Foster + Partners

M.I.S.T.
Masdar Institute of Science and Technology Architectural Concept Report

4th February 2008

Preface

“We can not ignore the damage that our buildings inflict on the natural environment. As the consequences of our past inaction becomes ever more apparent, designing for a sustainable future becomes a necessity, not a choice. Sustainable design means doing the most with the least means. Following the logic of ‘less is more,’ it employs passive architectural means to reduce energy consumption, minimising the use of nonrenewable fuel and reducing the amount of pollution. Responsible sustainable design is not simply about individual buildings; it should be implemented at all scales - from product design to the design of cities In the final analysis, sustainability is about good design.
The higher the quality of design, and the more efficient the project is, the longer the project will have a role, and in sustainability terms, longevity is a good thing.“

Lord Foster of Thames Bank OM

Following the pioneering benchmark master plan for MASDAR City in Abu Dhabi, this report presents Foster and Partners’ design scheme for M.I.S.T (Masdar Institute of Science and Technology) that is to become one of the first built projects in Masdar City with its phase 1A construction completion and full operation date set to 2009.

The report presents the overall vision for the M.I.S.T university campus, an institution that is to set new standards to the forefront of design, research and investigation in Sustainable Energy.

Subsequent chapters will introduce several aspects related to the design-construction concepts of the university from its micro to macro scale components that will set a clear framework for the development of M.I.S.T

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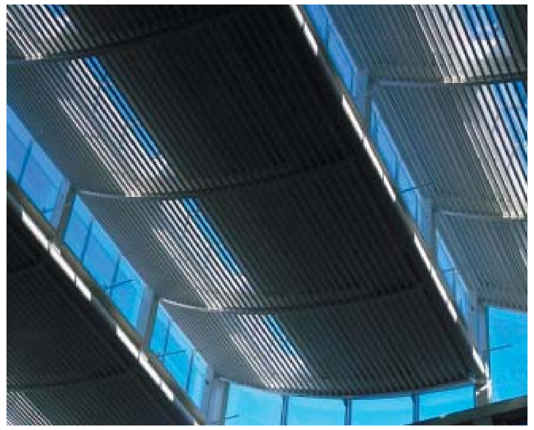

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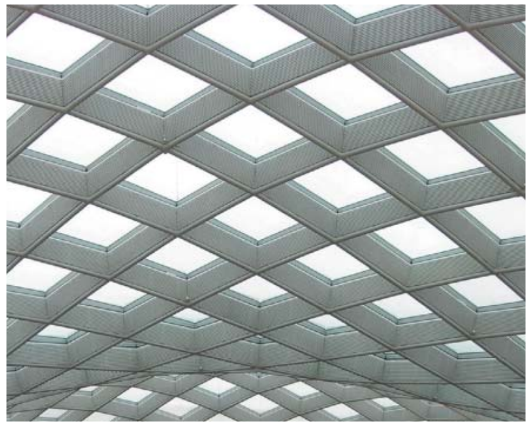



Introduction

1

MASDAR
ABU DHABI FUTURE ENERGY COMPANY

During April 2006, His Highness Sheikh Mohammed Bin Zayed Al Nahyan, the Crown Prince of Abu Dhabi, announced the "Masdar Initiative". The word Masdar means "the Source" in Arabic. This Initiative will be the source for an impressive range of innovative Abu Dhabi-based industries and research to position Abu Dhabi as a global leader in clean energy and sustainable development. Masdar complements the vision of the late Sheikh Zayed Bin Sultan Al Nahyan, the founder and the former President of the UAE, who pioneered environmental conservation in the country.

The commitment of the Government of Abu Dhabi to Masdar is clear and strong. Masdar will assist Abu Dhabi in maintaining its position in the global energy market over the long term. Masdar will also be a key resource in nation-building, by developing the human capital that will help create and lead a new UAE scientific and research culture.

Abu Dhabi has had the good fortune to be blessed with substantial natural resources. Sensible development of these assets during the past 45 years, together with valued international partners, has brought many benefits to the people as well as to our customers worldwide.

But a new era is now upon us, challenging us to venture beyond the achievements of the past and to lay the groundwork for the next 50 years of progress. We shall accomplish this by channeling our accumulated energy expertise and financial resources into new activities and industries such as Masdar. Under the visionary leadership of the President of the UAE, His Highness Sheikh Khalifa Bin Zayed Al Nahyan, Abu Dhabi will achieve its strategic developmental aims and contribute significantly to a cleaner and sustainable future for all.

Abu Dhabi is leveraging its substantial resources and expertise in global energy markets into the technologies of the future. One key objective of Masdar is to position Abu Dhabi as a world-class research and development hub for new energy technologies, while ensuring that Abu Dhabi maintains a strong position in world energy markets.

A related objective is to drive the commercialization and adoption of these and other technologies in sustainable energy, carbon management and water utilization. In doing so, Masdar will play a decisive role in Abu Dhabi's transition from technology consumer to technology producer. The goal is the establishment of an entirely-new economic sector in Abu Dhabi around these new industries, which will assist economic diversification and the development of knowledge-based industries.

The Abu Dhabi Future Energy Company (ADFEC) is the government-owned organization mandated to develop and execute Masdar. ADFEC will also ensure that Masdar further enhances Abu Dhabi's existing record of environmental stewardship and its contribution to the global community.

The Masdar Initiative aims to play a unique role in that evolution – representing a leading Middle Eastern oil-producing nation that is proactively engaging the world's best minds and organizations to envision a cleaner, more sustainable future.

The initiative embraces a spirit of purpose and focus. Through an extensive series of meaningful achievements, Masdar aims to make an enduring impact on Abu Dhabi, the region and the global community. By providing the leadership, platform and resources to create new ideas, breakthrough technologies and the commercial basis for their widespread adoption, Masdar will also demonstrate Abu Dhabi's continued contribution to the global community.
Through Masdar, we invite the global community to participate in the collective search for creative solutions to some of mankind's most pressing concerns: energy, the environment, and the sustainable use of vital natural resources.

The Masdar Institute of Science and Technology (M.I.S.T) was established to meet the exceptional and progressive goal of transforming Abu Dhabi's economy from one based on petroleum to one focused on sustainable technology and renewable energy. This new, private graduate Institute positions Abu Dhabi to make an historic transformation and to become a knowledge hub for global innovation.

Developed with the support and cooperation of the Massachusetts Institute of Technology (MIT), the Masdar Institute is an independent, a not-for-profit, research-driven graduate institution focused on science and technology. The Institute will educate a workforce that will be prepared to compete in global markets and participate in research and development with an emphasis on alliances with global corporations and entrepreneurial opportunities.

MIT is assisting the Masdar Institute of Science and Technology in four integral areas: (1) development of graduate degree programs; (2) joint collaborative research; (3) outreach that encourages industrial participation in research and development activities of the Institute; and (4) support for capacity-building at the Institute in terms of its organization and administrative structure, as well as scholarly assessment of potential faculty candidates for the Institute.

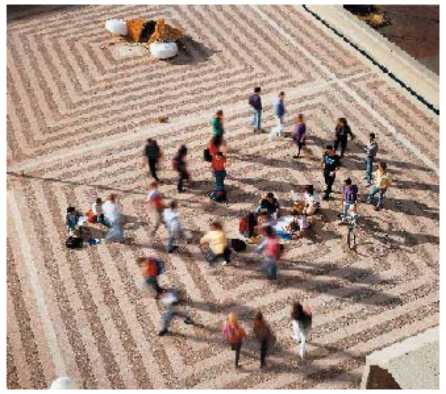
Beginning in September 2009, the Masdar Institute will offer five, 24-month Master of Science degree programs. Additional programs, including PhD programs, will be added as the Institute continues to develop.

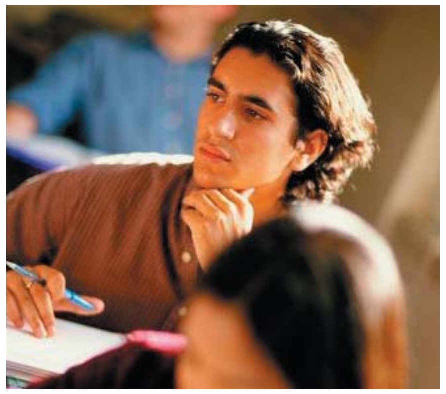
The first batch of graduate students will report in September 2009 to a 16,540 sq.m campus with a gradual expansion of the institute over the next six to seven years to a 102,000 sq.m campus. This will provide a worldwide focal point for the development of renewable energy and sustainable technologies within the environmentally conscious backdrop of the Masdar Initiative.

The Masdar Research Network (MRN) is a unique collaborative research framework between Masdar and leading global scientific institutions. The Network will create a nucleus of world class scientific research in advanced energy and sustainability technologies. It leverages the core research strength of each partner to accelerate innovation and commercial development of the most promising technologies.

The Network's partners include Imperial College London (UK); RWTH Aachen (Germany); University of Waterloo (Canada); Tokyo Institute of Technology (Japan); Columbia University (USA); CIEMAT – Research Centre for Energy, Environment and Technology (Spain), and the German Aerospace Centre – DLR (Germany).

All bring advanced technologies and strong ties to industry, allowing the Network to develop, validate and finance a broad spectrum of research projects. Research tracks currently underway include photovoltaic (crystalline thin-film and low-cost poly-silicone), water management (desalination, membrane technologies); solar thermal and carbon management (carbon capture and storage). Projects are jointly financed by Masdar and industrial partners selected by the host institution, with resulting IP rights shared among the parties.








