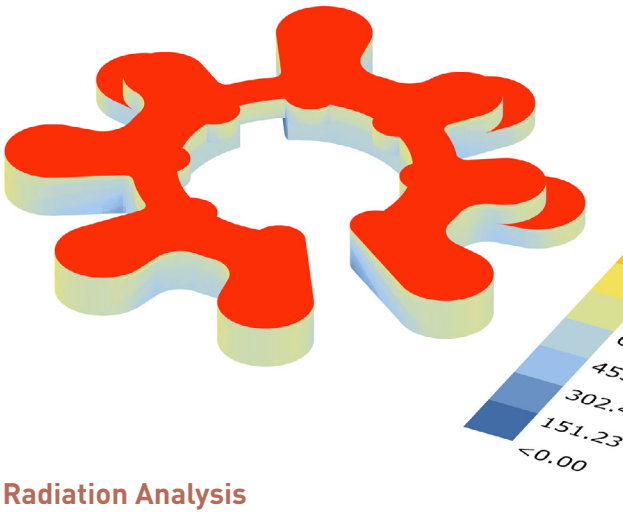

+ 9,00 m
+ 4,50 m
± 0,00 m
- 3,20 m



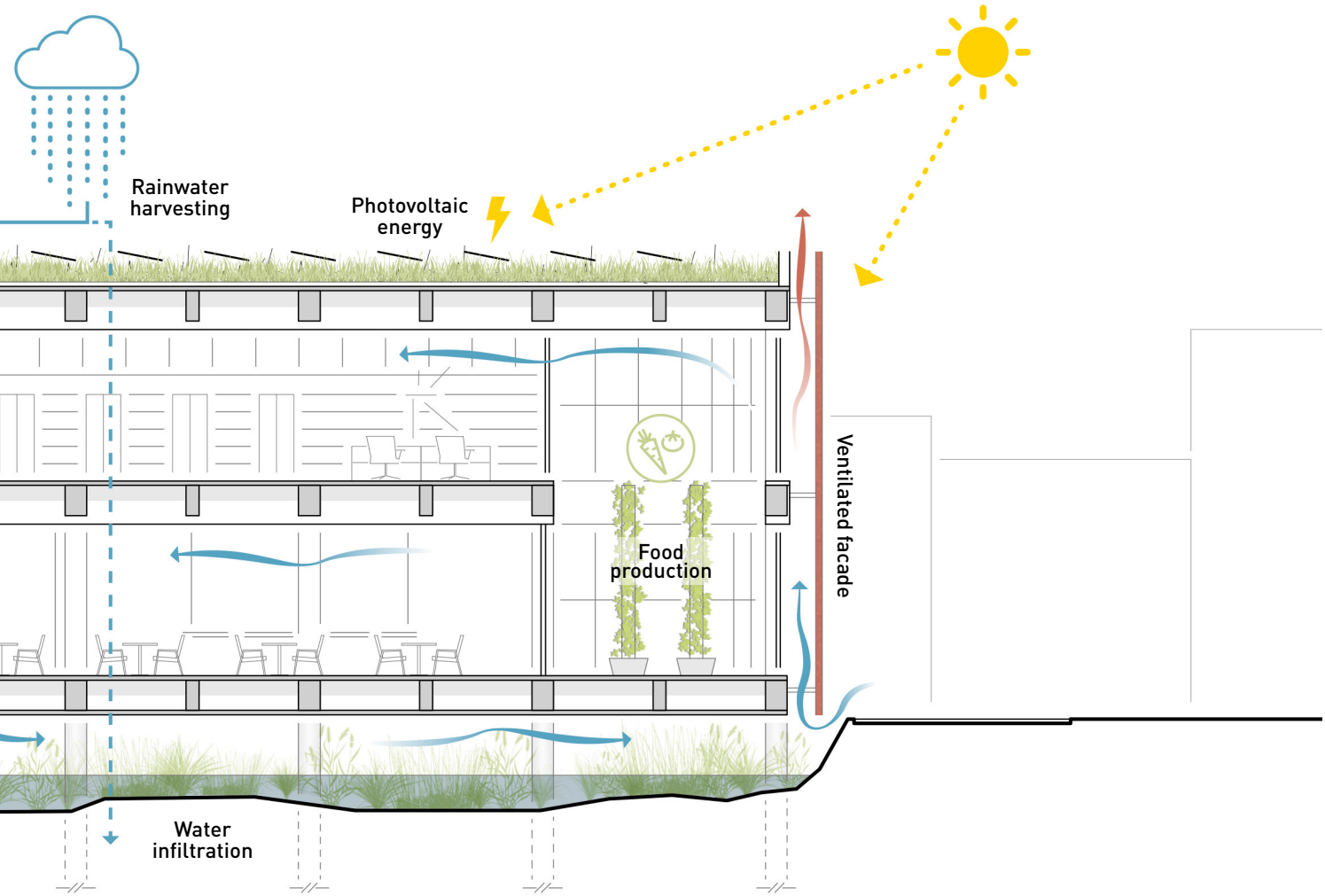
Environmental strategies

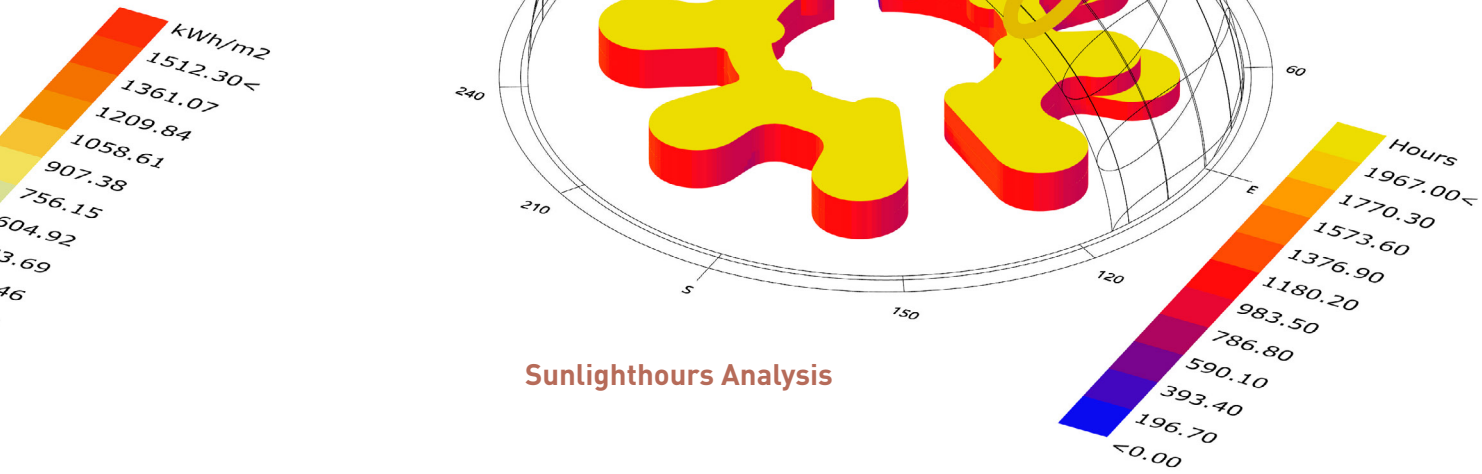
The project seeks to have a **holistic approach** to sustainable environmental performance. To this end, it uses **nature based solutions** and others through construction technology.

In the first place, importance is given to the ***natural ventilation*** of the building, creating currents that allow the exchange of air. In order to reduce heat gain and control the insulation of the project, the building has a ***ventilated facade*** and a ***vegetated roof*** in response to the strong radiation received in Bogota. In terms of water management, the project has a ***bioreactor membrane system*** that allows it to capture and recycle rainwater and utility water. In addition, it ***reduces runoff by allowing water to infiltrate into the ground*** thanks to its palafitic structure. Through the ***¨Frailejón¨ columns***, the project also captures rainwater and fog to filter it and make it ***drinkable***. The generation of clean energy is done through ***photovoltaic panels*** and ***skylights*** that reduce energy costs and allow the growth of ***biotic walls***. Finally, the project ***supports biodiversity*** and environmental resilience by allowing the wetland to expand without interfering with its dynamics, favoring ***evapotranspiration and cooling of the urban environment***.

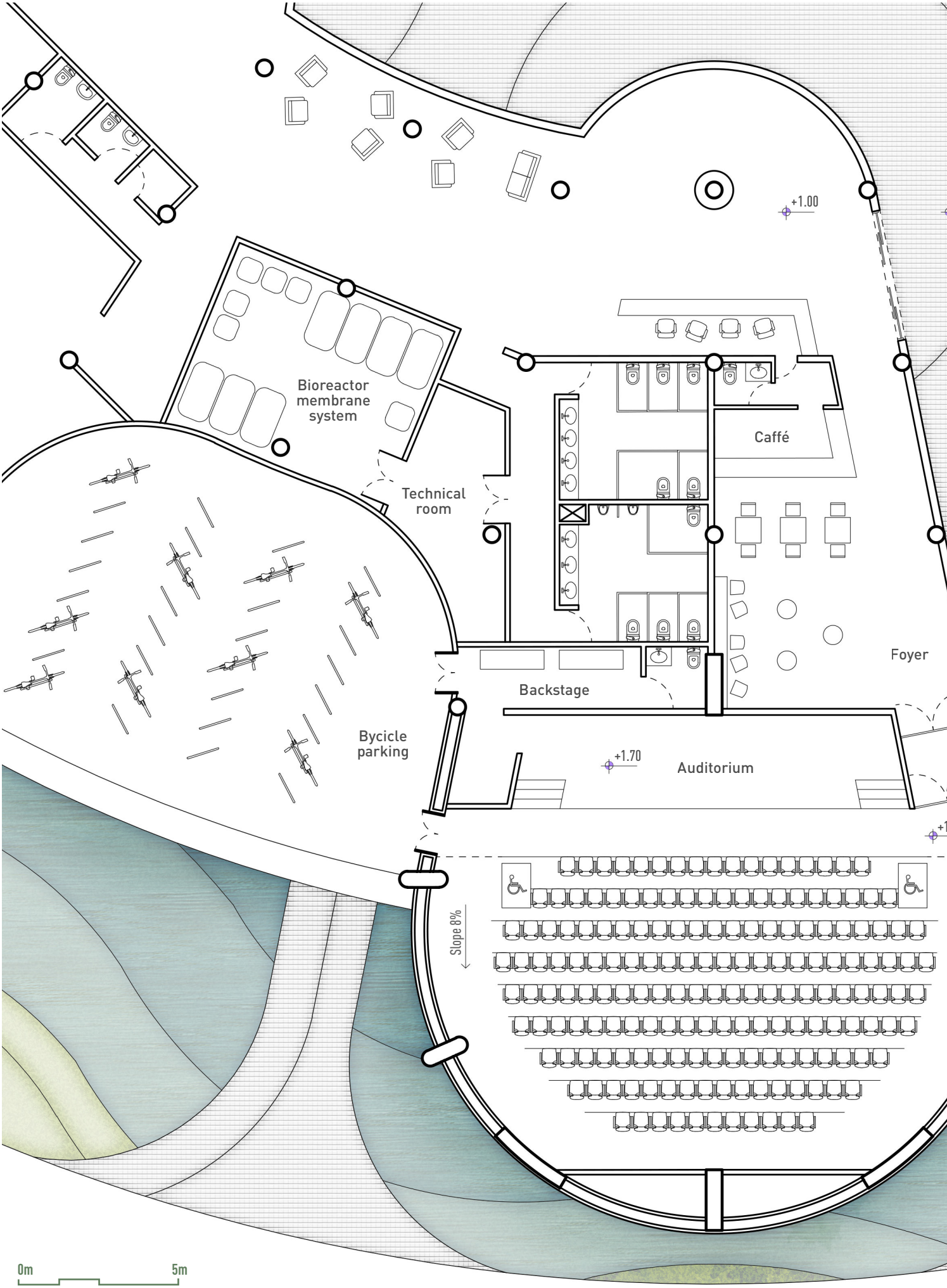


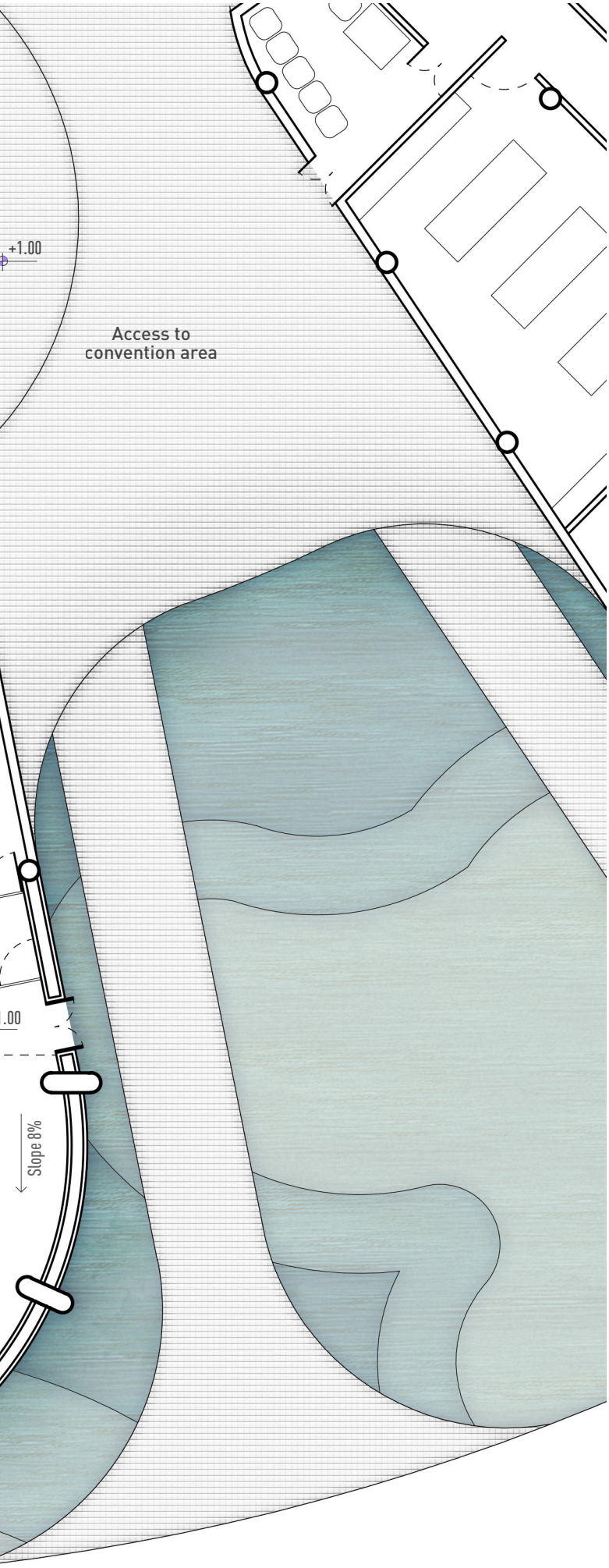
Radiation Analysis
1 Jan 9:00 - 31 Dec 17:00