Cooperation with

Massachusetts Institute of Technology, USA

Research Network Partner

Imperial College London, England

University of Waterloo, Canada

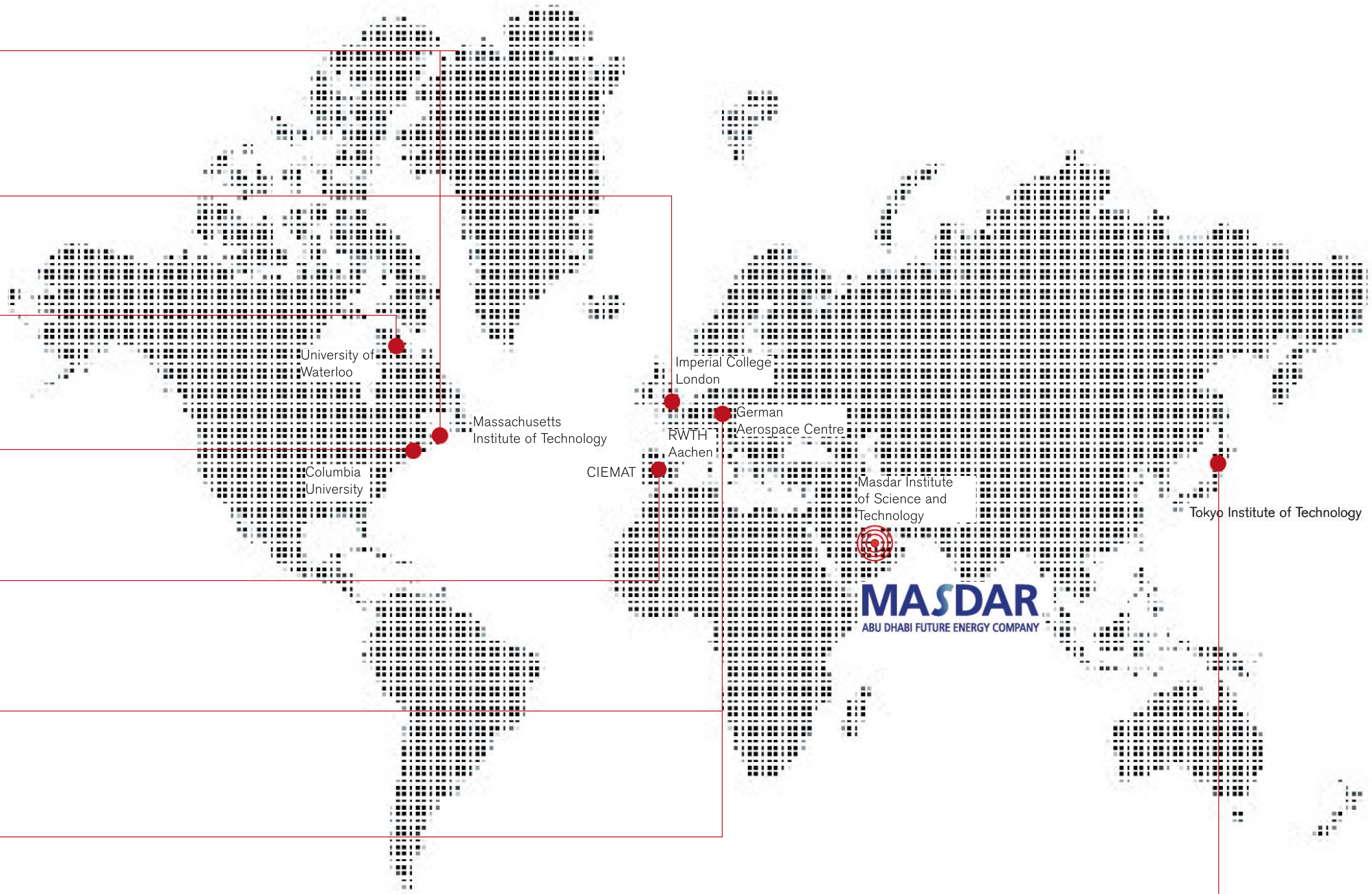
Columbia University, USA

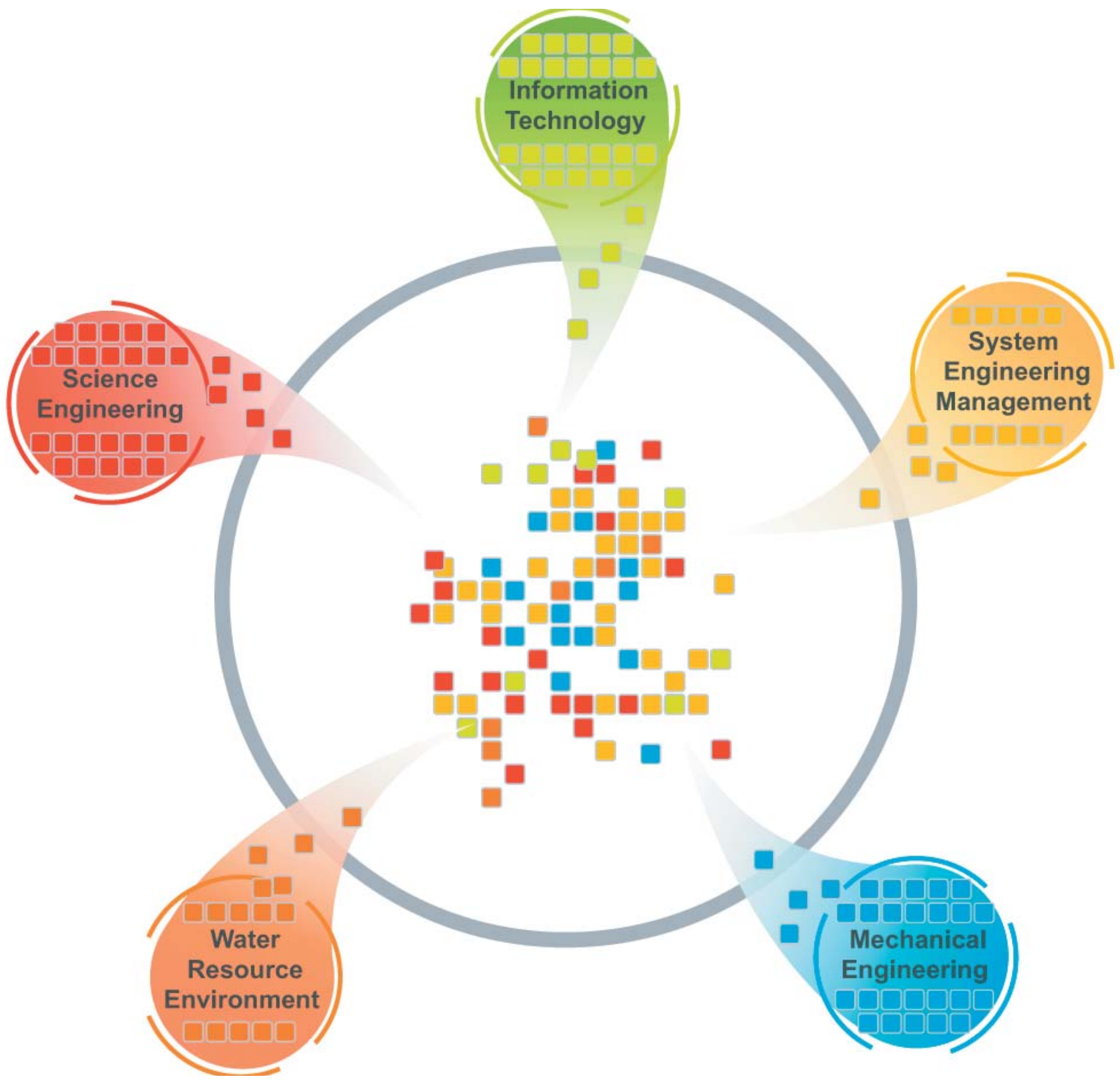
CIEMAT, Spain

RWTH Aachen, Germany

DLR, Germany

Tokyo Institute of Technology





= **INTERACTION** / **COLLABORATION** / **FLEXIBILITY** = **INNOVATION**

INTERACTION: The M.I.S.T. vision is to bring together Faculty from different areas of scientific research, who share the same goals for discovering the next generation of sustainable technologies to meet the worlds future needs.

COLLABORATION: The M.I.S.T. concept is to bring together different programmes to create new areas of sustainable technology research through the direct collaboration between Faculty and graduate students.

FLEXIBILITY: The creation of flexible research space to meet the individual Faculty needs is fundamental to the realisation of interaction and collaboration. Scientific research must be able to expand and contract organically to suit its needs.

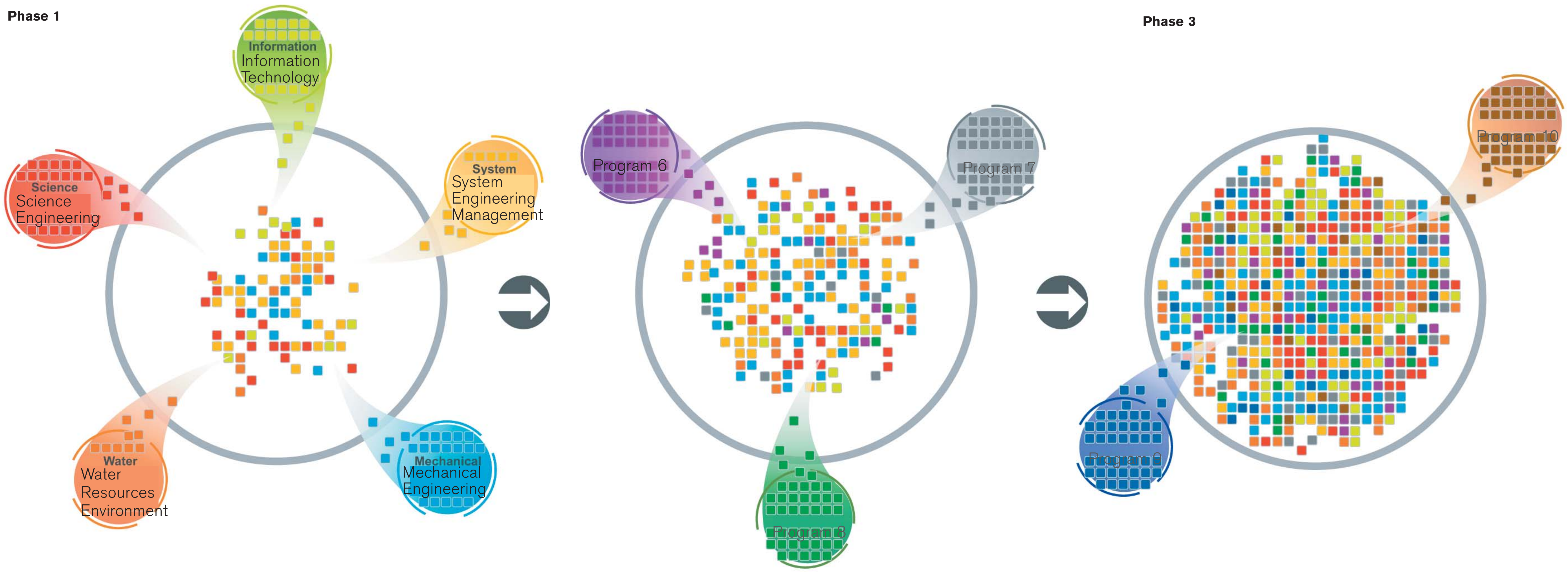
The M.I.S.T. vision is to create a postgraduate research facility that will lead to the discovery and invention of the next generation of sustainable technologies.

In order to create this cutting edge research a fundamental concept of the M.I.S.T. design is to create innovation through collaboration and interaction between different research programmes. The M.I.S.T. vision is to stimulate this innovation at a number of different levels; on a global scale through the Masdar Research Network, and at a personal level through the direct interaction between different faculty and their students on an individual basis.
The interaction and collaboration is created by developing a new type of research facility where super flexible laboratories are designed that can be adapted for all the specific needs of the different types of Programs and their individual Faculty. By creating these flexible laboratory spaces the vision for M.I.S.T. is that the different Programs will be mixed within the actual laboratories; rather than the more typical University model where individual buildings are designed for individual types of science or Programs.

The Architectural concepts developed for the M.I.S.T. design aim to create the interaction both within the working environment of the laboratories and within the Institute itself on a social level. The concept design has been developed to create an exciting and vibrant social community, that will ultimately reach out and link to the surrounding developments in the Masdar city. This is achieved by designing buildings typologies for the residential and laboratory buildings that respond directly to both their internal functional requirements, but within the context of the Abu Dhabi climate. The design of the buildings is key to the creation of external public streets, squares and shades colonnades that will be beautiful and comfortable environments.

The challenge is moreover to deliver the design of M.I.S.T. that is itself a fully sustainable development, and which is at the cutting edge of both current and immerging sustainable technologies. M.I.S.T. will be the first phase of the Masdar city to be constructed, and will be in itself a built manifestation of the Masdar masterplan vision.

The ultimate aim of the M.I.S.T. vision for interdisciplinary research is for the acceleration of discovery and innovation. The M.I.S.T. design will make the conversations between different types of research, that happen from time to time to occur on a daily basis. The vision is that the next generation of sustainable technologies will stem from these conversations between people. Our goal is that the super flexibility of the laboratory designs will allow these daily interactions to lead to new areas of collaboration, which can then expand and develop free from the normal constraints of the building themselves.

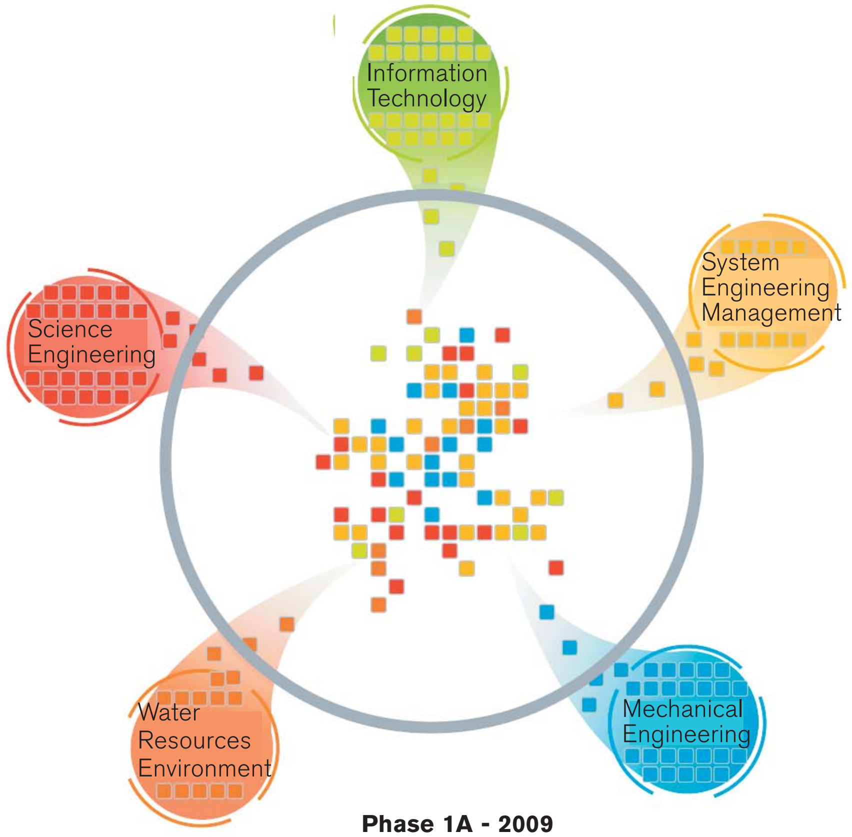


The types of research that will occur at M.I.S.T. are many and varied ranging from alternative fuels, sustainable power infrastructure, to solar harvesting. Initially 5 Programs will be provided, which will increase to a total of 10 Programs by 2015.

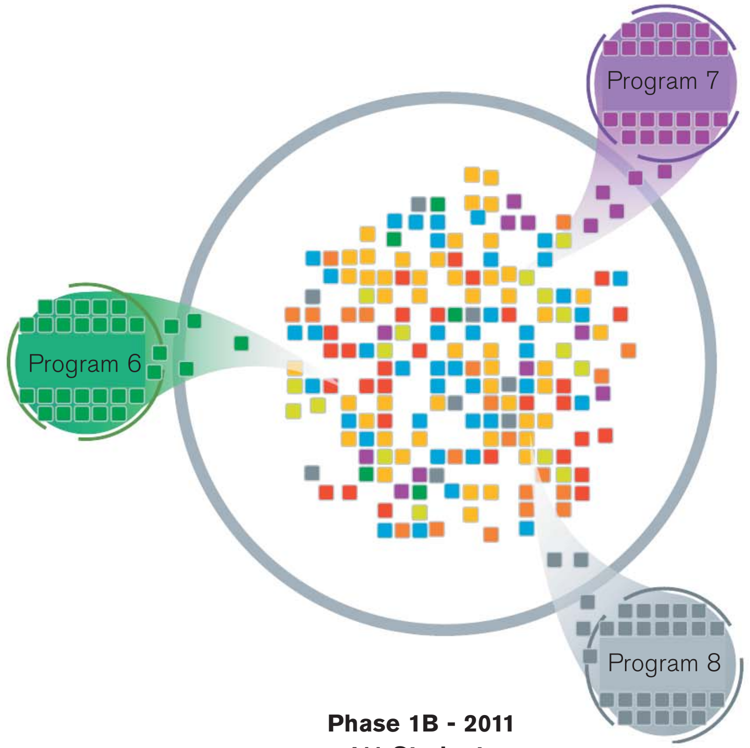
Essentially the conceptual model for the M.I.S.T. research programs remains the same as the growth of the university occurs, with either increasing student numbers, or the addition of new Programs adding to the overall blended mix of faculty and students. The design of the laboratory interiors must have the flexibility to continuously change the planning of the spaces, as different Program types are added into the spaces.

By the very nature if the different types of sustainable technologies research within each type of program, some of the scientific researchers will be more familiar with the interdisciplinary theme and collaboration than others. It will be vital that during the next stage of the design development, that a detailed assessment is made of the different research types requirements, to ensure all their functional needs are met. This will include looking at both their technical requirements and different preferred working methods. This detailed information will be used to then develop the support network of infrastructure and services, in parallel with the design development of laboratory casework.

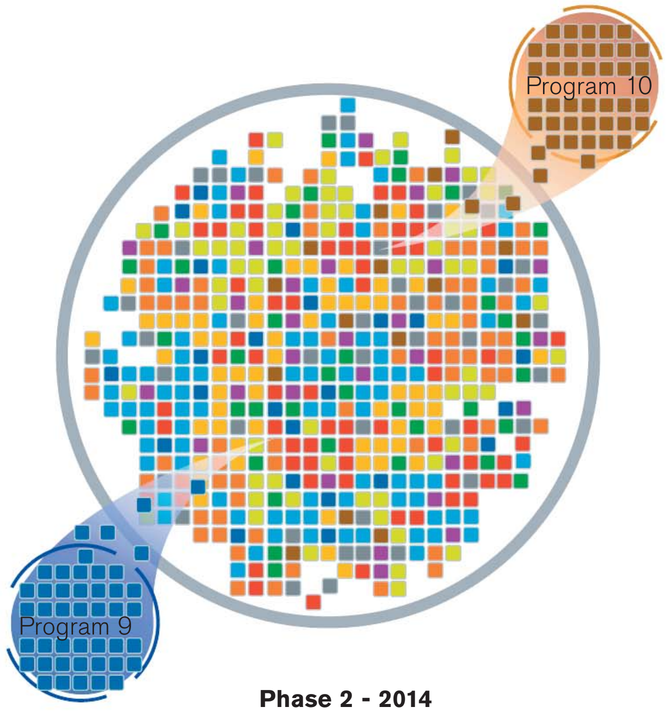
The energy use requirements for the mix of science types envisaged within any individual laboratory, and as a campus as a whole will need careful development and analysis with the consultant team, to ensure that the technical performance is met within the sustainability parameters set by the Masdar Masterplan.