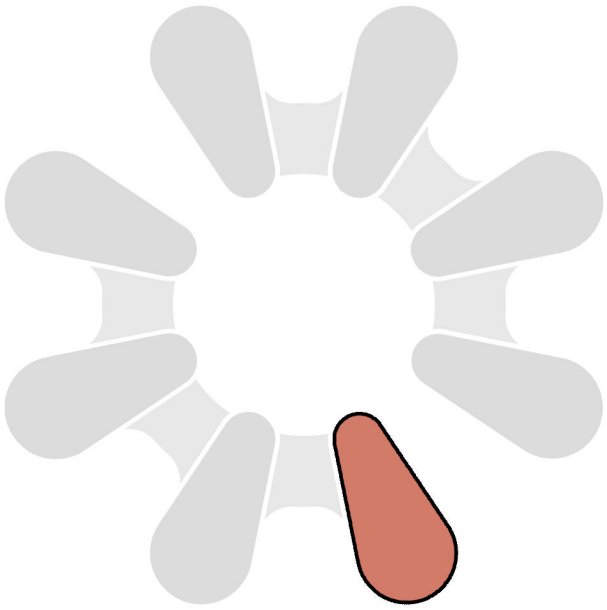




Sunlighthours Analysis


+1.00
Bioreactor membrane system
Technical room
Caffé
Foyer
Backstage
Bycicle parking
+1.70
Auditorium
Slope 8%
0m
5m

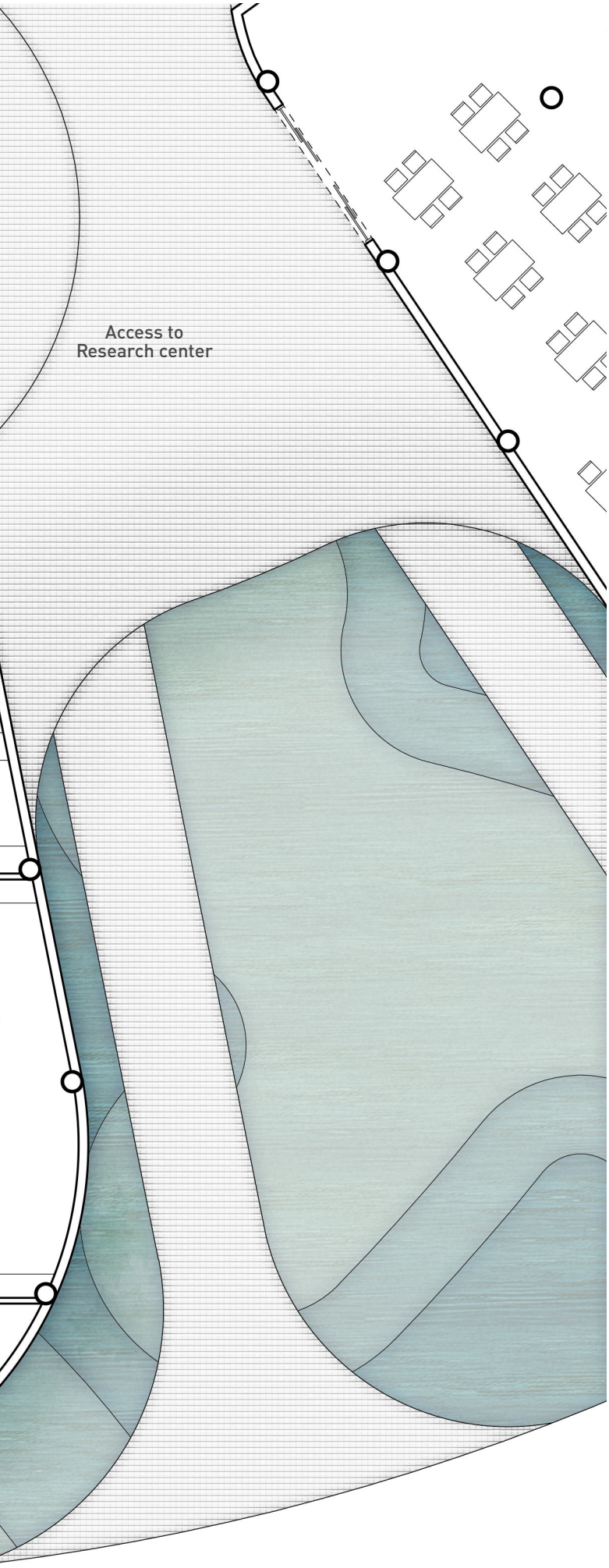


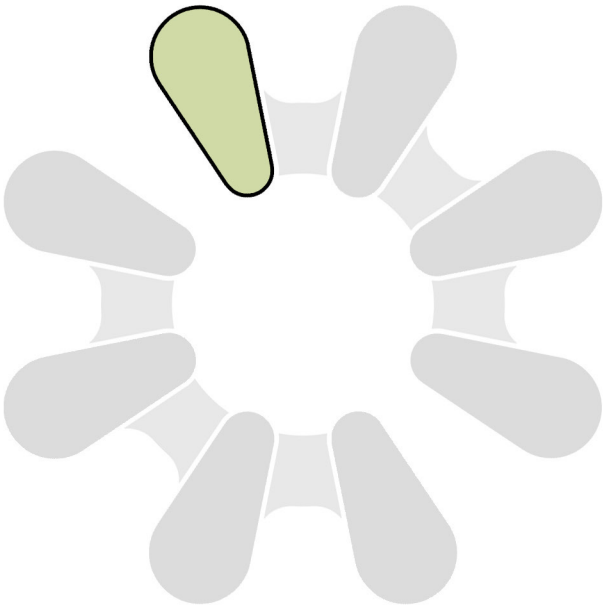


Convention area

- Lobby = 80 m^2
- Caffè = 35,5 m^2
- Foyer = 40 m^2
- Auditorium = 252 m^2
- Restrooms = 50 m^2
- Technical Room & Bioreactor membrane system = 67 m^2
- Bycicle parking = 160 m^2 / 32 spots


Lobby
Media library
Seminar's room
Edu Lab
Experimental
Greenhouse
0m
5m

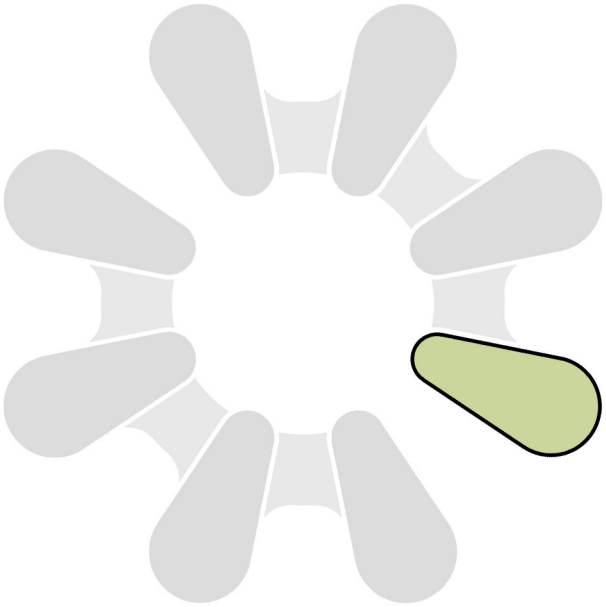




Academic area

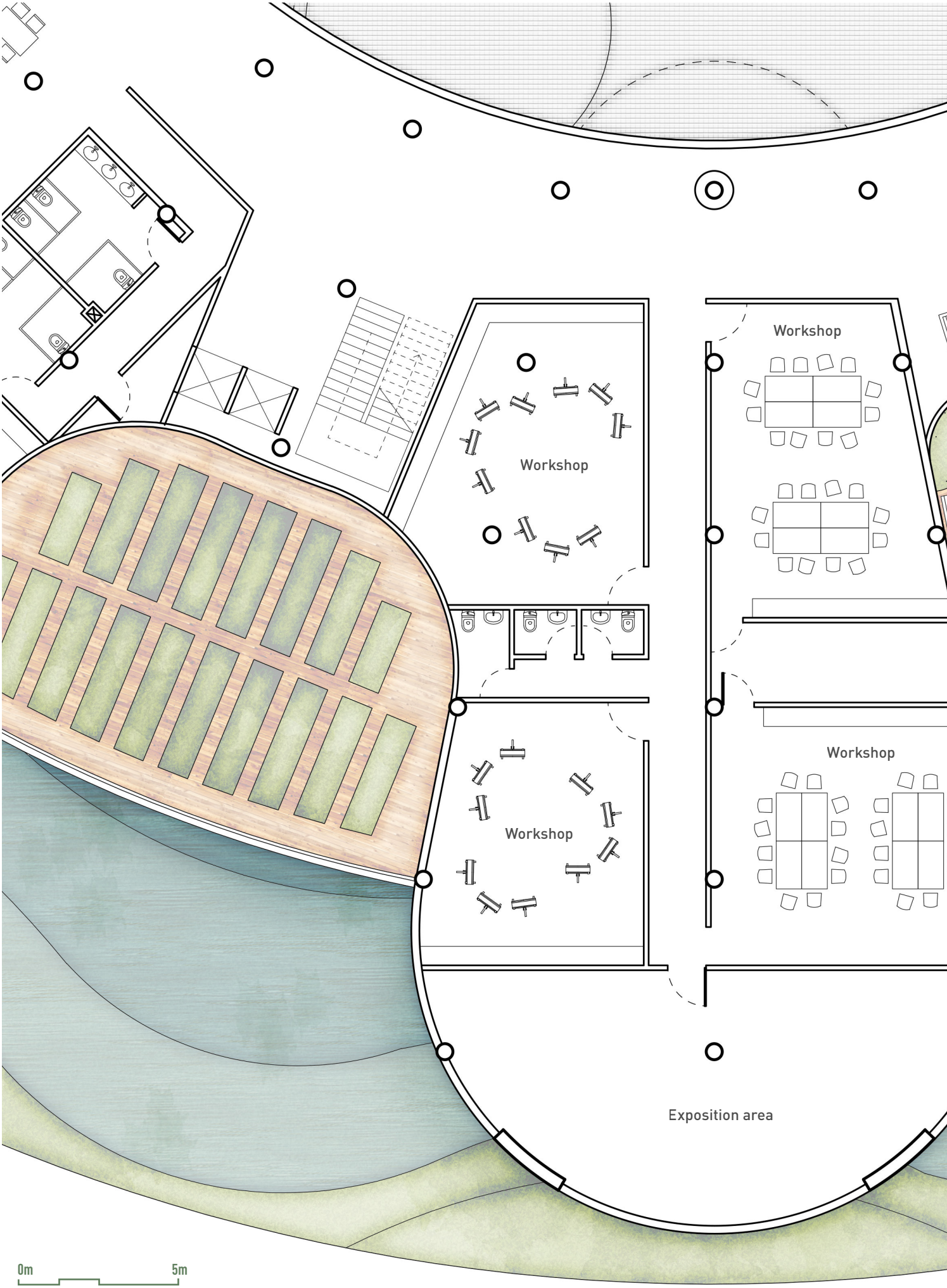
- Lobby = 74 m^2
- Media Library = 48 m^2
- Edu Lab = 66 m^2
- Seminar's room = 90 m^2
- Restrooms = 37 m^2
- Experimental Greenhouse = 94 m^2
- Technical rooms = 20 m^2

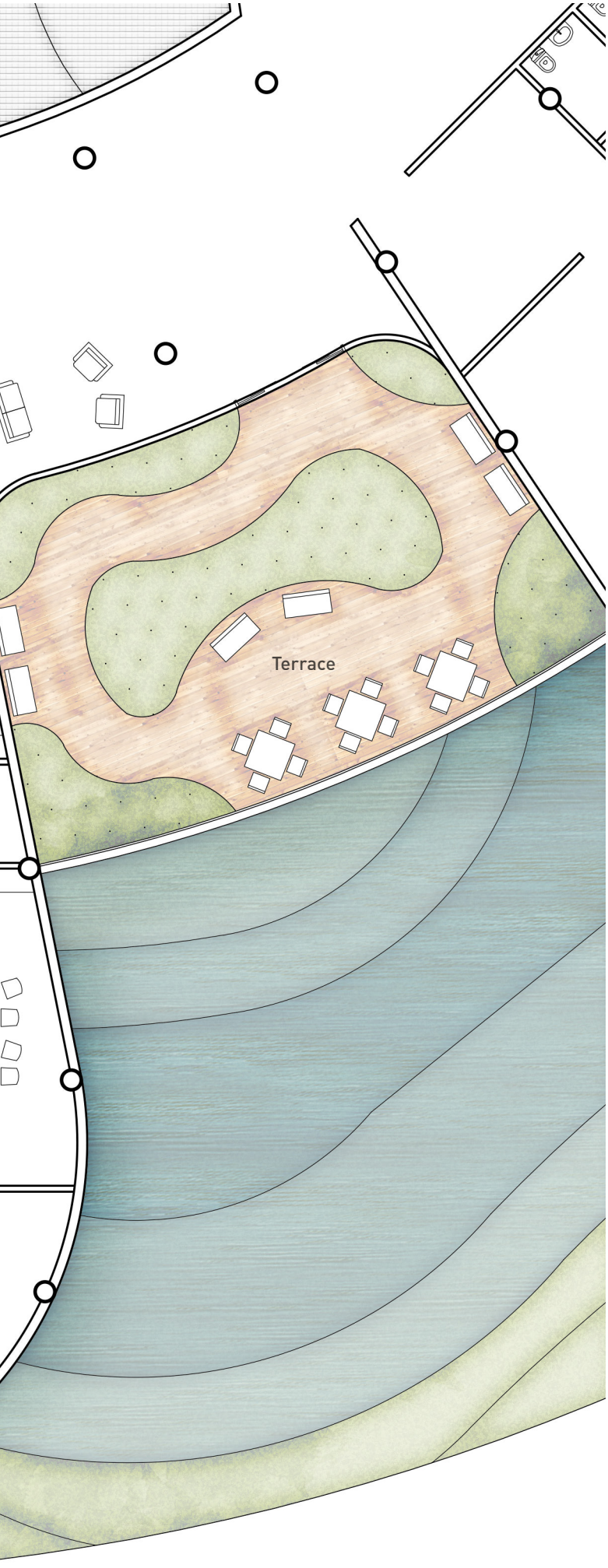

Waste room
Limnology Laboratory
Water Dynmics Laboratory
Deposit
Limnology Laboratory
Water Dynmics Laboratory
Water Purification Laboratory
0m
5m