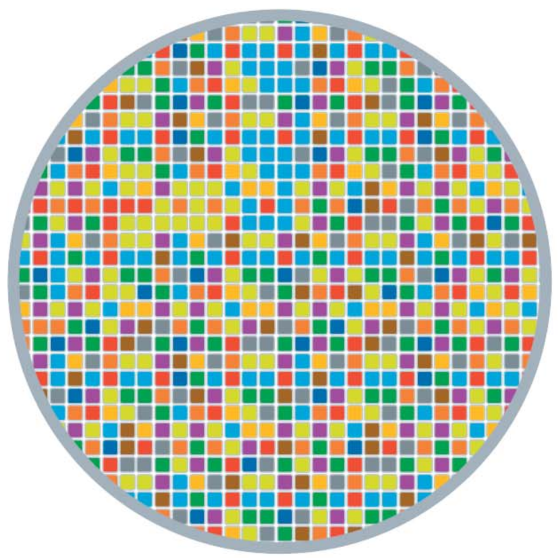
Phase 1A - 2009
100 Students



Phase 1B - 2011
411 Students



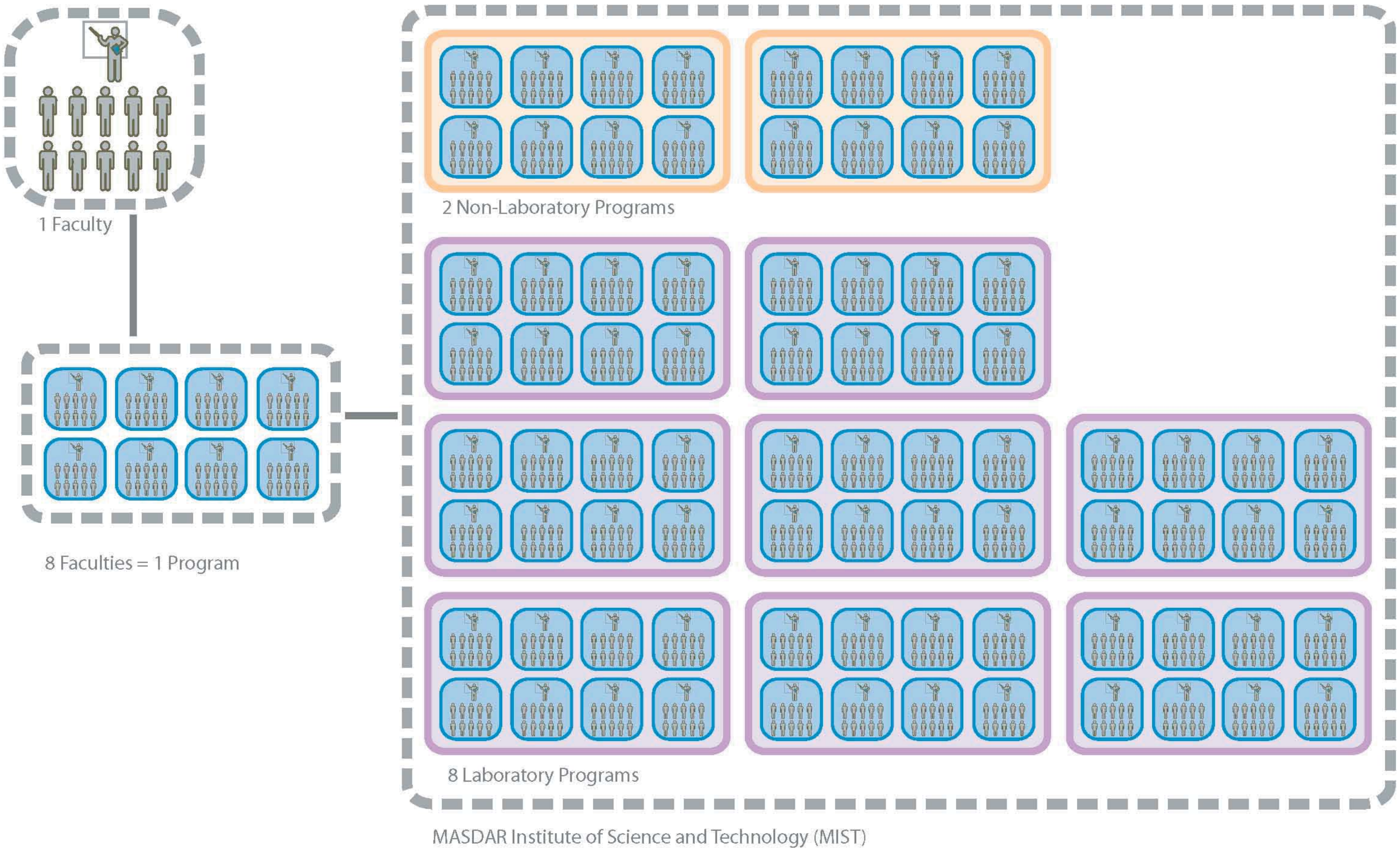
Phase 2 - 2014
739 Students



Phase 3 - 2015
800 Students

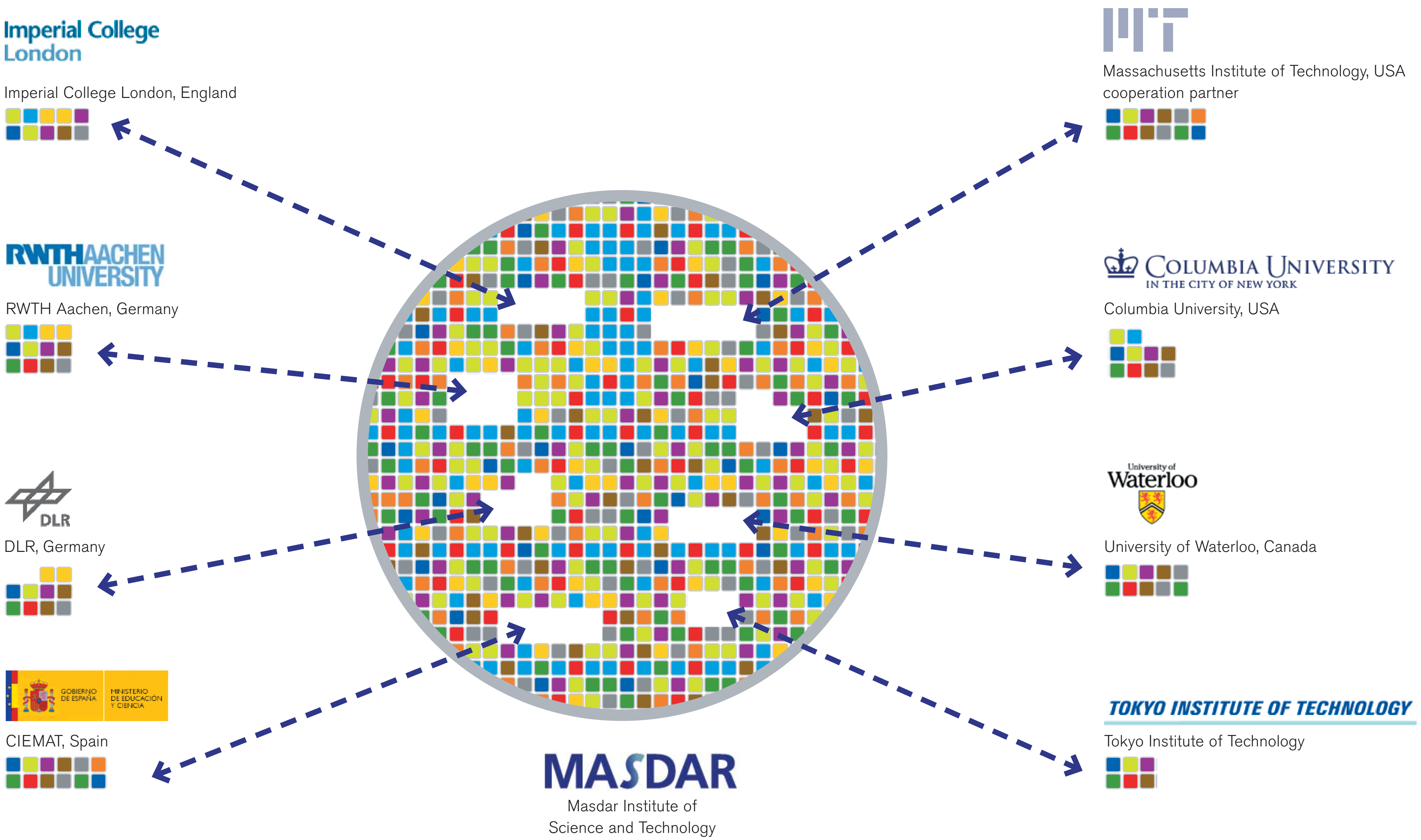
The growth of student numbers and the delivery of the M.I.S.T. buildings have been set out by the MASDAR client team. Ultimately the number of Faculty and students within each Program is only an estimate of the projected growth.

The design team must therefore provide a building design that allows for the potential for the different types of research to occupy a different percentage of the space within M.I.S.T. The percentages will inevitably change over time, suggesting that very specific space layouts could easily become obsolete over a short period of time. Flexibility to account for these changes and the definition of a generalised space/ infrastructure requirement will need to be developed to allow for this growth.


1 Faculty
8 Faculties = 1 Program
2 Non-Laboratory Programs
8 Laboratory Programs
MASDAR Institute of Science and Technology (MIST)

Research Network

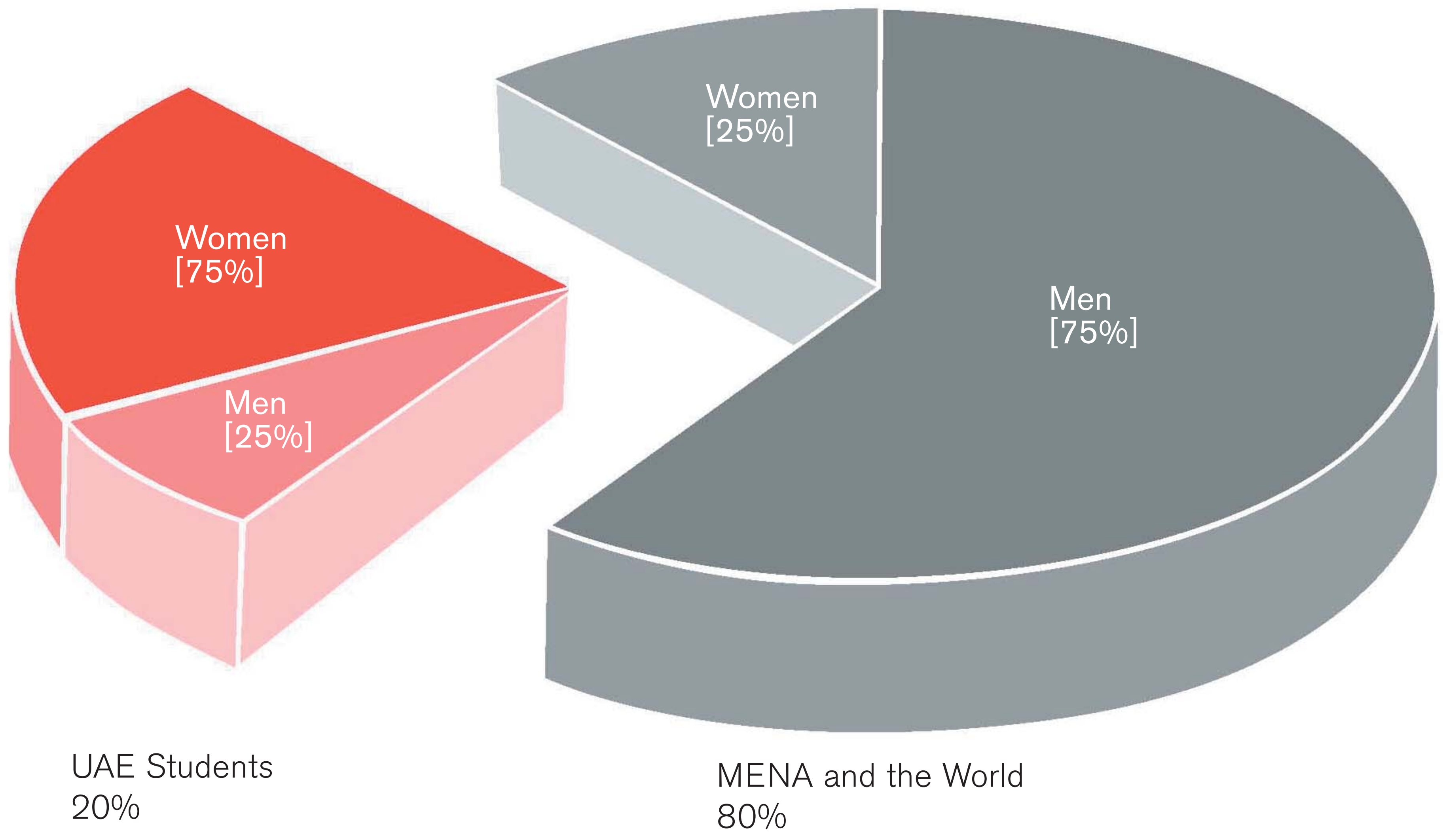
The Masdar Research Network will allow all researchers the opportunity for frequent exchanges between the affiliated institutions, promoting international interaction. It will allow the core research strength of each partner to accelerate innovation and commercial development of the most promising technologies while creating a more united community towards establishing a new sustainable future.



The demographics breakdown of the envisaged student population as shown has been provided by the client team.

Although it is very difficult to predict the student demographics with accuracy at this stage, the information is important as it has implications on a number of design issues for the brief. As we develop the MIST scheme design will we need to look at the specific issues of the design of various elements of the buildings. This will include, ensuring that the individual needs for different types of religions are met.