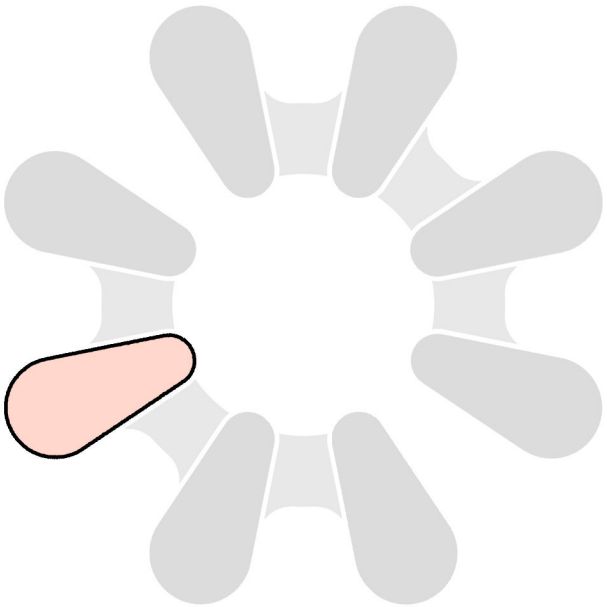


Laboratories area floor type

- Lab 1 = 65 m^2
- Lab 2 = 72 m^2
- Lab 3 = 64 m^2
- Lab 4 = 55 m^2
- Lab 5 (corner) = 112 m^2
- Restrooms = 12 m^2
- Waste room = 18 m^2
- Deposit = 20 m^2


Workshop
Workshop
Workshop
Workshop
Exposition area
0m
5m

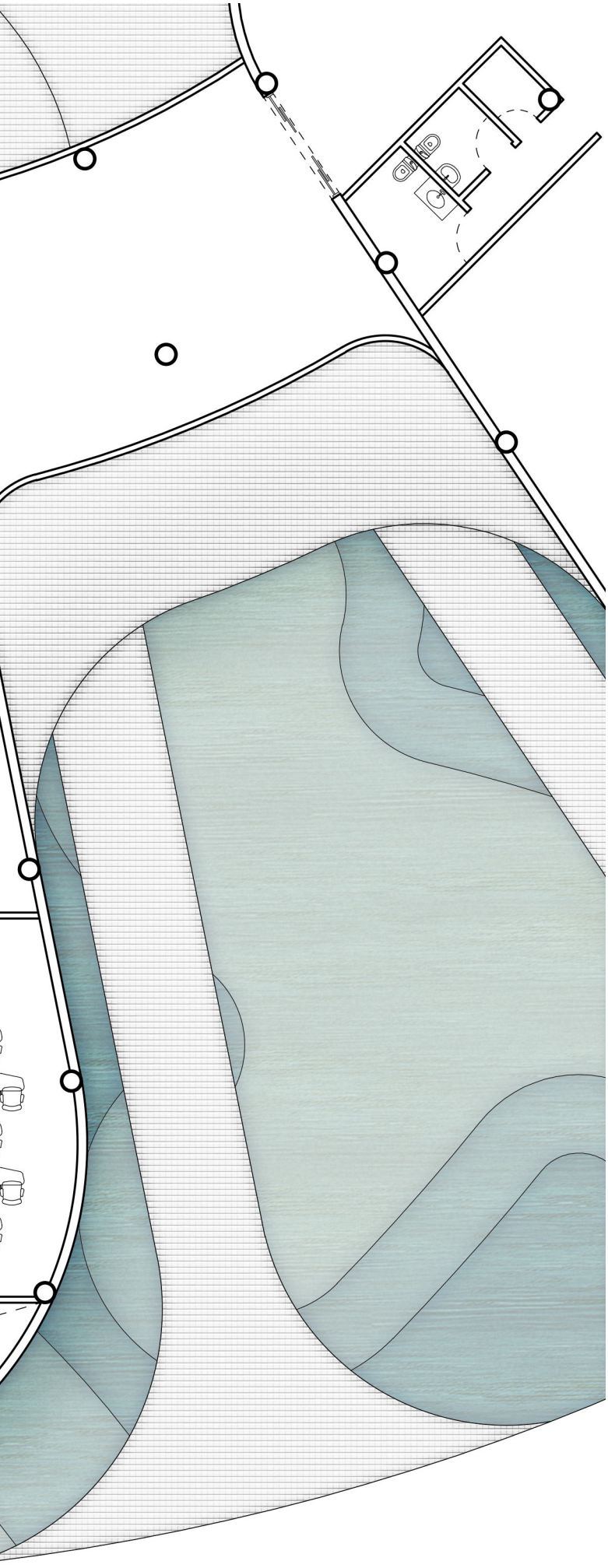


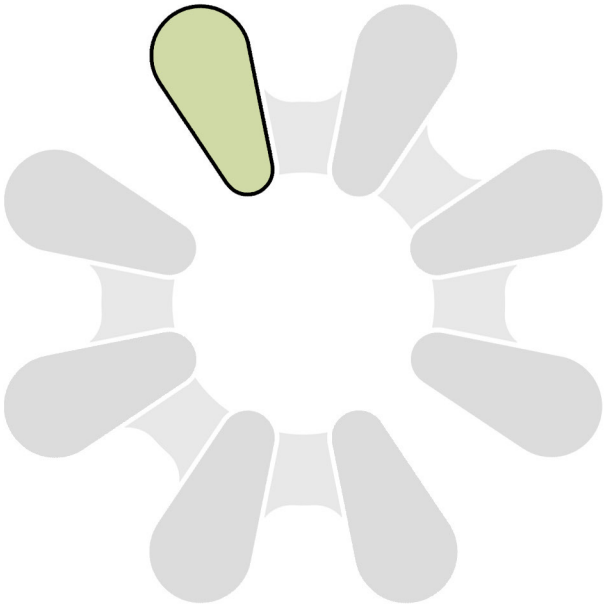


Arts area

- Workshop 1 = 65 m^2
- Workshop 2 = 72 m^2
- Workshop 3 = 64 m^2
- Workshop 4 = 55 m^2
- Exposition area = 112 m^2
- Restrooms = 12 m^2
- Waste room = 18 m^2
- Deposit = 20 m^2

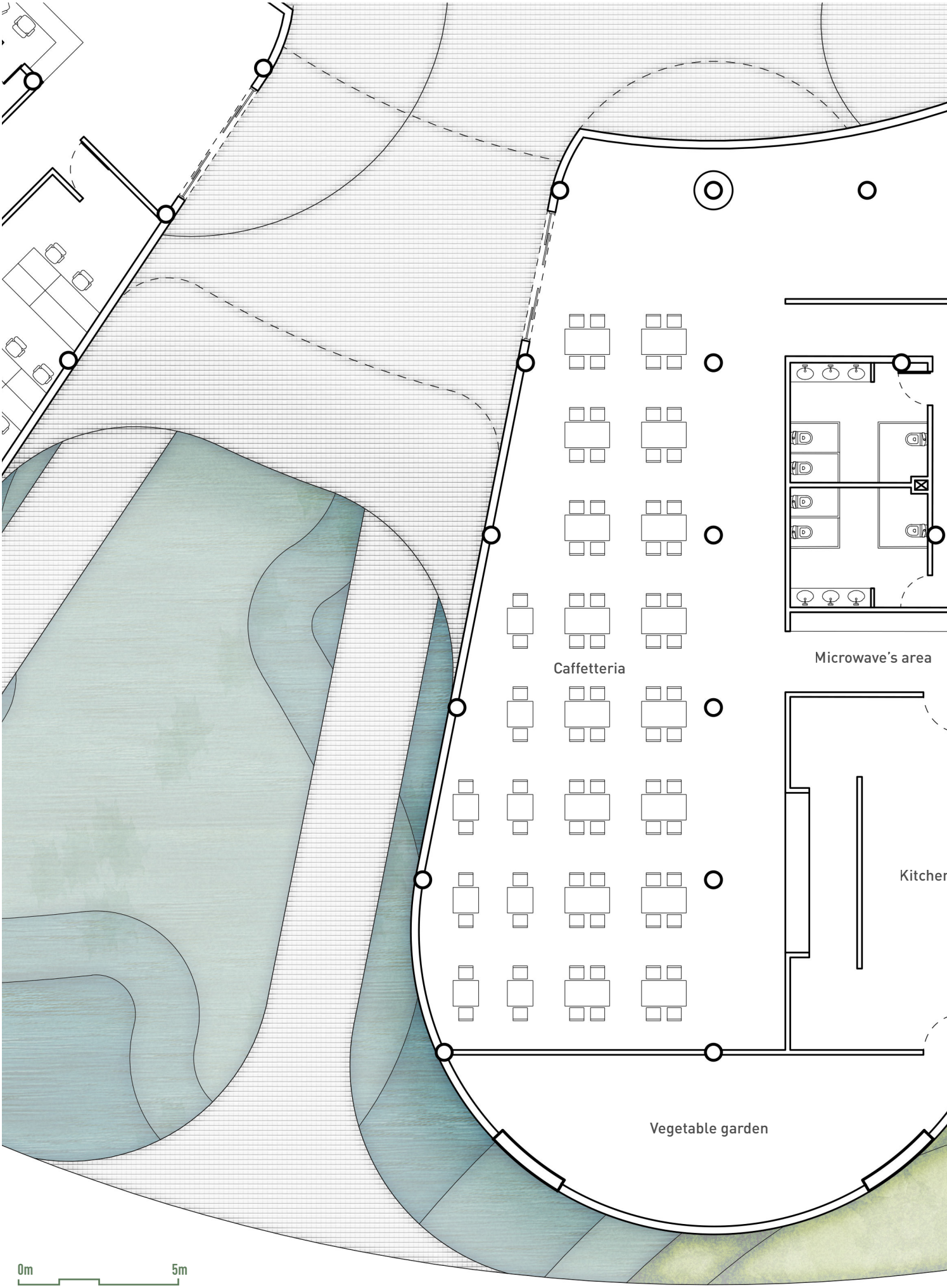

Seminar's room
Library
Seminar's room
0m
5m

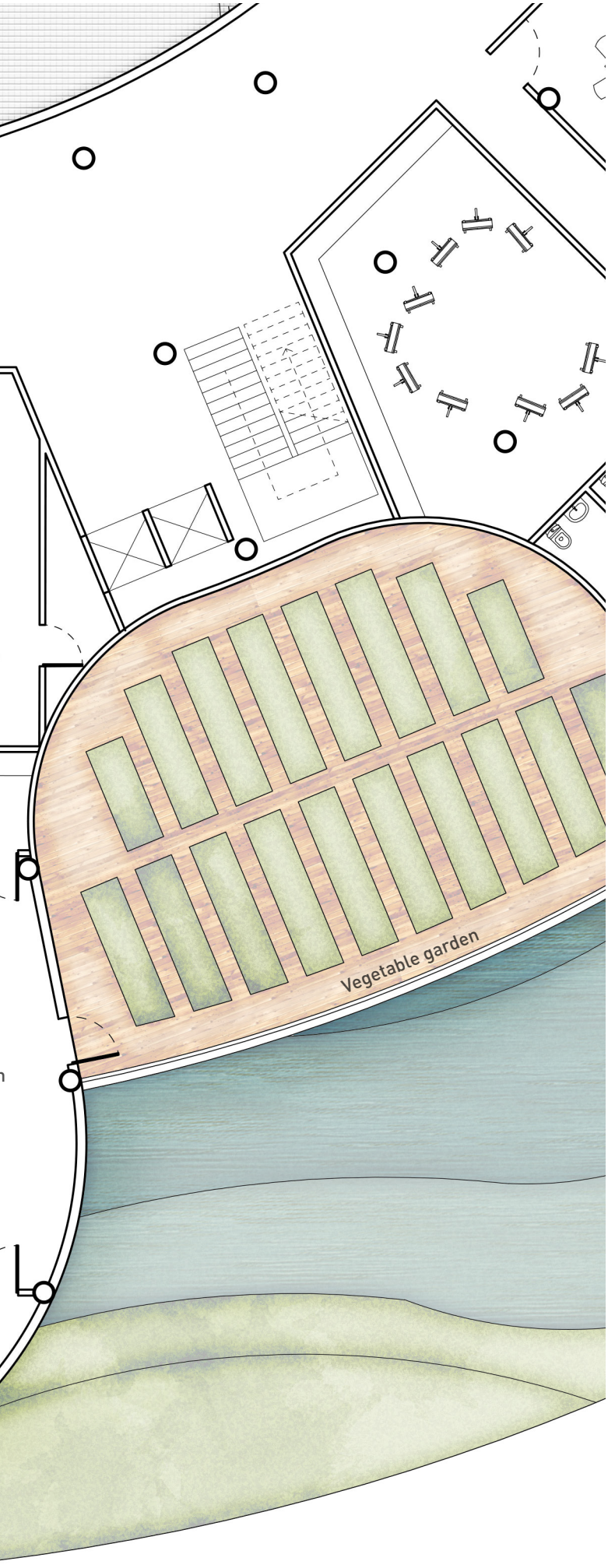


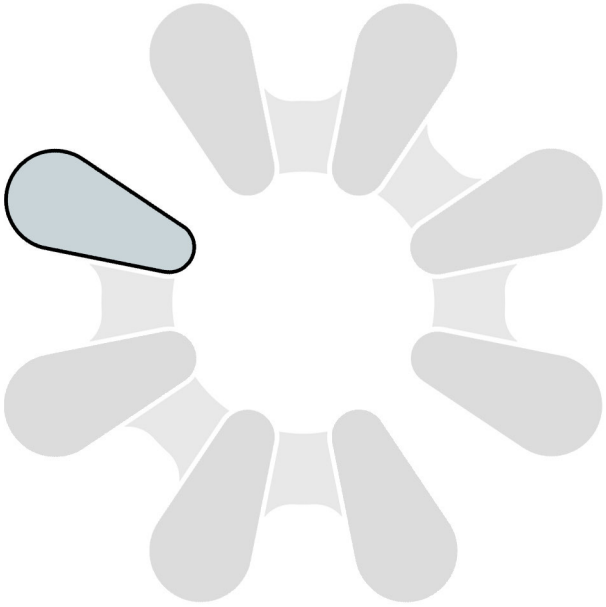


Library area

- Seminar's room 1 = 75 m^2
- Seminar's room 2 = 86 m^2
- Library = 154 m^2
- Restrooms = 12 m^2
- Deposit = 3 m^2