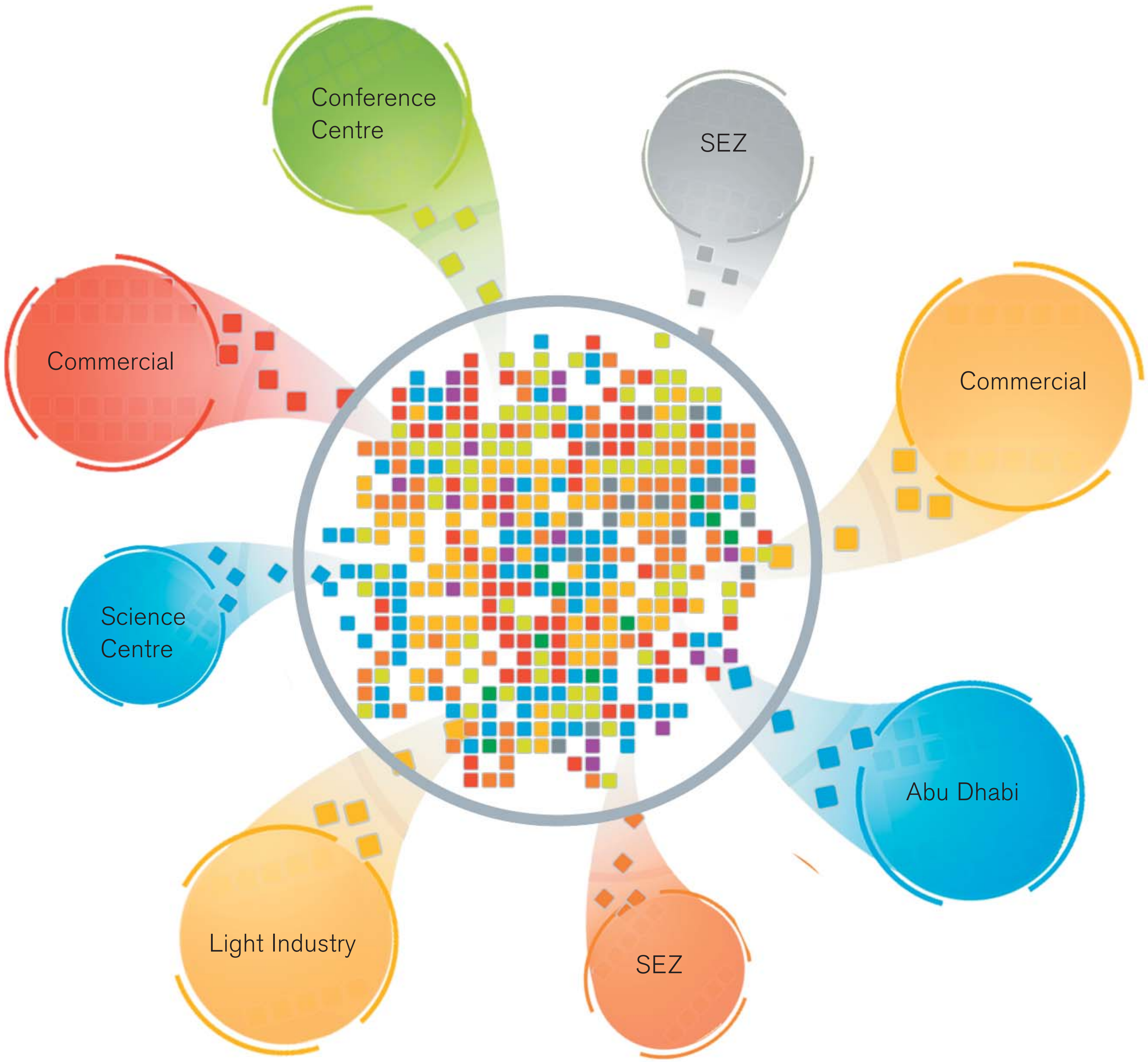
We will also need to look at the location and design for female only residential accommodation, that has been requested. At this stage, we have made proposals for different options for the location of this accommodation within the campus, based on an assumption of 30% of the student residential accommodation being female only. We will need to also consider, how any potential variation in the actual male female ratio's within each project phase, can be accommodated.



Located within the heart of Masdar city, MIST forms the fulcrum of innovation and research forging links with industry and surrounding businesses adjacent to the campus and beyond.

Using the model established at MIT in Boston, the MIST campus aims to encourage communication and interaction by allowing industry and business to mix freely with the intellectual minds leading the research and development into the sustainable technologies of the future today.

This will be achieved by providing a shaded streetscape full of social and educational spaces that are mixed throughout the campus with the emphasis on bringing the labs and recreational spaces closer together, recognising the vision that much of scientific discovery and dialogue happens in the spaces in between. This will encourage activity within MIST thoroughout the day and night connecting the various areas of the city through the campus.

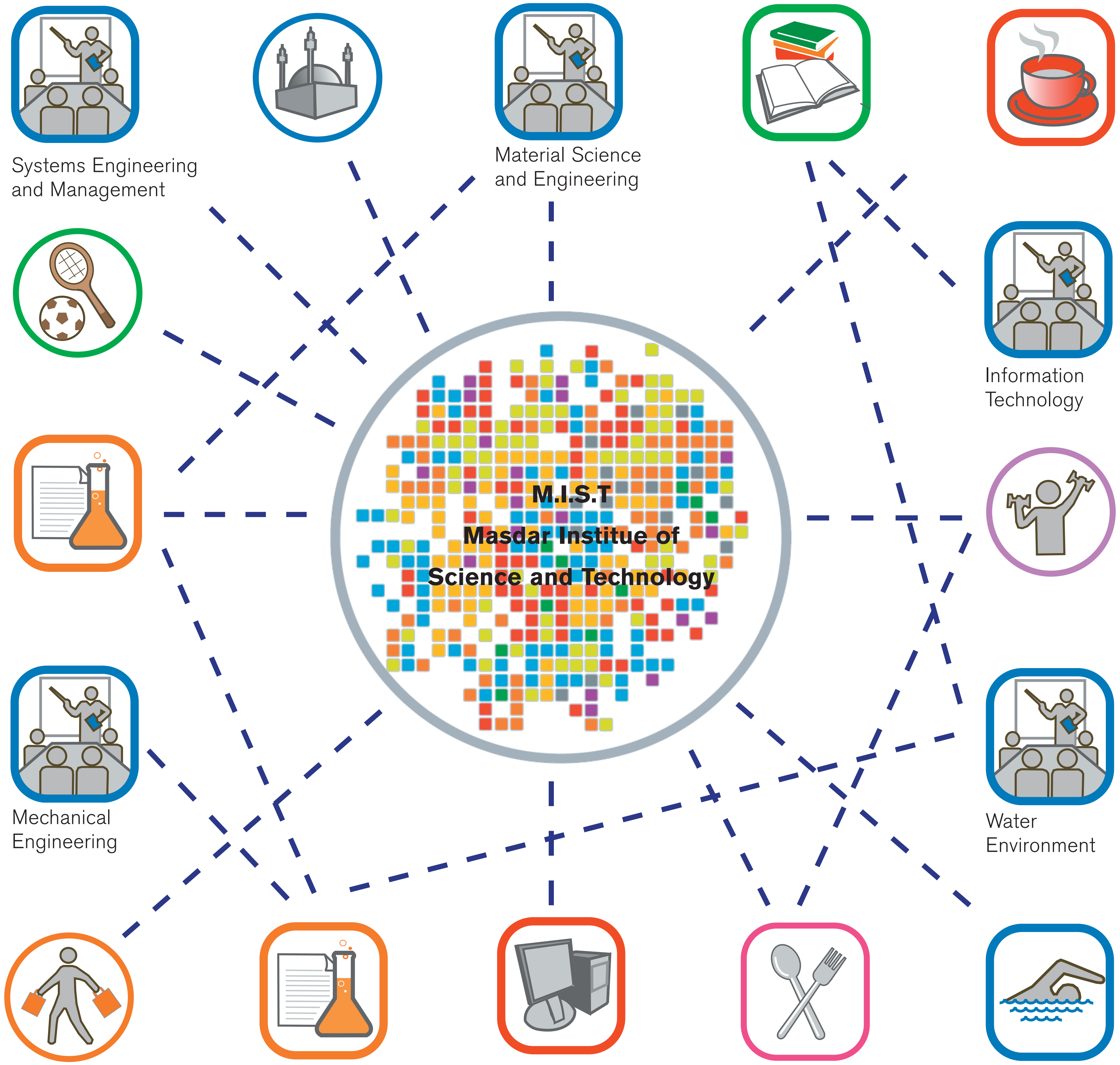


"It has been said that sustainability can be measured in how well you know your neighbour. The creation of lively energetic neighbourhoods requires careful planning of the scale of the buildings, but more importantly of the space between the buildings" (MASDAR masterplan – People and Community)

It is becoming increasing recognised, that social interaction between scientists, outside of the laboratory environment, is a vital part of successful and innovative research. The importance of the design of all shared and social spaces of MIST is, we believe, very significant.

Shared functions will include but are not limited to the following: classrooms, sports facilities, café's, restaurants, libraries, clean rooms, mosques and prayer rooms. However it is the design of the public spaces – the street levels, their aesthetic and effects on local micro-climate that is vital for the success of these spaces, as they need to be bound together into a cohesive urban and social network.

These ideas are a significant focus of the overall Masdar masterplan design concept, and the MIST concept design is a development of the urban concepts established in the Masdar planning guidelines. In particular we have developed a design for the ground plane based on the concept of self shading building structures and spaces, street, and courtyards. A number of options are proposed for the ground plane in this concept document, the detailed design and performance (micro climate / reduced energy consumption) of these spaces will need to be developed through modelling in the scheme design phase, with the input of the consultant team.

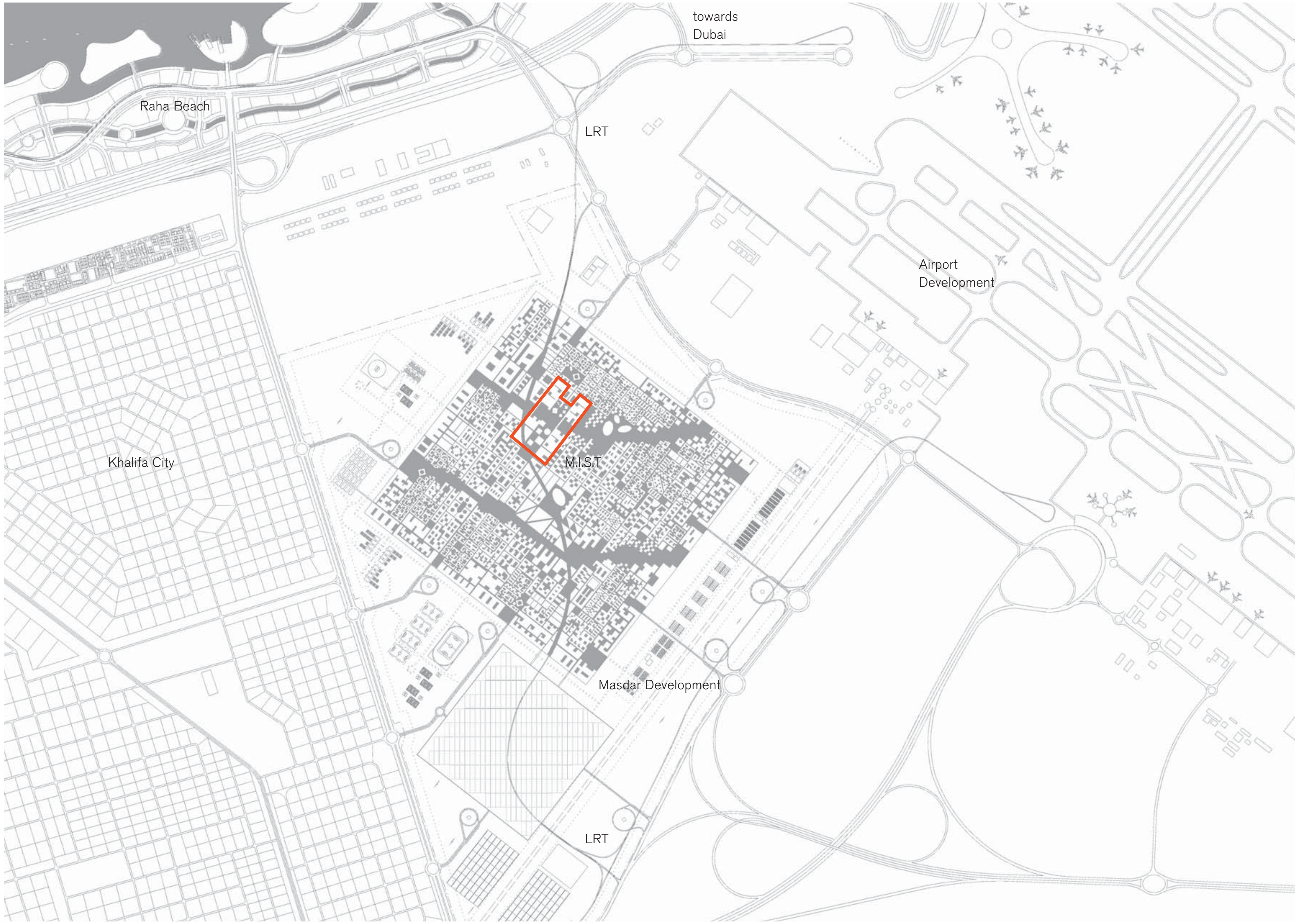


Sattellite View

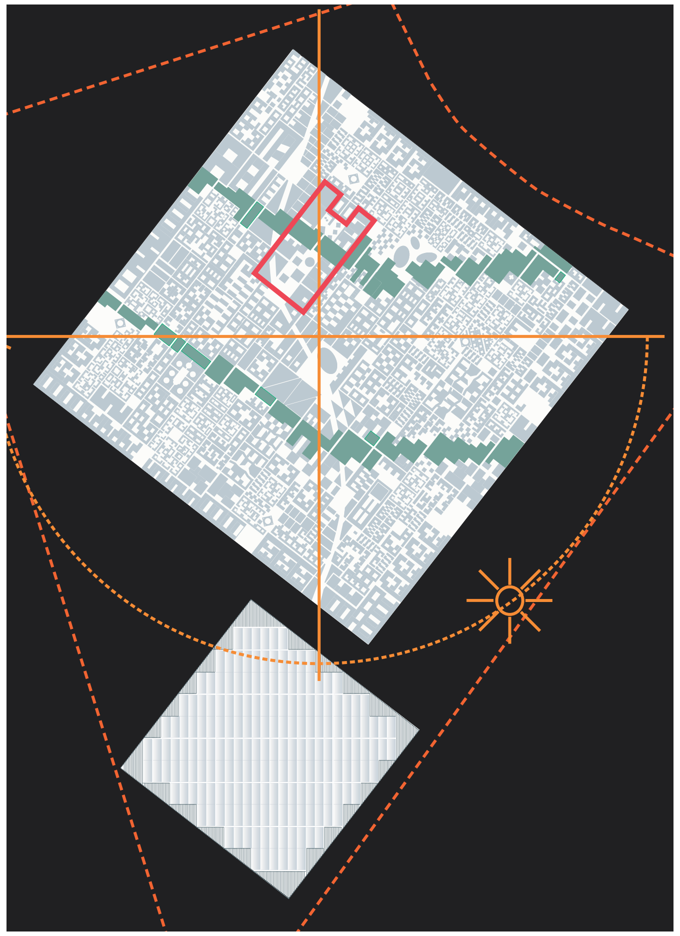
Location of M.I.S.T within Masdar Masterplan

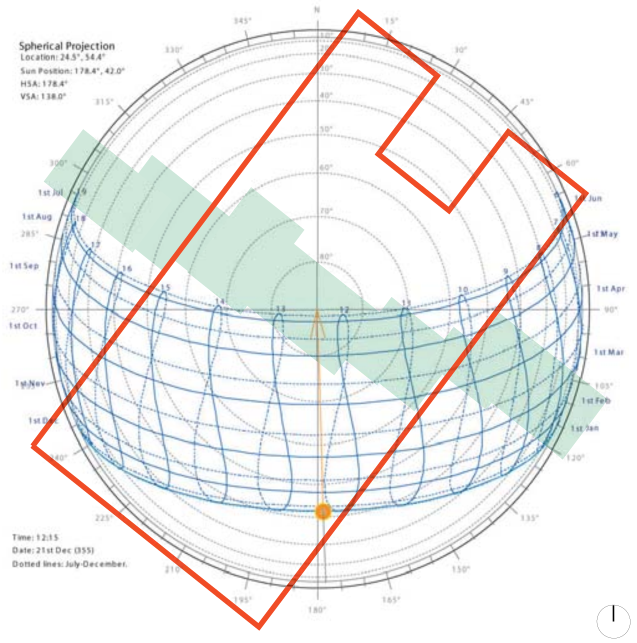
M.I.S.T. is located within the greater conurbation of Masdar city, which is situated to the east of Abu Dhabi's old city sandwiched between the new developments of Raha Beach and Khalifa City and Abu Dhabi International Airport. Developed by Foster + Partners, the masterplan for Masdar city aims to set a new standard in the development of a sustainable city.

M.I.S.T. will be designed and developed using some of the fundamental strategies behind the greater masterplan of Masdar city and underwritten by strategies that have been evolved from the rich heritage of the Middle East. Traditional techniques and methodologies such as orientation, natural ventilation utilising windtowers and high-density low-rise development providing cool shaded environments have been researched and been adapted to the modern demands of a contemporary city and a sustainable future.