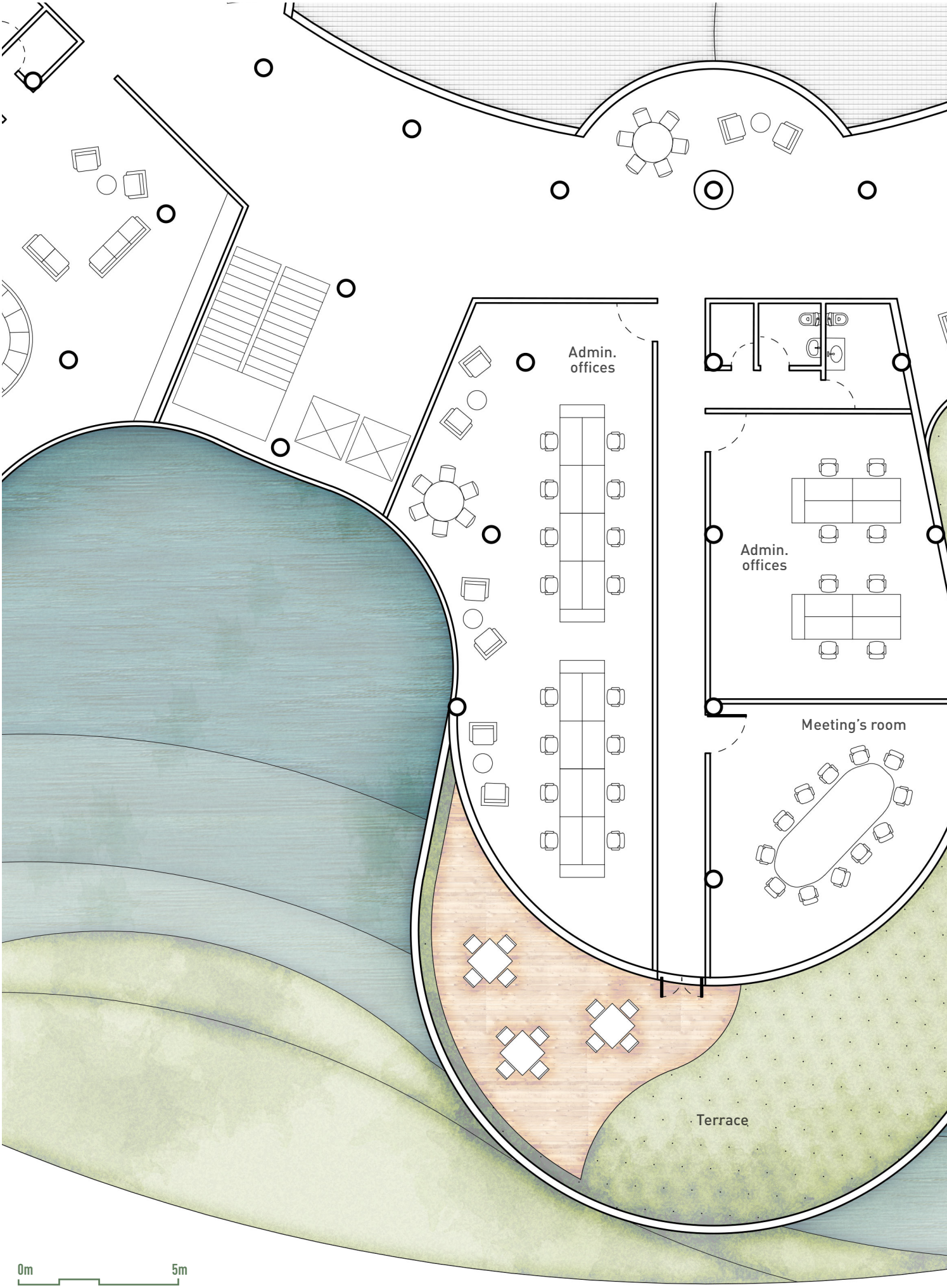

Caffetteria
Microwave's area
Kitcher
Vegetable garden
0m
5m

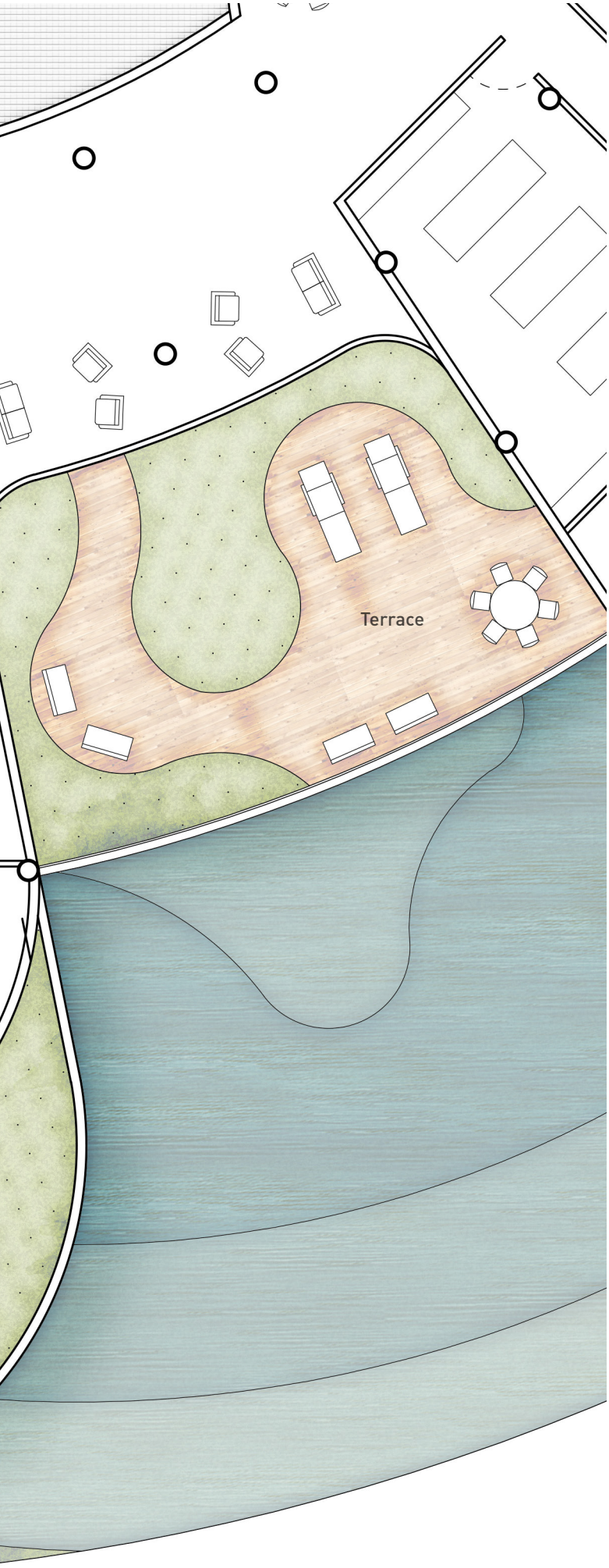


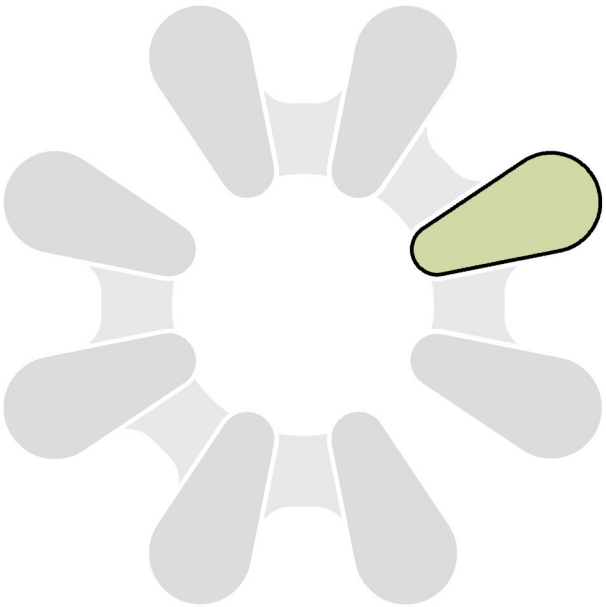


Caffetteria area

- Caffetteria = 180 m^2
- Kitchen = 70,3 m^2
- Vegetable garden = 65 m^2
- Restrooms = 33 m^2
- Exterior vegetable garden = 160 m^2