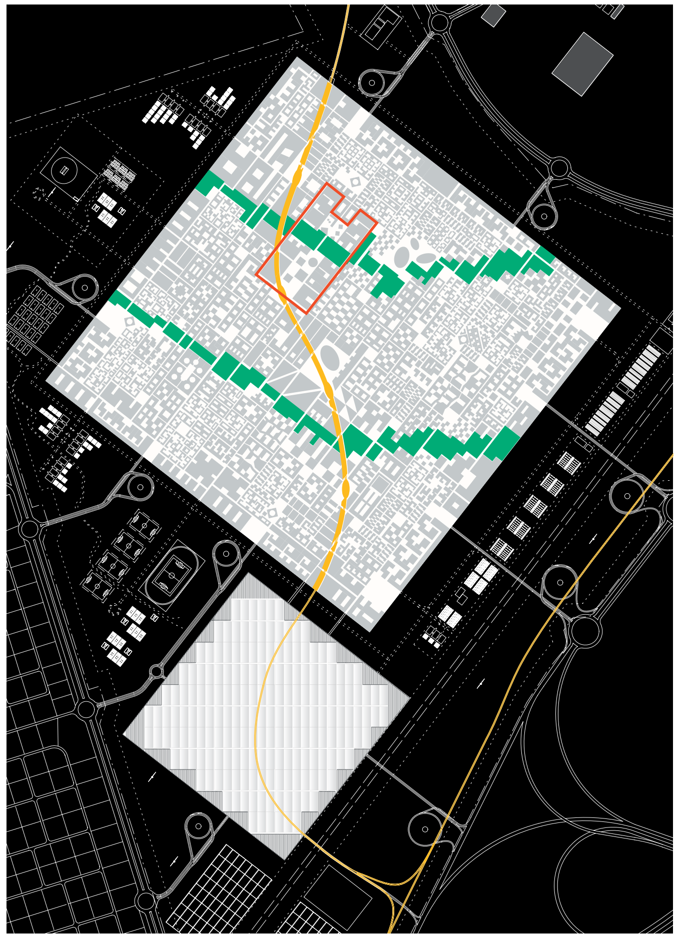


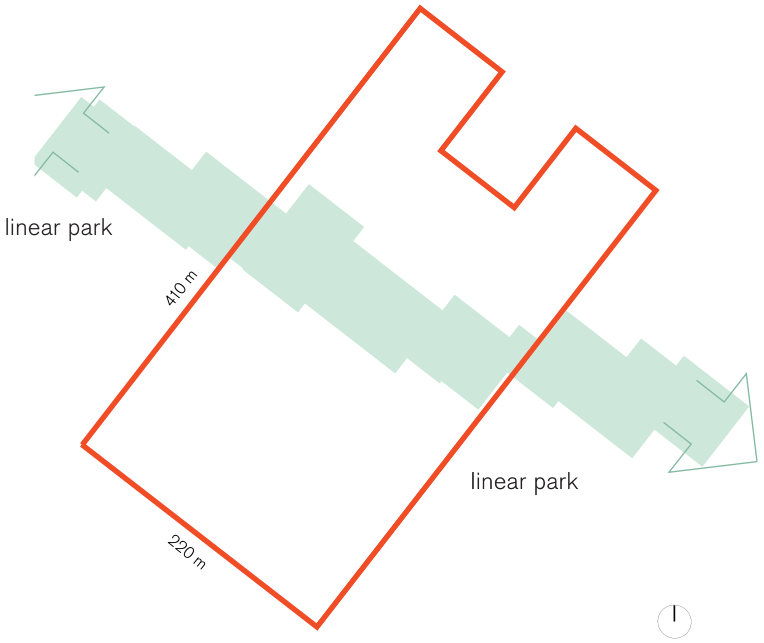
Solar



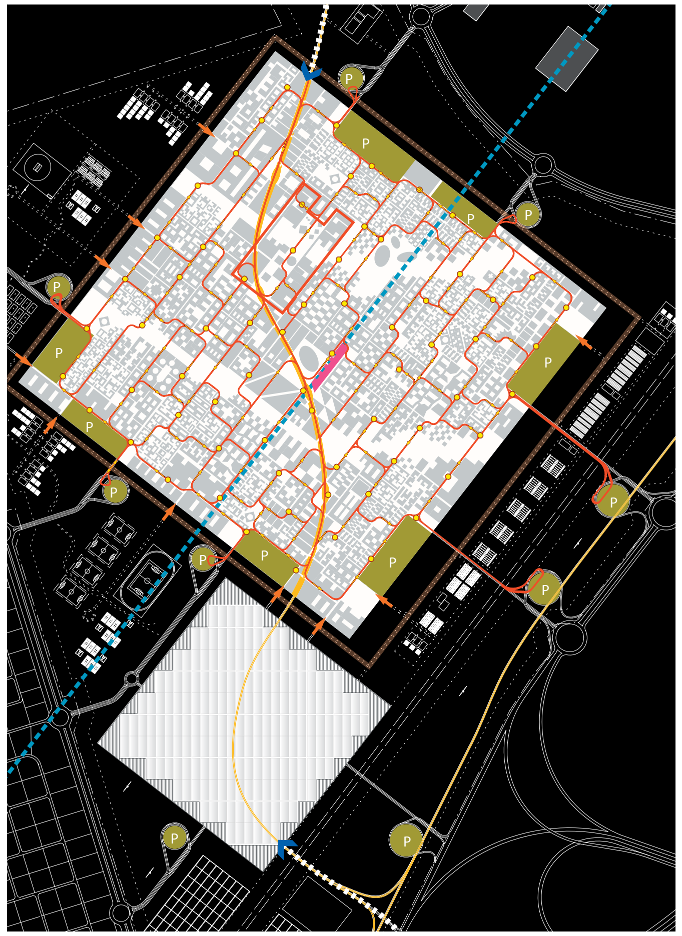


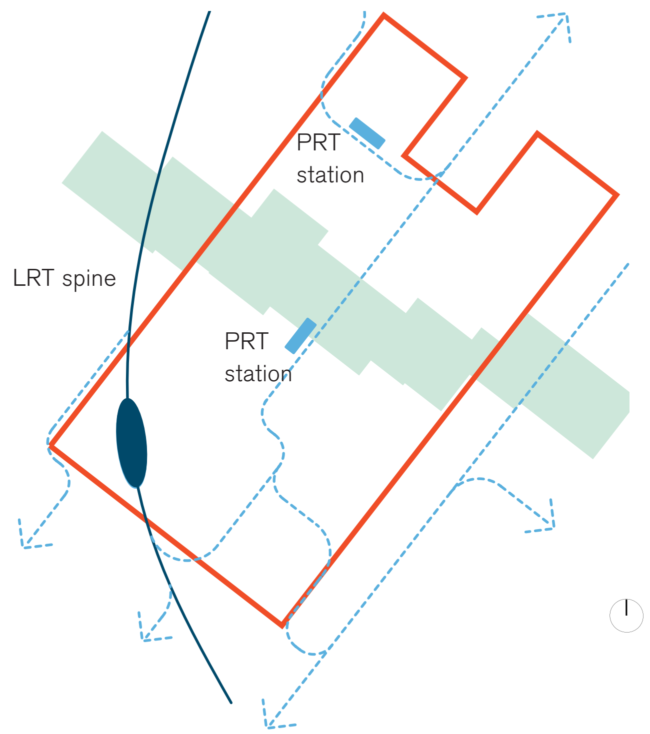
Linear Park



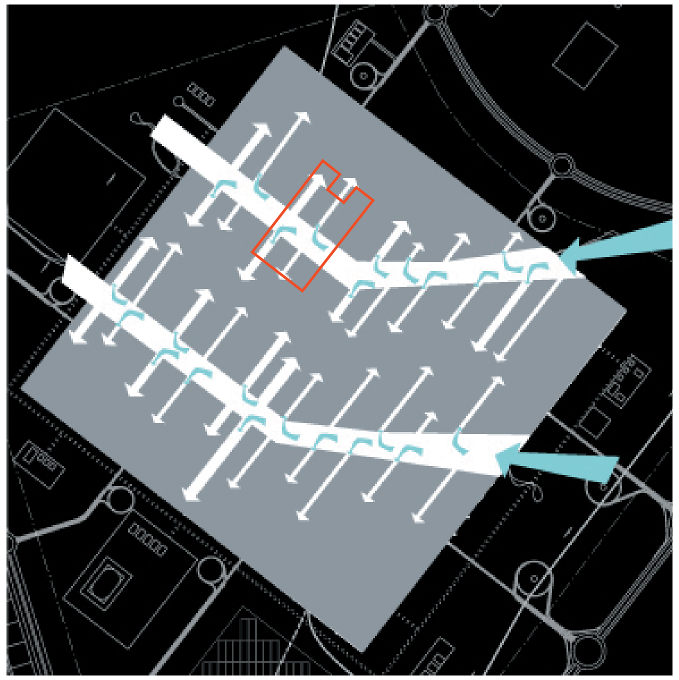


Transport



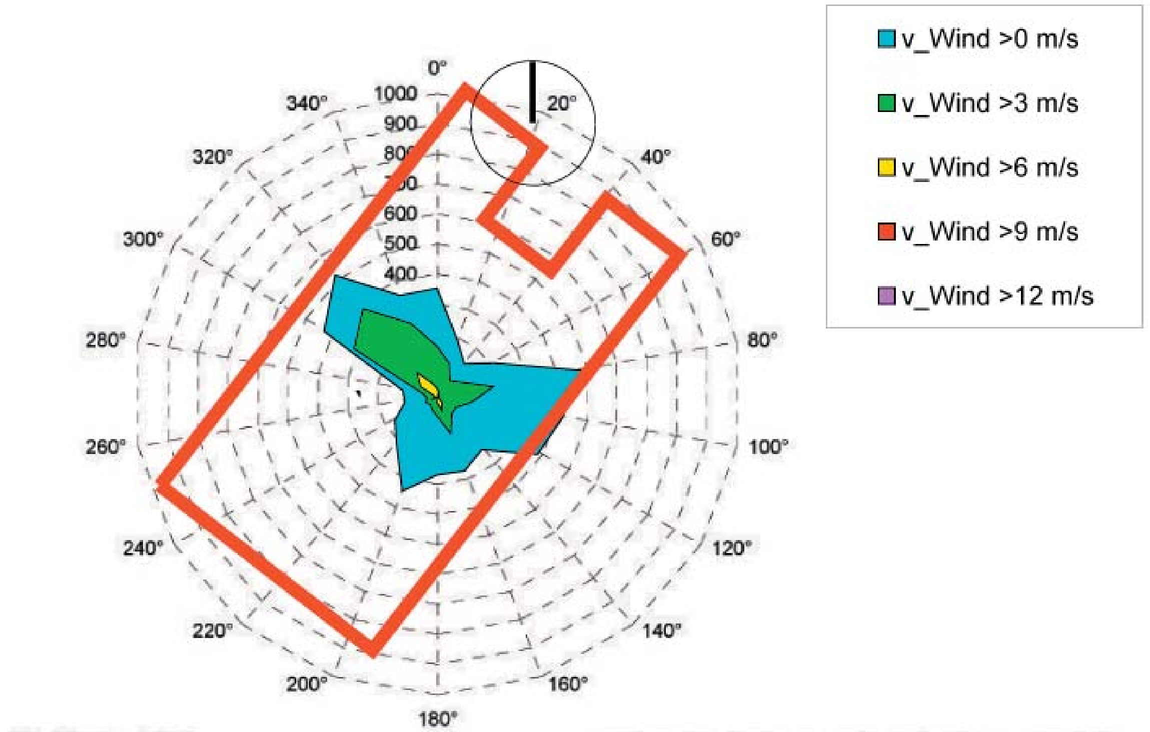


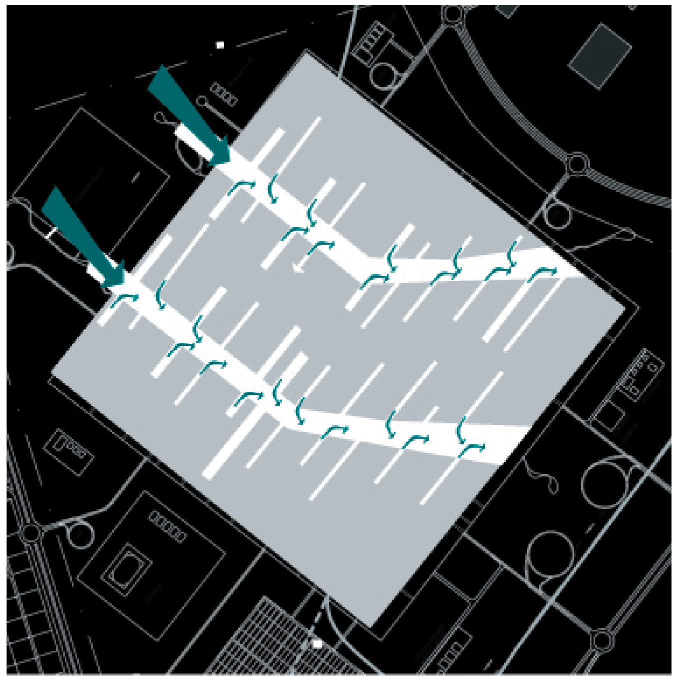
Wind



Cold wind coming from inland

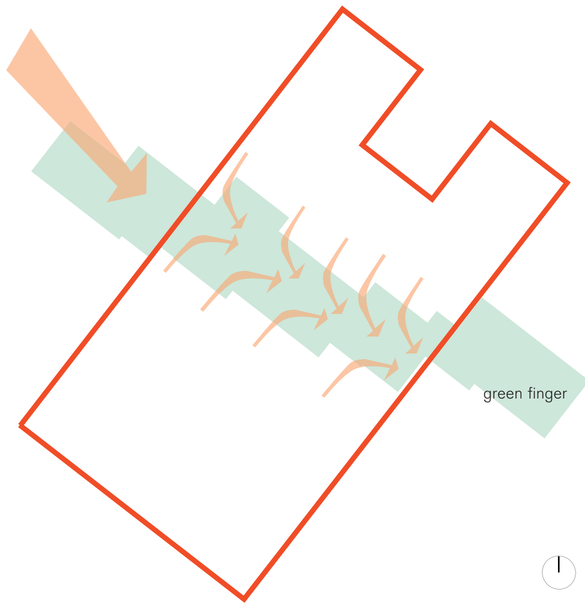
Cold wind

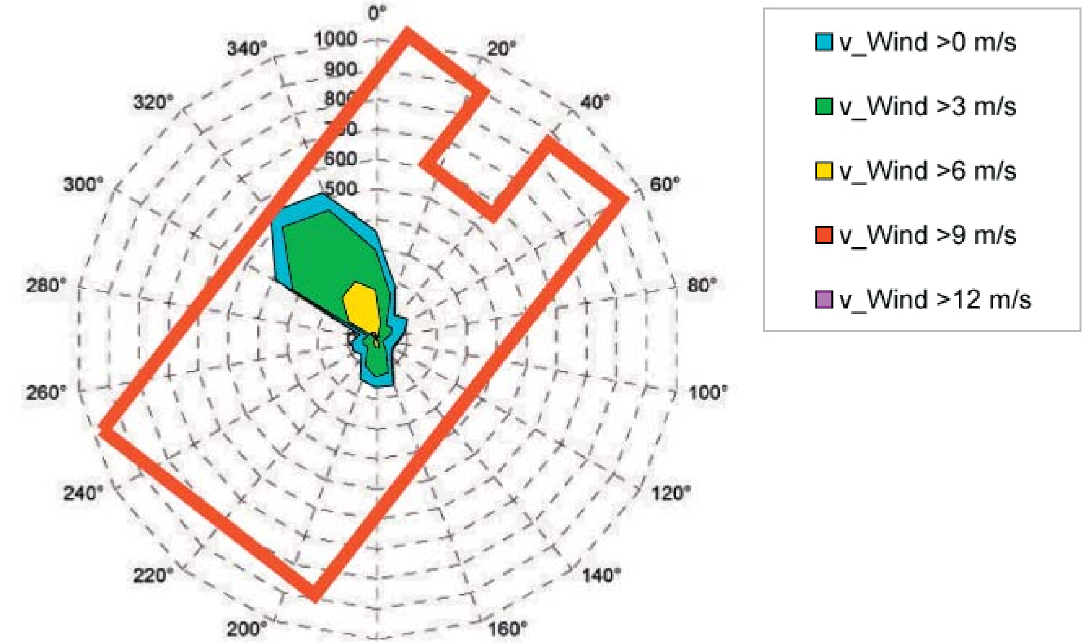




Hot wind coming from ocean

Hot wind



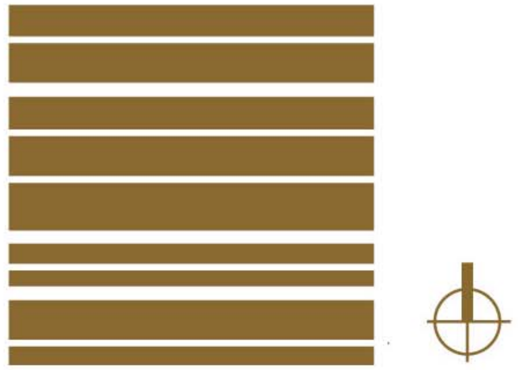


Introduction

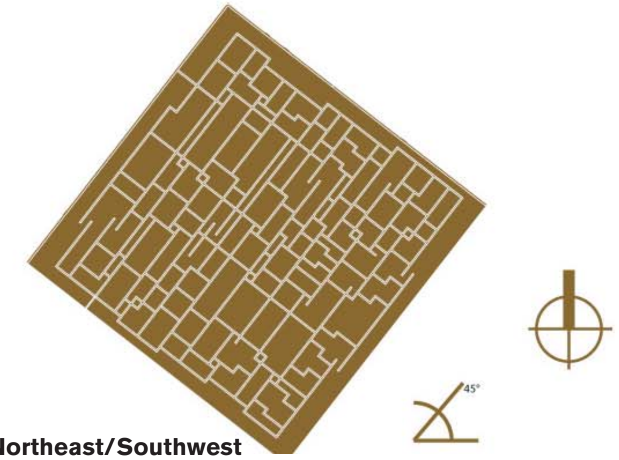
Lessons from Masdar Masterplan-Orientation

Orientation

North/South
The North-South orientation of streets allows sunlight penetration to the urban fabric with a subsequent increase in cooling loads



East/West
An East-West alignment results in an increase in cooling load requirement due to the exposure of external walls to sunlight.



Northeast/Southwest
The Northeast-Southwest orientation of the city fabric provides optimal shading