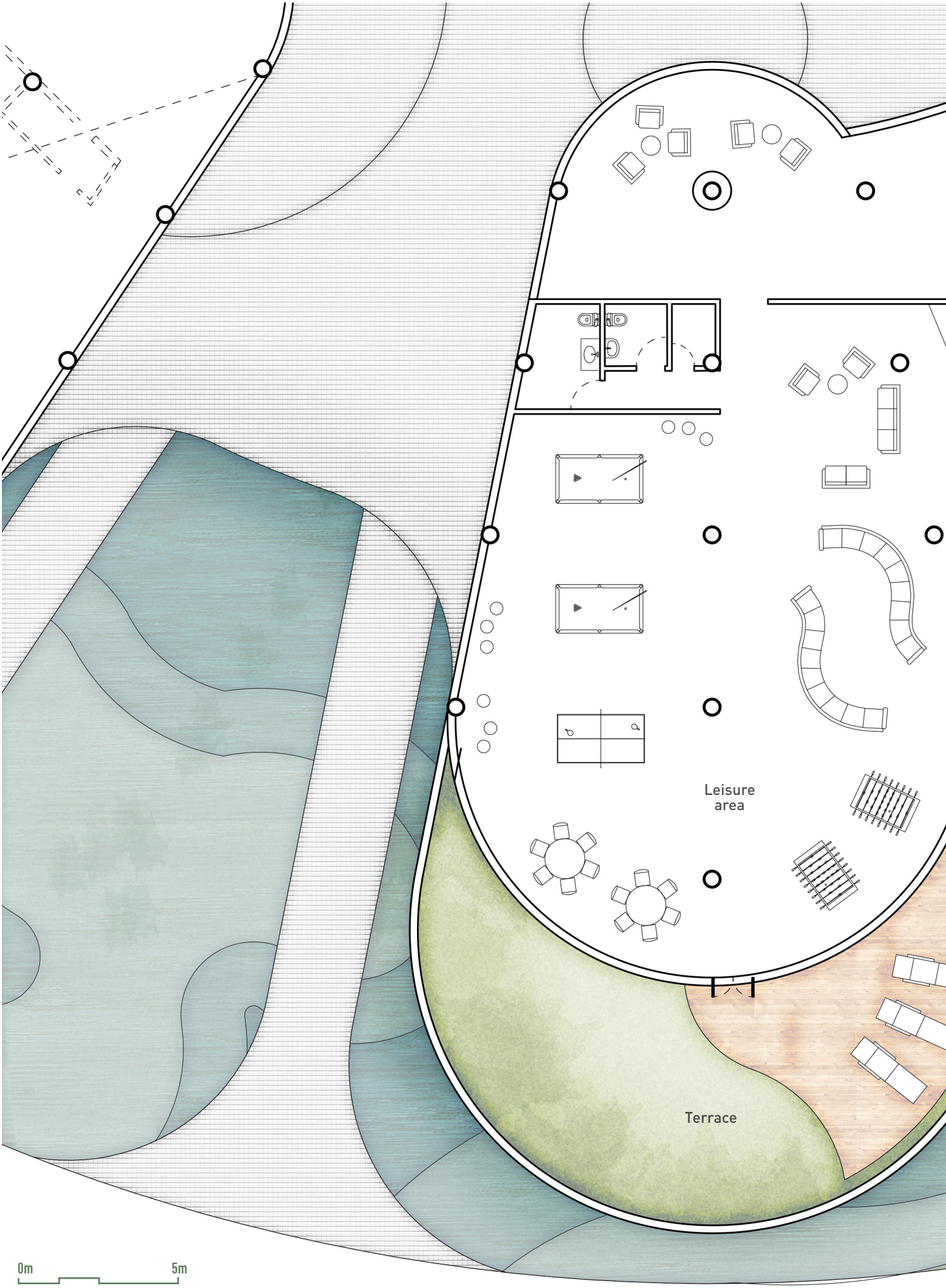

Admin.
offices
Admin.
offices
Meeting's room
Terrace
0m
5m

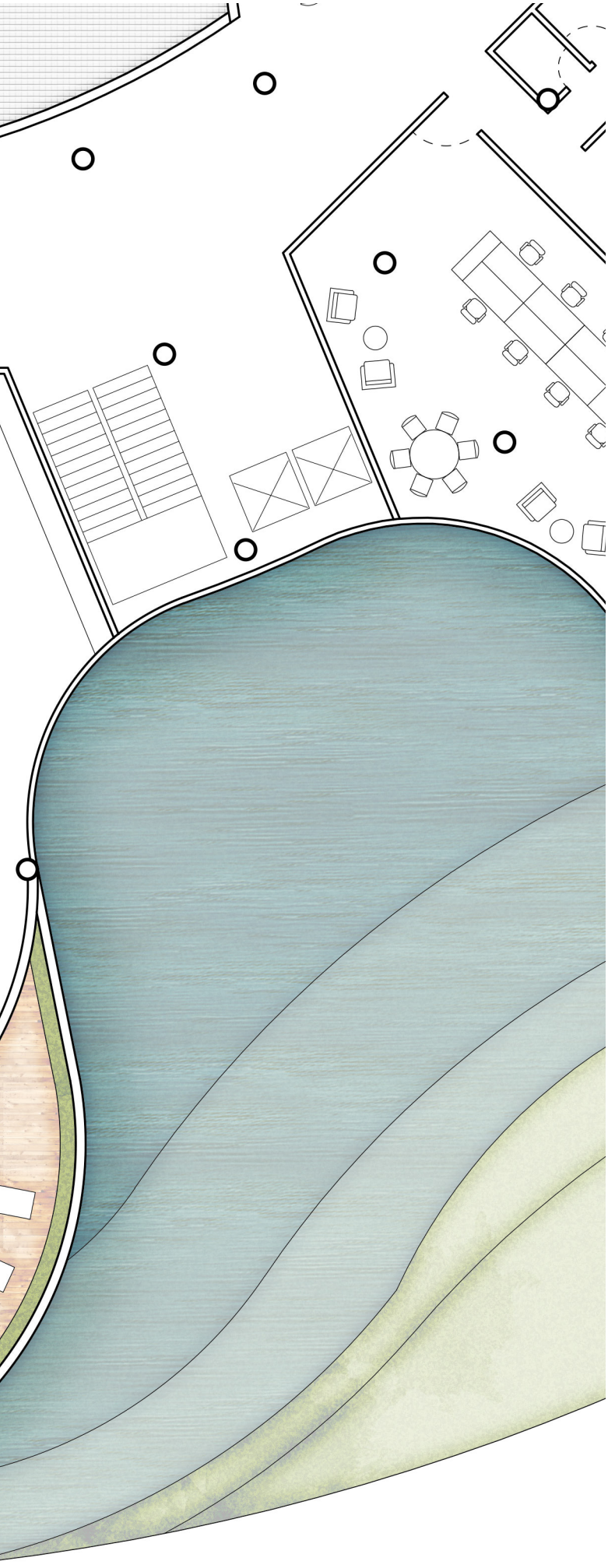


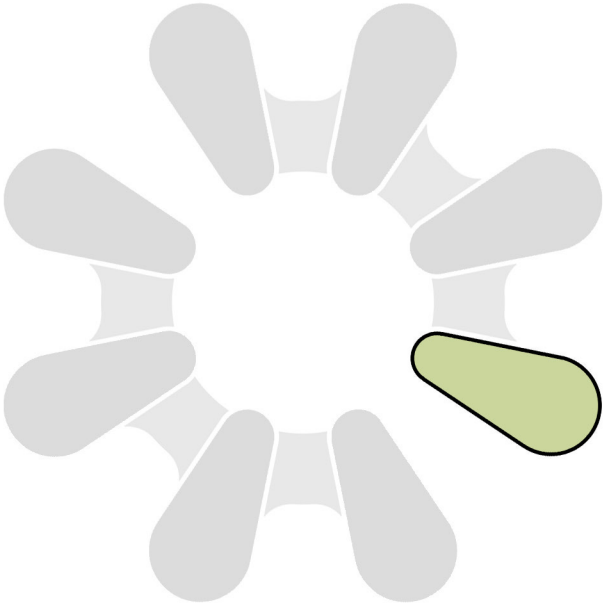


Administration area

- Admin. office (long) = 125 m^2
- Admin. office (short) = 65 m^2
- Meeting's room = 59 m^2
- Restrooms = 12 m^2
- Terrace = 141 m^2

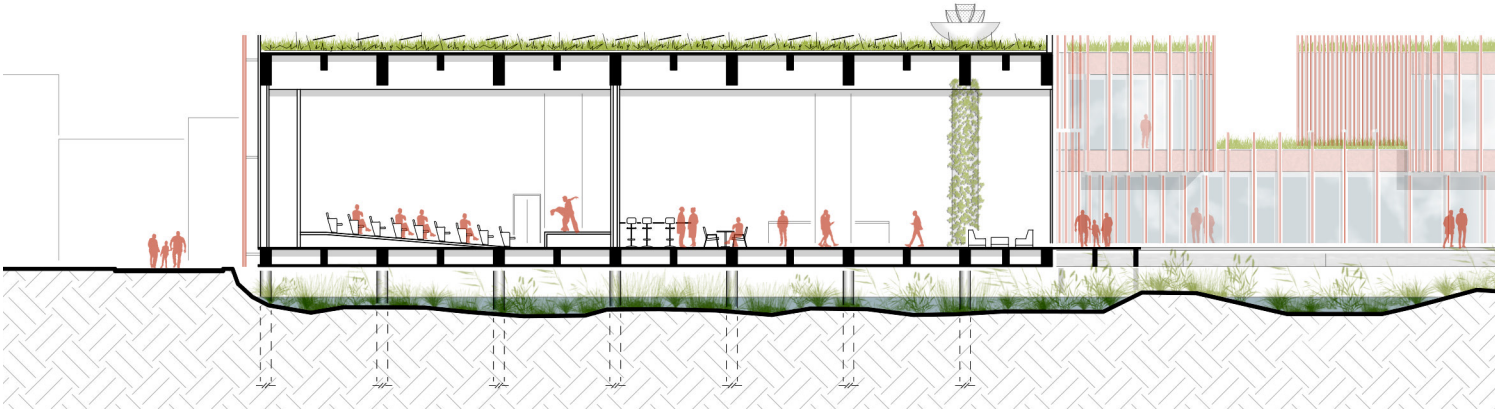

Leisure
area
Terrace
0m
5m



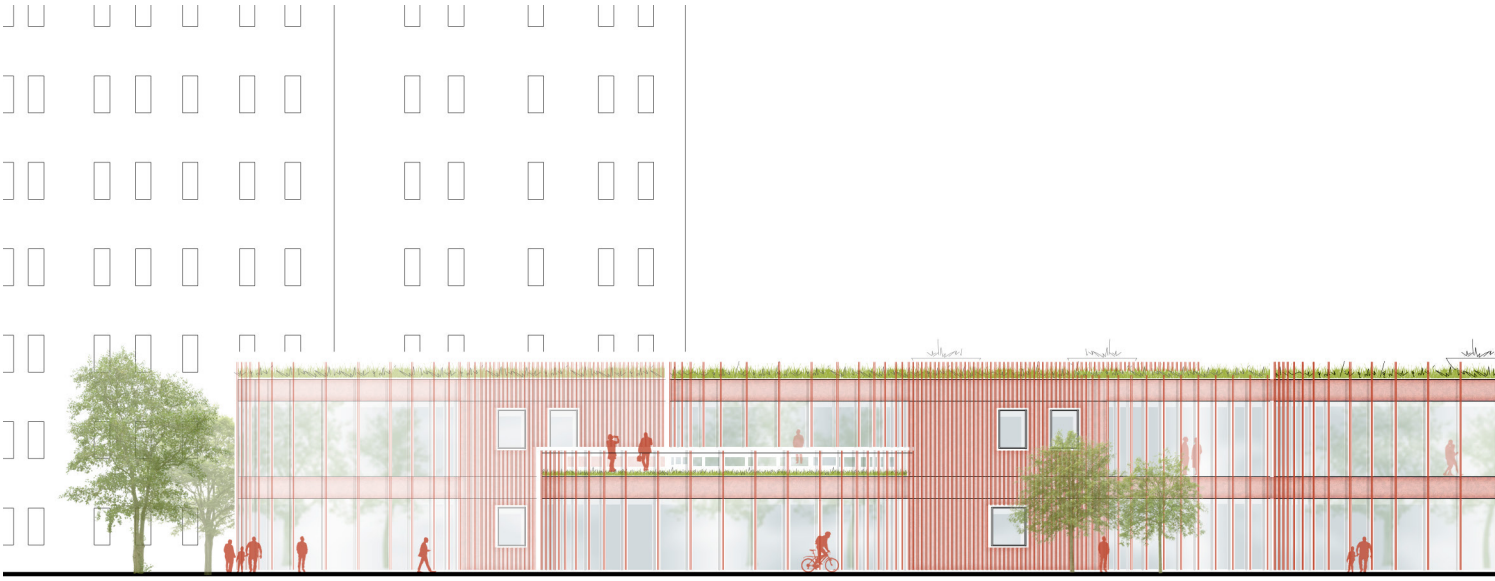


Leisure area

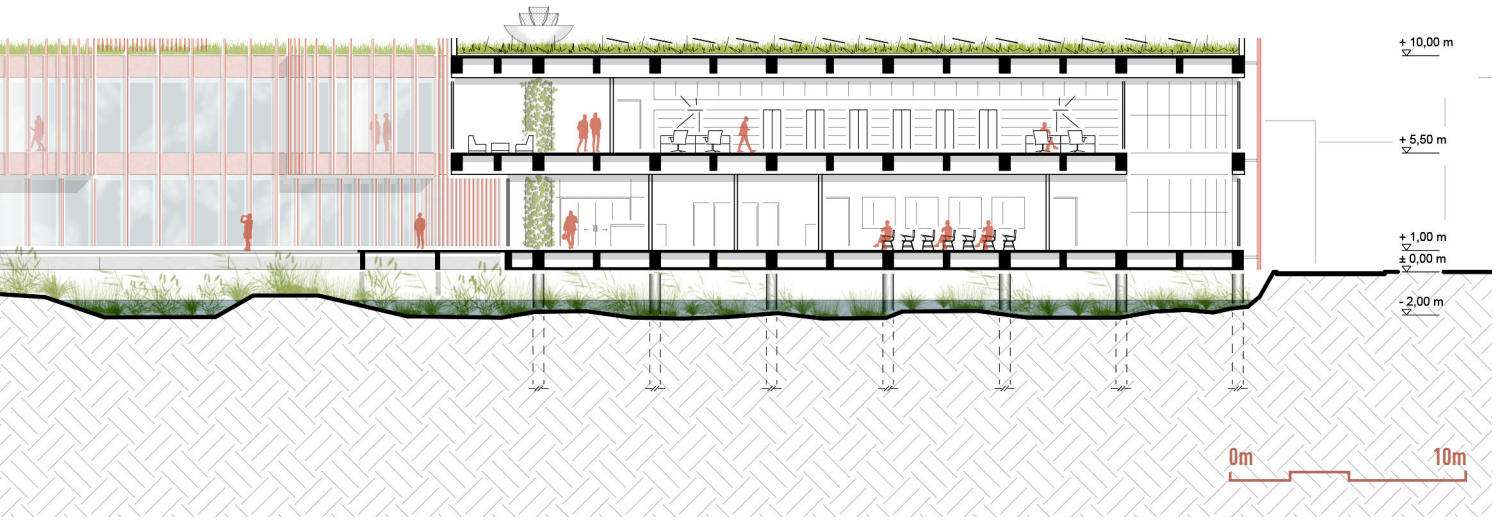
- Admin. office (long) = 125 m^2
- Deposit = 3 m^2
- Restrooms = 12 m^2
- Terrace = 141 m^2

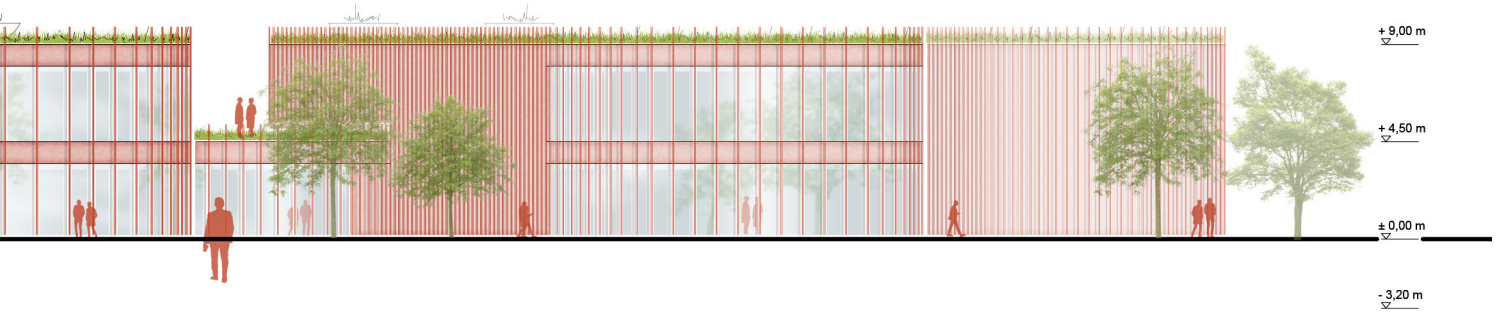


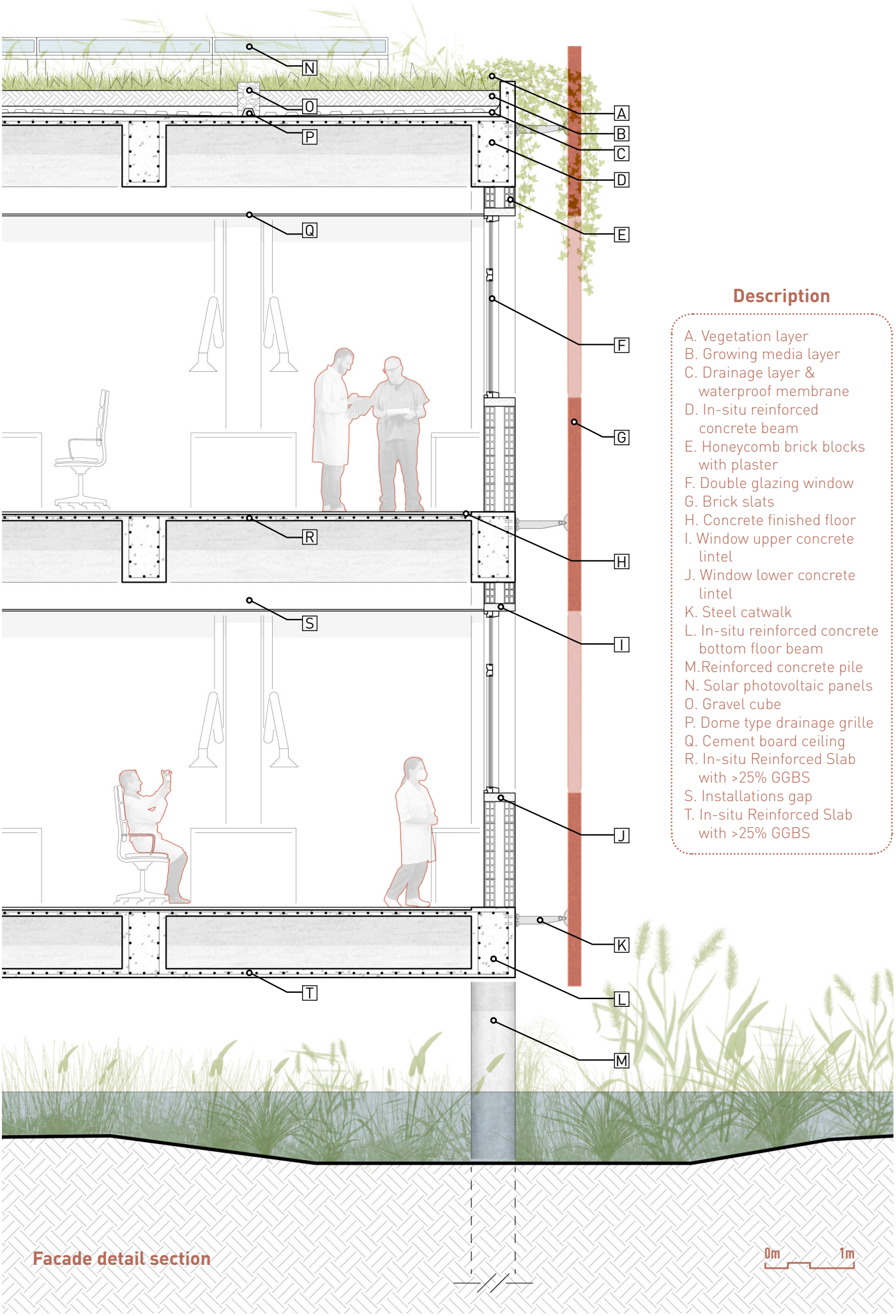
Section B-B'



Southwest elevation


+ 10,00 m
+ 5,50 m
+ 1,00 m
± 0,00 m
- 2,00 m
0m
10m

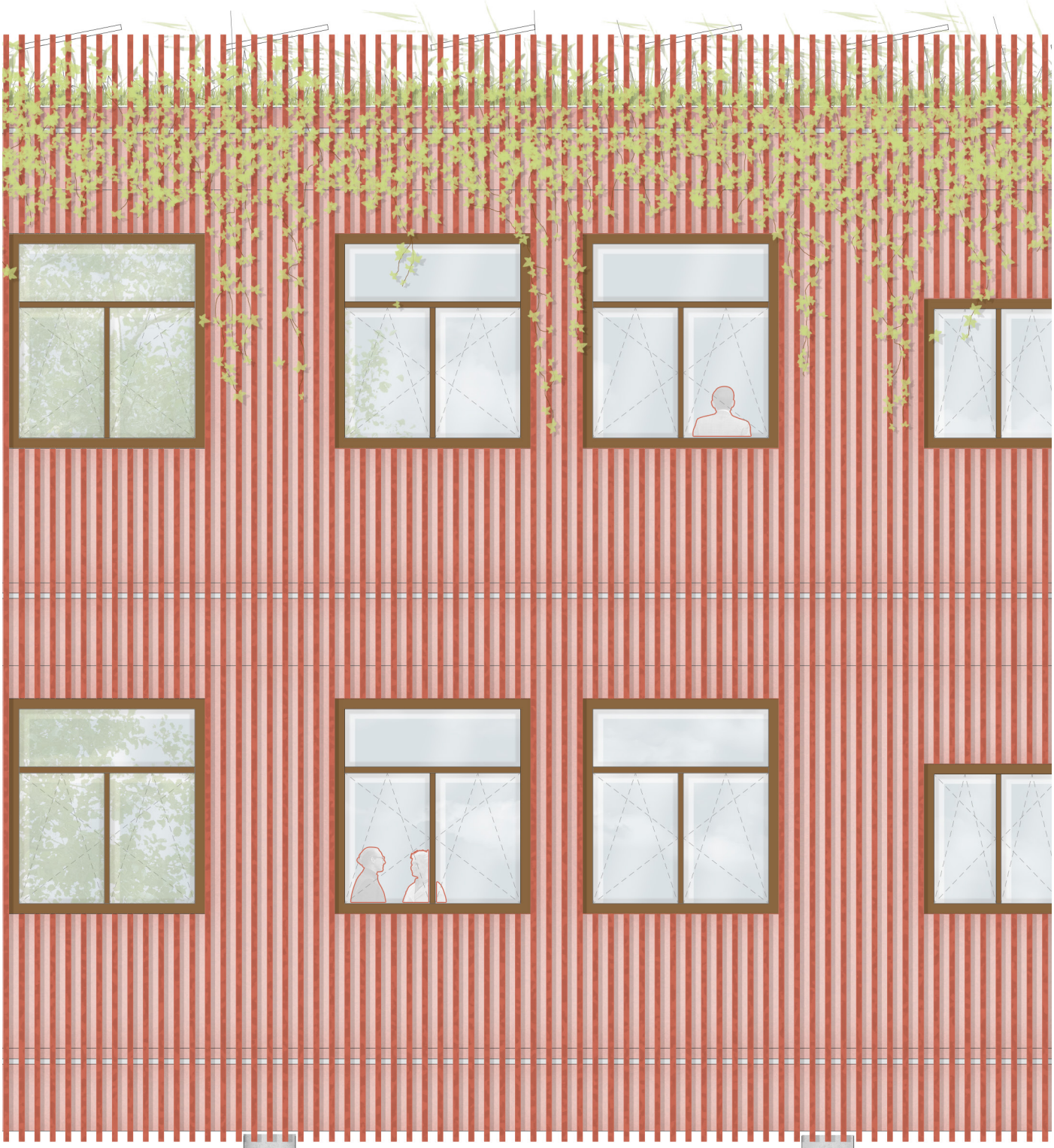

+ 9,00 m
+ 4,50 m
± 0,00 m
- 3,20 m



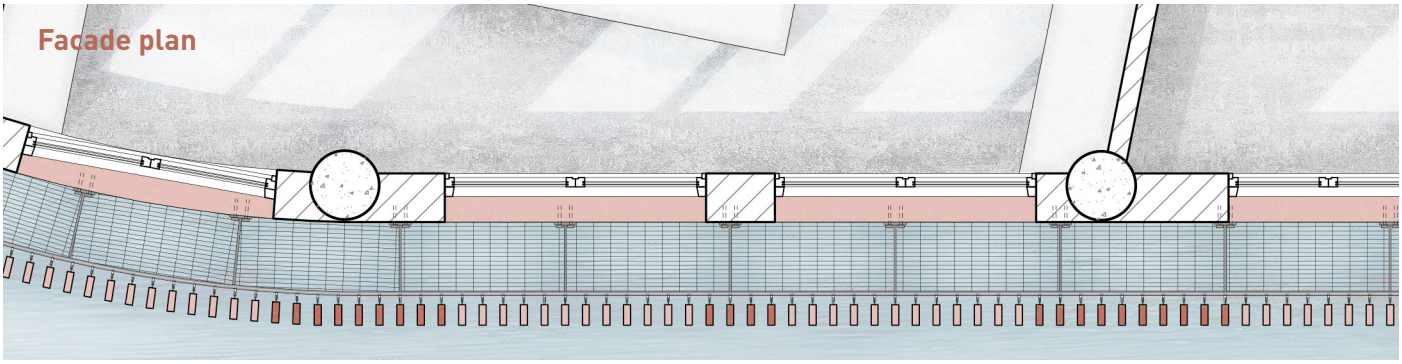
Description

A. Vegetation layer
B. Growing media layer
C. Drainage layer & waterproof membrane
D. In-situ reinforced concrete beam
E. Honeycomb brick blocks with plaster
F. Double glazing window
G. Brick slats
H. Concrete finished floor
I. Window upper concrete lintel
J. Window lower concrete lintel
K. Steel catwalk
L. In-situ reinforced concrete bottom floor beam
M.Reinforced concrete pile
N. Solar photovoltaic panels
O. Gravel cube
P. Dome type drainage grille
Q. Cement board ceiling
R. In-situ Reinforced Slab with >25% GGBS
S. Installations gap
T. In-situ Reinforced Slab with >25% GGBS

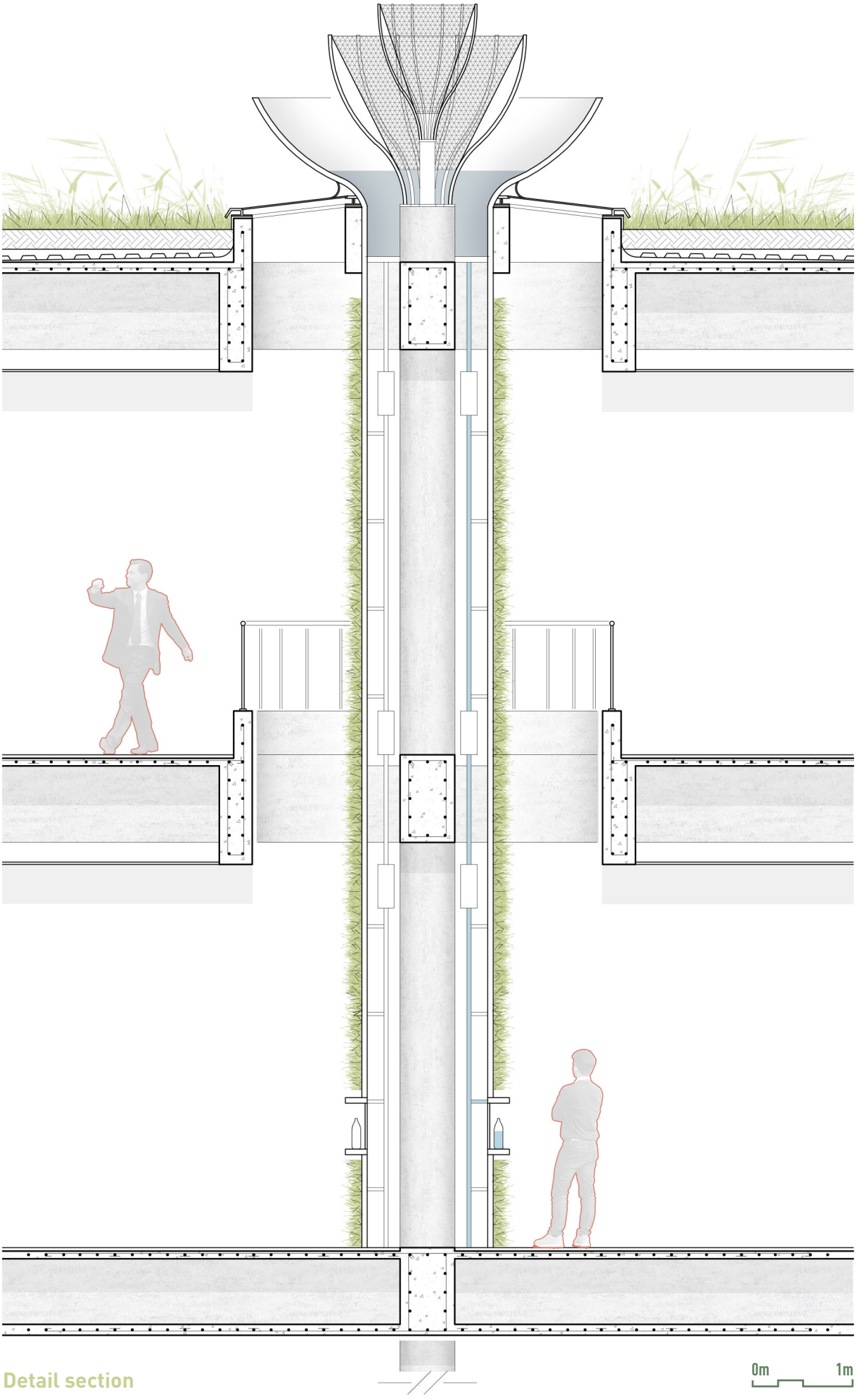
Facade detail section



Facade elevation



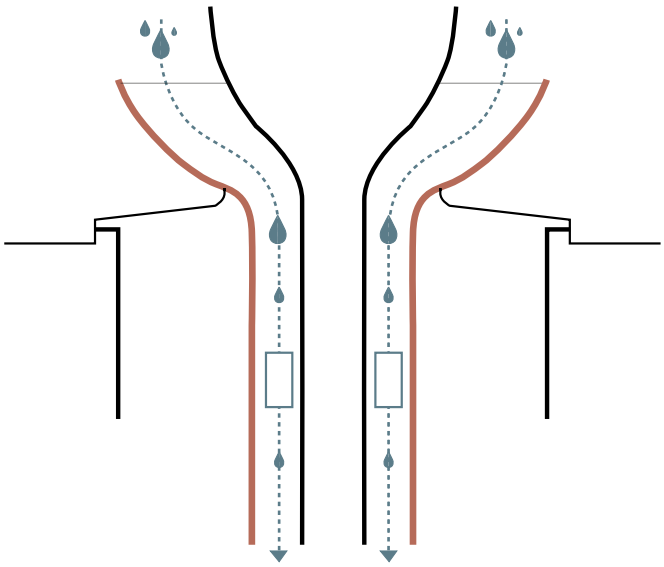
Facade plan



Detail section

The "Frailejon" column

Illus. 70.

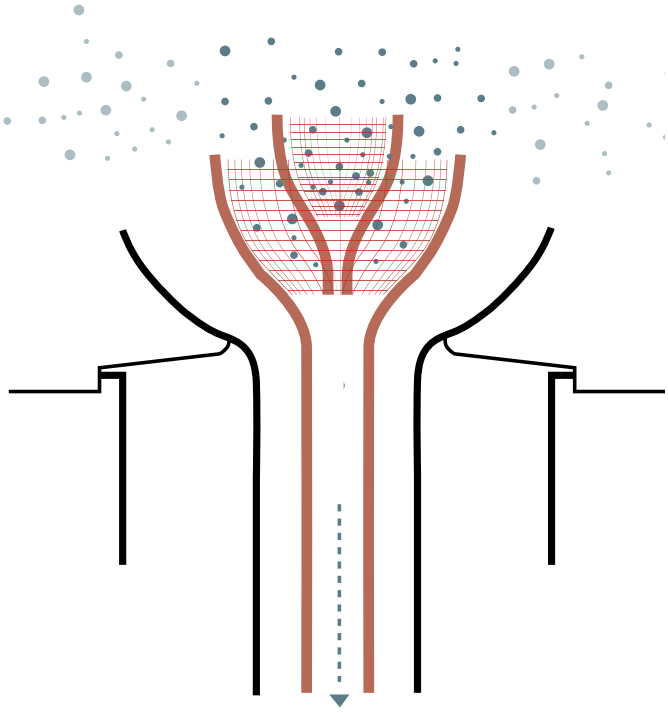


Rain water capturing

Biomimicry explanation

The "Frailejon" is a species of plant found in the thermal floors of the sub-paramo and paramo of Colombia, Venezuela and Ecuador. The largest paramo in the world is located near Bogota, the paramo of Sumapaz. The Frailejon fulfills a fundamental function in the ecosystem and it is to absorb the humidity of the fog to store it and to purify it, to the point of making it drinkable. It has leaves with dense hairiness organized in rosette to trap the fog and channel the water to its trunk (Mi Señal Colombia, 2022).

The Frailejon column is an exercise in biomimicry that aims to add the capacity of the building structure to participate in the production of ecosystem services. Therefore, it proposes a technological solution to the production of drinking water inspired by the endemic plant. To do so, it captures uncontaminated rainwater and then performs a multiple filtering process to make it drinkable for users on the second floor of the building and at the same time nourish the vertical garden that covers the column. In addition, it takes advantage of the foggy conditions in the early mornings of Bogota to absorb moisture through a mesh that allows its condensation and also redirect it to the trunk and purify it.



Fog absorption by condensation

Eco-productivity evaluation

Eco-productive architecture is that which is capable of **generating ecosystem services** in an integral way that allows a project to have a positive impact on the environment, instead of having "less bad" impacts (Ibáñez, 2017). In other words it helps restoring and regenerating ecosystems in the cities. The Wetland's Research Center was designed following the approach of this theory, hoping to nurture the discussion of architecture environmental performance on the academic field.

Professor Andrés Ibáñez in the article *Ecoproductive Architecture for Multifunctional and Restorative Cities* (2019) explains the visualization methods for multifunctional ecoproductivity, where two kinds of **radar diagrams** are developed. After estimating the project's yearly production of different ecosystem services, the contributions are displayed in the right units and an axis for each one of them. The center of the radar represents a value of zero and the results of the estimation then are marked according to the production rate. **The polygon** produced by connecting all the markings of contributions **represents the overall ecoproductivity** of the project and can be easily compared to the pre-existing site conditions (Ibañez, 2019).

For the purpose of this thesis the estimation of the ecosystem services contributions have been calculated through spreadsheets shared with students by Professor Ibáñez in courses in the year of 2017, at the Pontificia Universidad Javeriana, Bogotá. The results are presented in the radar diagrams, but out of respect for intellectual property rights, spreadsheets will not be presented.

Building Input Data

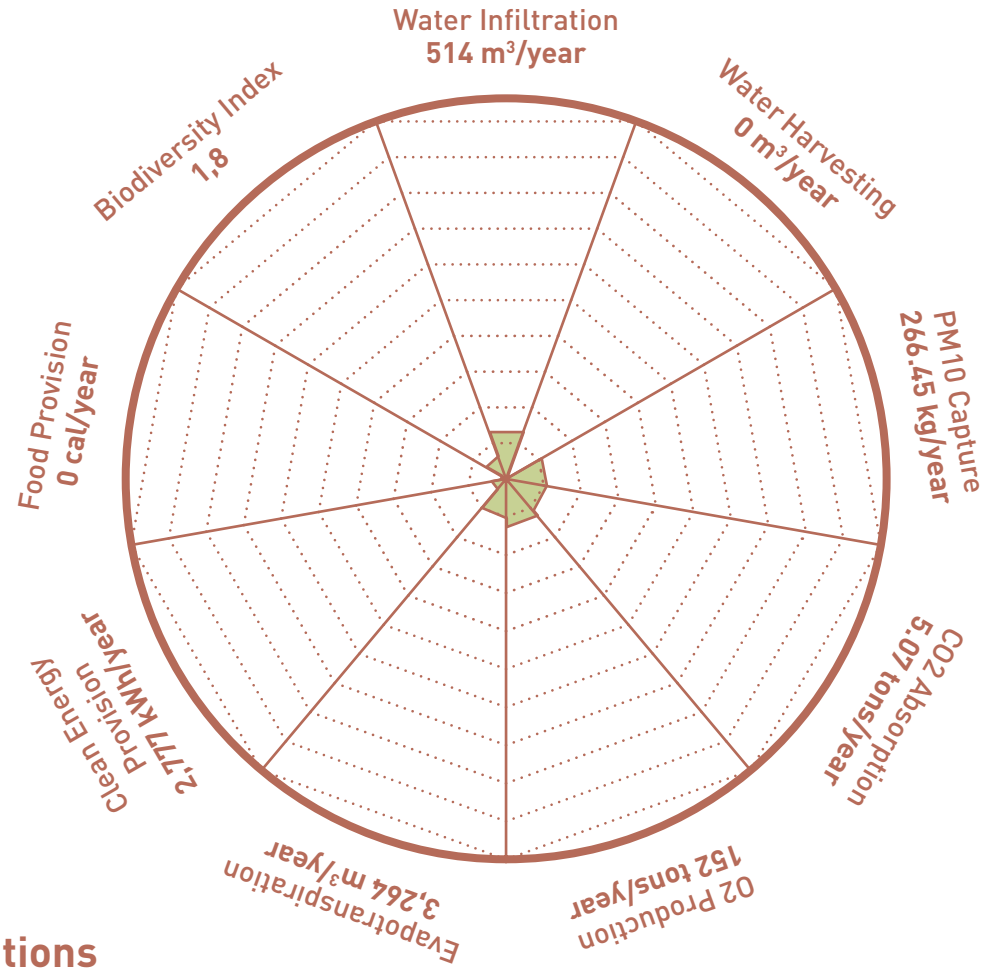
Total Site Area (m^2) = 10,927

Before the project

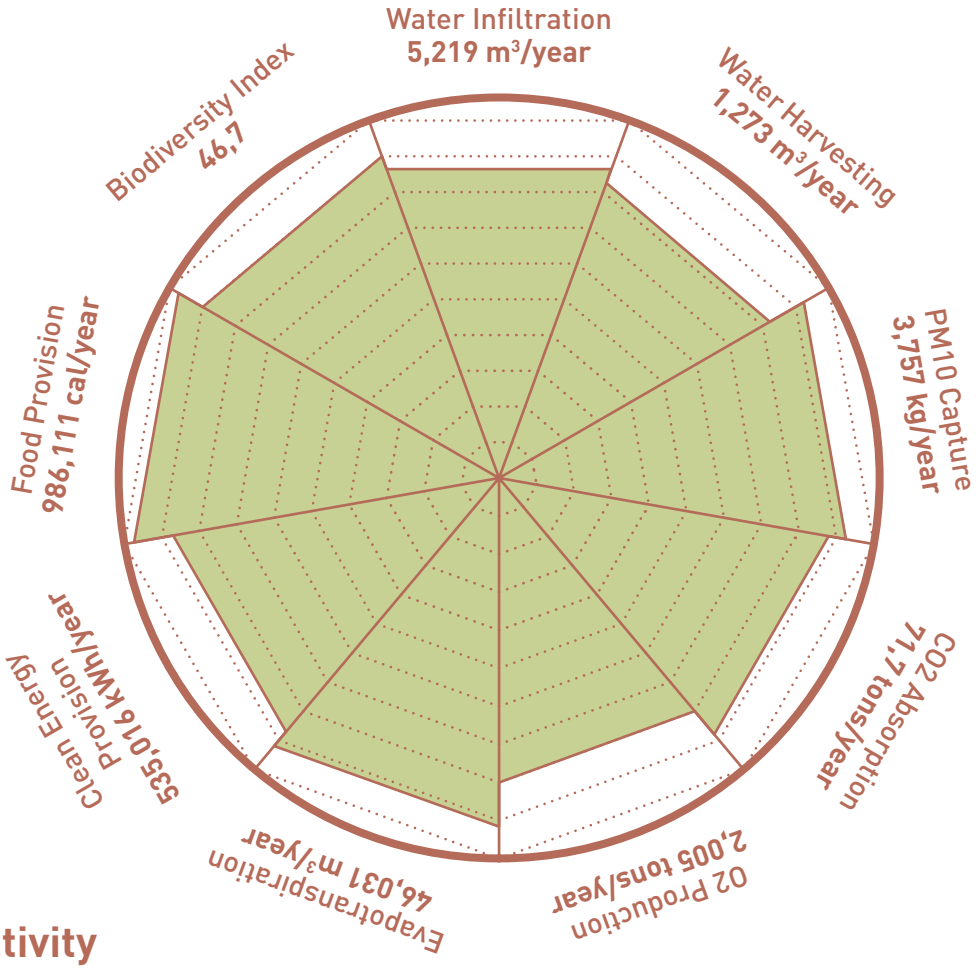
- Permeable Soil Area (m^2) = 1,209
- Impervious Soil Area (m^2) = 9,718
- Number of Trees (un) = 2
- Impervious Roof Area (m^2) = 1,629
  Demolished Existing Building

After the project

- Permeable Soil Area (m^2) = 10,879
- Impervious Soil Area (m^2) = 47.5
  Palafitic Structure Footprint
- Number of Trees (un) = 51
- Impervious Roof Area (m^2) = 423
- Green Roof Area (m^2) = 4,766
- Biotic Walls Area (m^2) = 32.4
  Vertical Gardens
- Solar Panels Area (m^2) = 1,190
- Productive Crop Area (m^2) = 71



Previous site conditions



Project ecoproductivity

EDGE App Assessment

EDGE (Excellence in Design for Greater Efficiencies) is a free software, a green building standard, and an international green building certification system created by the International Finance Corporation (IFC). It has developed an online application that allows to evaluate the environmental performance of a project in order to apply for a certification. EDGE focuses mainly on resource efficiency in three specific areas which are direct **energy** consumption, **water** consumption and **embodied energy** of the construction **materials** of the project.

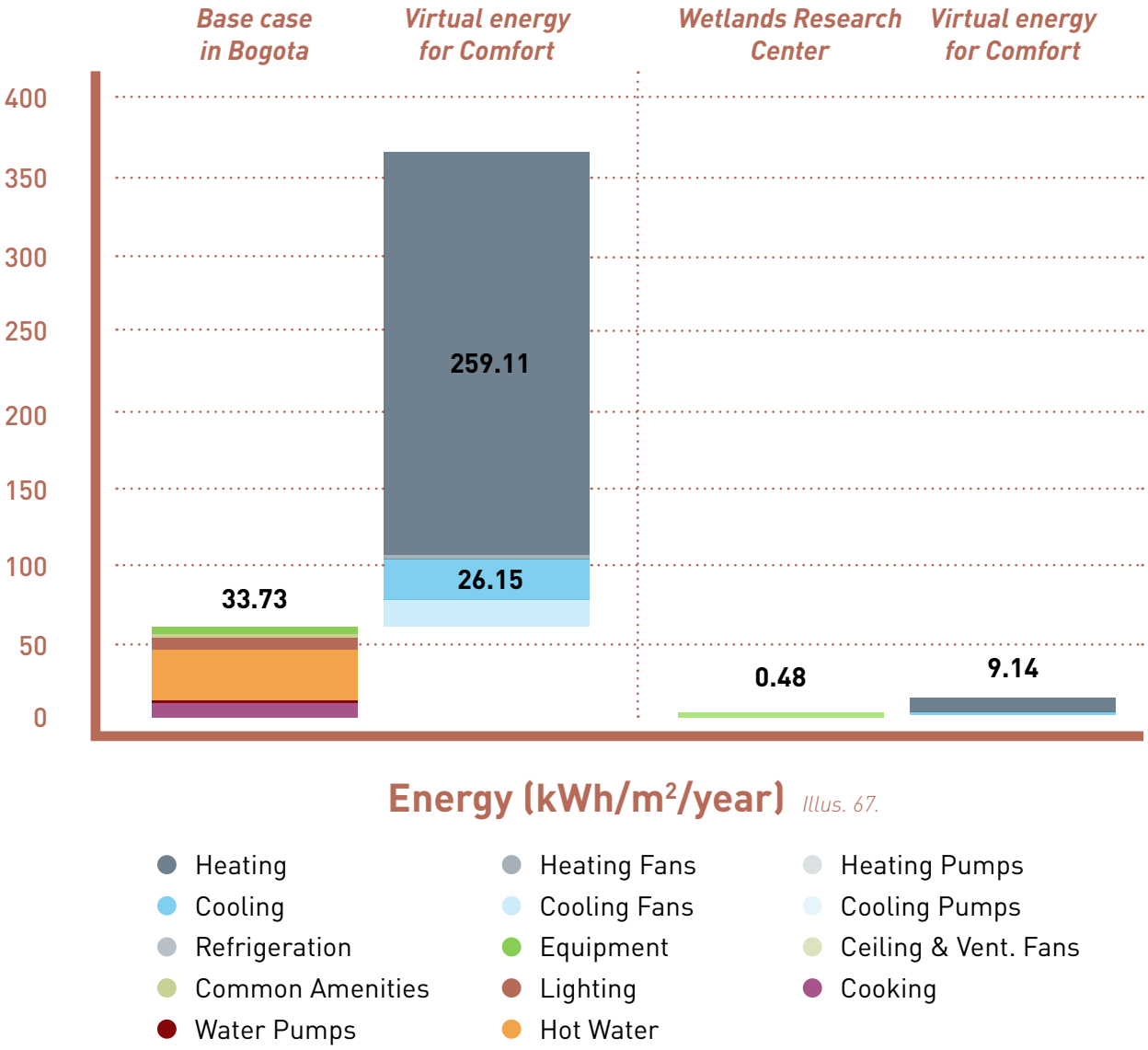
The online application is a cloud-based engine that predicts performance results using city-based climate data, consumption patterns and algorithms. It has climate and lifestyle data from different cities around the world which makes it a **location-specific tool**. It also estimates the payback period through estimated utility savings that supports the decision making in terms of the environmental impact strategies. The software allows to make the evaluation of different types of buildings, creating a series of categories that are: homes, apartments, serviced apartments, hotels, resorts, retail, industrial, office, healthcare, education and mixed use. Once the type of project is selected, the application uses the consumption patterns and data as a baseline for **comparing a base case building** in the specific context with the improved case of the new building.

For the purpose of this thesis the online EDGE application was used in order to estimate and experiment with different strategies, and to test the project's design environmental performance. Since Bogotá is one of the cities of which the application has climate data, all the calculations were made for a case of a **mixed-use project** in the specific location in the city.

Building Input Data

- Total Project Floor Area (m^2) = 7,703
- No. of Floors Above Grade = 2
- No. of Floors Below Grade = 0
- Floor-to-Floor Height (m) = 4.5
- Roof Area (m^2) = 4,915
- No. of Holidays (Days/Year) = 18
- Hours of Operation (Hrs/Day) = 12
- Administrative Office = 244 m^2
- Cafeteria = 178 m^2
- Restrooms = 244 m^2
- Auditoriums = 252 m^2
- Classrooms = 252 m^2
- Computer Rooms = 48 m^2
- Corridors = 2,163 m^2
- Labs = 1,512 m^2
- Mechanical & Electrical Room = 85 m^2
- Kitchen = 70 m^2
- Leisure & Entertainment = 278 m^2
- Library = 154 m^2
- Lobby = 154 m^2
- Staircase = 66 m^2
- Storage = 164 m^2
- Terraces = 423 m^2
- Workshops = 508 m^2
- Conference = 908 m^2
- Area with Exterior Lighting = 1,729 m^2
- External Carparking Area = 1,839 m^2

Energy efficiency measures = 95,79%

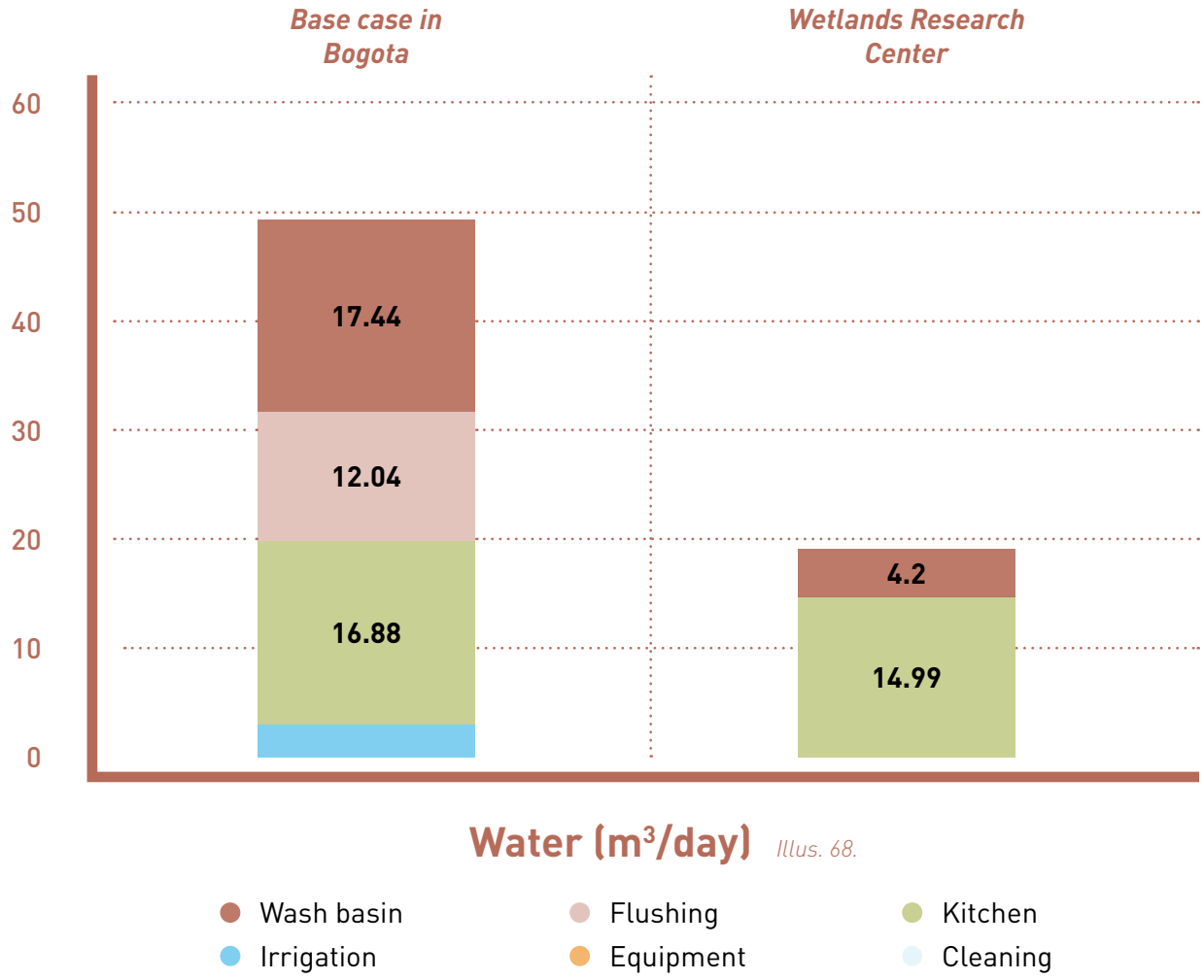


Illus. 67.

Energy efficiency strategies

- **Window-to-Wall Ratio: 18%**
  Base Case Value: 22%
- **External Shading Devices: Yes**
  Base Case Value: No
- **Insulation of Roof: U-value 4.71 W/m2·K**
  Base Case Value: 1.91 W/m2·K
- **Insulation of Bottom Floor Slab: U-Value 0.57 W/m2·K**
  Base Case Value: 0.49 W/m2·K
- **Green Roof Area: 97%**
  Growing Media Depth (mm) 300
- **Efficiency of Glass: U-Value 3.99 W/m2·K, SHGC 0.56 and VT 0.45**
  Base Case Value: 5.73 W/m2·K & SHGC 0.68 & VT 0.7
- **Efficient Lighting for Internal Areas: Luminous Efficacy 90 L/W**
  Base Case Value: 65 L/W
- **Efficient Lighting for External Areas: Luminous Efficacy 90 L/W**
  Base Case Value: 65 L/W
- **Lighting Controls: Auto On/Off Type**
- **Skylights: Skylit Floor Area (m2) 81.6**
- **Onsite Renewable Energy: 93% of Annual Energy Use.**
  Renewable Energy System Type: Solar Photovoltaic - 320,101 (kWh/year)
  Base Case: No Onsite Renewable Energy

Water efficiency measures = 61,13%

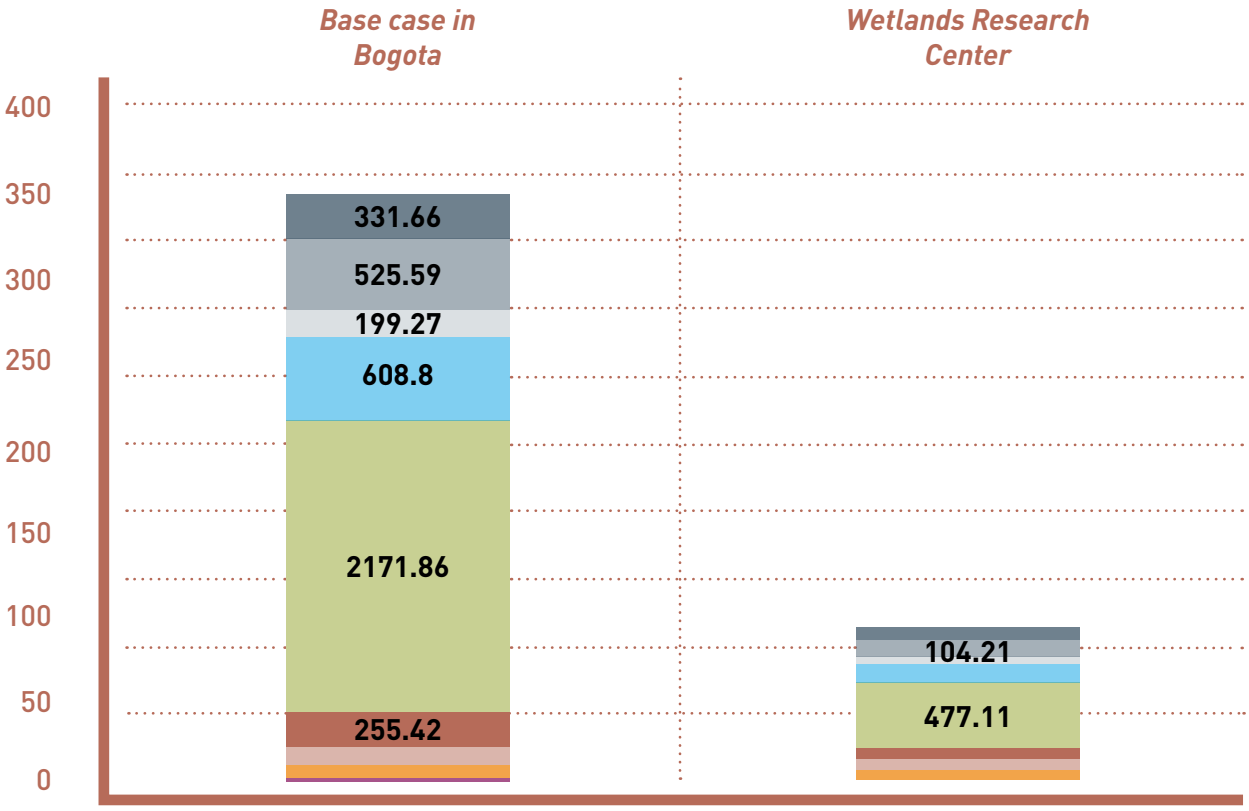


Illus. 68.

Water efficiency strategies

- ✓ **Water-efficient Faucets for Private Bathrooms: 0.4 L/cycle**
  Base Case Value: 1.66 L/cycle
- ✓ **Water-efficient Faucets for Public Bathrooms: 0.4 L/cycle**
  Base Case Value: 1.2 L/cycle
- ✓ **Efficient Water Closets for All Bathrooms: 6 L/High volume flush and 3 L/Low volume flush (Dual flush type)**
  Base Case Value: Single flush, 8 L/flush
- ✓ **Efficient Water Closets for Public Bathrooms: 6 L/High volume flush and 3 L/Low volume flush (Dual flush type)**
  Base Case Value: Single flush, 8 L/flush
- ✓ **Water-efficient Urinals: 2 L/flush**
  Base Case Value: 4 L/flush
- ✓ **Water-efficient Faucets for Kitchen Sinks: 8 L/min**
  Base Case Value: 10 L/min
- ✓ **Water-efficient Dishwashers: 2 L/Rack**
  Base Case Value: 5 L/Rack
- ✓ **Water-efficient Pre-rinse Spray Valves for Kitchen: 2 L/min**
  Base Case Value: 5 L/min
- ✓ **Water-efficient Landscape Irrigation System: 4 L/m2/day**
  Base Case Value: 6 L/m2/day
- ✓ **Rainwater Harvesting System: 97% of Roof Area Used for Collection.**
  Roof Catchment Area (m2): 4,766
  Base Case Value: 6 L/m2/day
- ✓ **Waste Water Treatment and Recycling System: 100% Treated.**
  Sewage Treatment Plant Technology: Membrane Bioreactor (MBR)
  Base Case: No Water Recycling System
- ✓ **Condensate Water Recovery: 100% Recovery**
  Base Case: No Water Recycling System

Materials efficiency measures = 73,96%



Embodied energy (MJ/m²) *Illus. 69.*

- Bottom Floor
- Intermediate Floors
- Floor Finish
- Roof
- Exterior Walls
- Interior Walls
- Window Glazing
- Window Frames
- Insulation

Materials efficiency

- **Bottom Floor Construction:**
  Concrete Slab | In-situ Reinforced Slab with >25% GGBS
  Base Case Material: Concrete Slab | In-situ Reinforced Conventional Slab
- **Intermediate Floor Construction:**
  Concrete Slab | In-situ Reinforced Slab with >25% GGBS
  Base Case Material: Concrete Slab | In-situ Reinforced Conventional Slab
- **Floor Finish:**
  Concrete | Finished Floor
  Base Case Material : Tiled | Ceramic Tiles
- **Roof Construction:**
  Concrete Slab | In-situ Reinforced Slab with >25% GGBS
  Base Case Material : Concrete Slab | In-situ Reinforced Conventional Slab
- **Exterior Walls:**
  Brick Wall | Honeycomb Blocks (40-60% voids) with External and Internal Plaster
  Base Case Material: Brick Wall | Solid Brick (0-25% voids) with External and Internal Plaster
- **Interior Walls:**
  Brick Wall | Honeycomb Blocks (40-60% voids) with External and Internal Plaster
  Base Case Material: Brick Wall | Solid Brick (0-25% voids) with External and Internal Plaster
- **Window Frames: Aluminium**
  Base Case Material : Aluminium
- **Window Glazing: Double Glazing**
  Base Case Material: Single Glazing

Conclusions

The area around the wetland of "Techo" in the Kennedy district of Bogotá is in alarming conditions of environmental contamination and evident urban deterioration. In line with the general objective proposed at the beginning, it can be affirmed that it was achieved the design of an **urban and architectural ecoproductive project that allows the restoration of the environmental conditions** of the sector under study and even enhance its provision of ecosystem services.

According to the first of the specific objectives and the work developed to evaluate the environmental performance of the project, it can be affirmed that **the project generates a quantifiable improvement in the environmental conditions** of the site. By means of the ecoproductivity evaluation method, the growth of ecosystem services from different fronts became evident. Such as water infiltration capacity in the soil, oxygen production, carbon dioxide capture, support for biodiversity, provision of food and clean energy, among others. On the other hand, through the EDGE online application method, it was verified that the building has an advanced performance in the management of the main resources proposed, which are water management efficiency, energy efficiency and embodied energy of materials.

Regarding the second specific objective, it can be concluded that the project **experimented with innovative strategies in architecture to improve people's quality of life**. To this end, the project used strategies based on biomimicry, on the ecoproductivity of buildings and on a type of configuration that promotes a different relationship with the natural environment.

In accordance with the third specific objective, it can be affirmed that **the project guarantees the strengthening of social capital** thanks to the meeting spaces that it promotes both inside and outside the project. Within the project, public activities are developed that provide services to the population and allow for the strengthening of human relations around the knowledge of their own context, in addition to developing scientific knowledge and generating employment opportunities.

In line with the fourth and last specific objective, it can be corroborated that **the project supports different forms of life, allowed the reincorporation of different species to the urban ecosystem and promotes a relationship with human beings**. All this thanks to the multiple biotic elements of its infrastructure and the integration of the expanded wetland through the project.

06

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