FAR density
Site to footprint

FAR
University
plot

2.35

Introduction

Lessons from Masdar Masterplan-Street Profile and Dimension

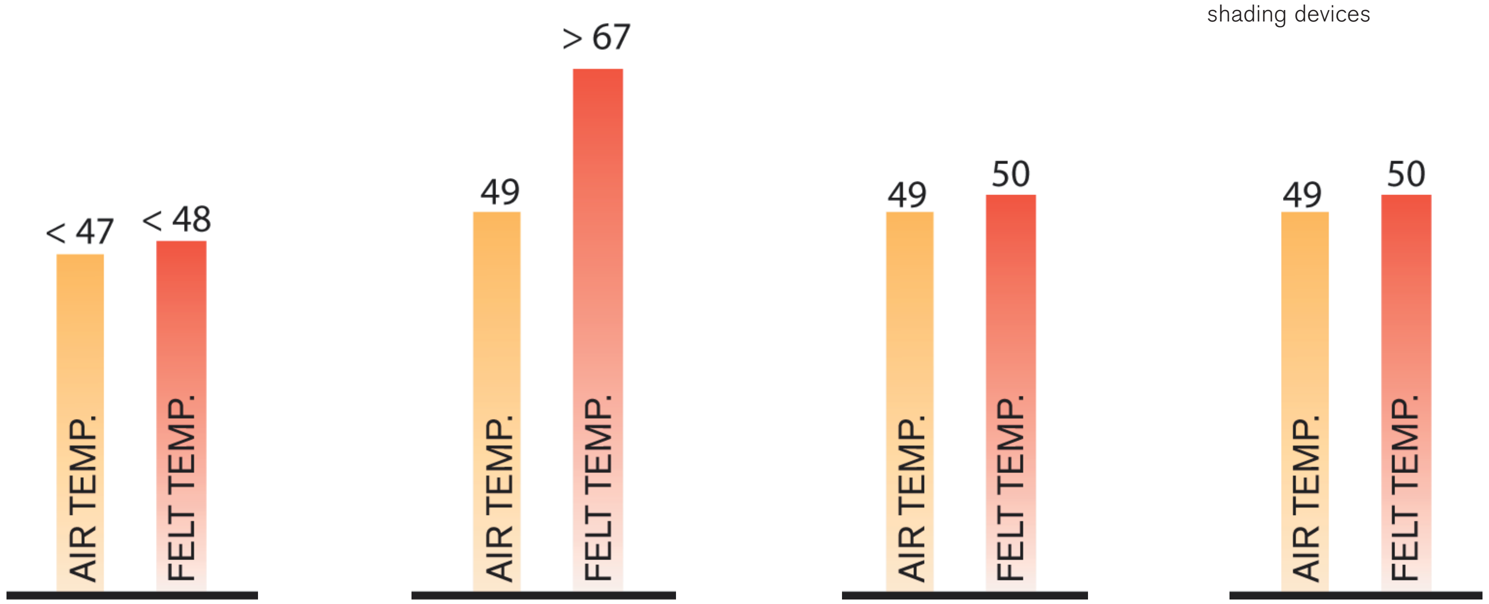
Street Profile: overhang/ courtyards

vegetation in courtyard

open courtyard

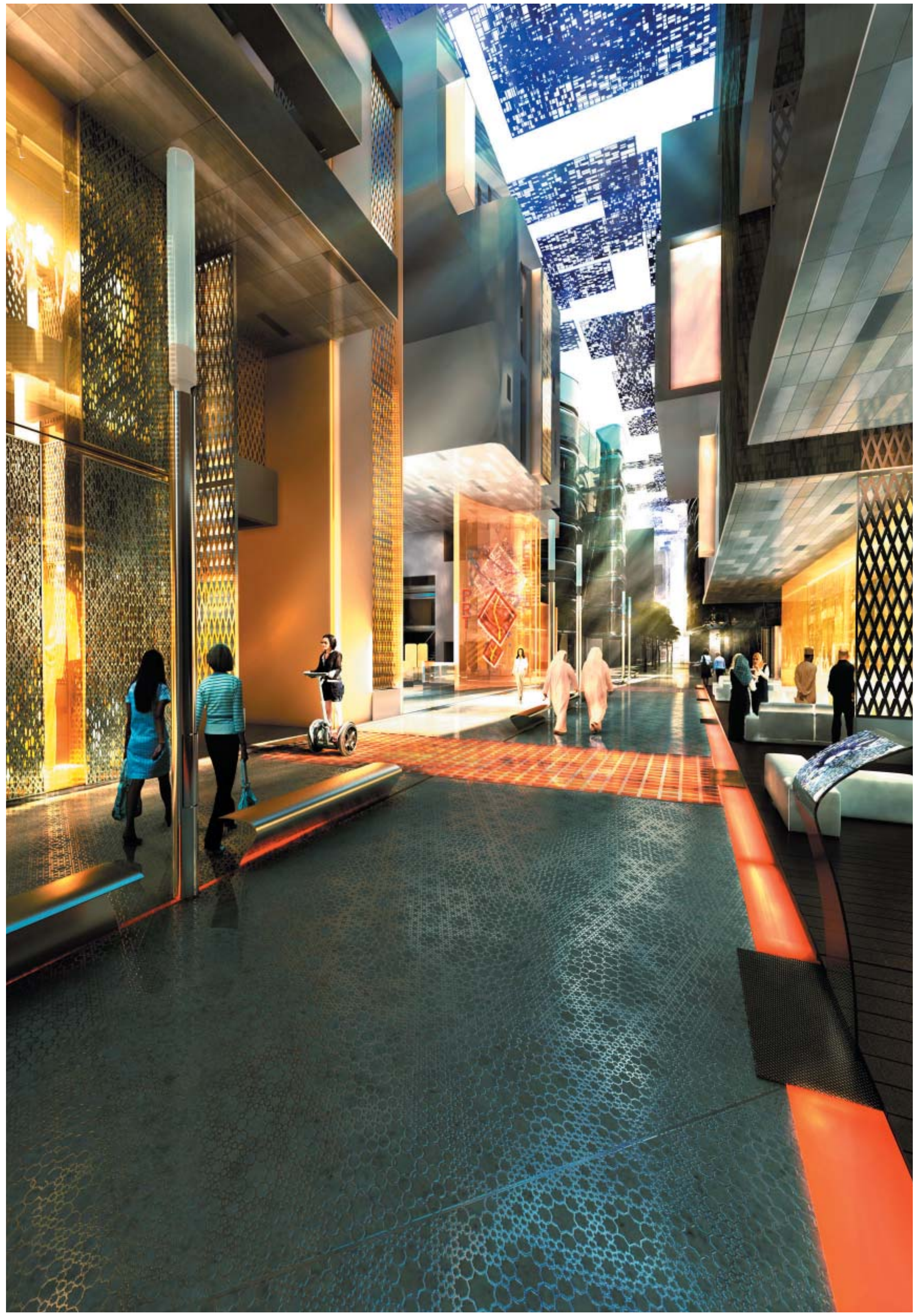
street setback

street setback with shading devices



Courtyards
Traditionally utilized in hot climates, courtyards offer multiple advantages in creating efficient and comfortable micro climates that modify harsh climatic conditions and to reduce energy consumption. Surrounding walls or colonnades provide shade for the courtyard, while permitting natural, indirect light. Courtyards contribute to natural ventilation, which helps to reduce the cost for artificial cooling and to increase comfort. In addition, courtyards often fill an aesthetic and social function providing a pleasant place for family gatherings and social activities.

Street configuration
A narrow street with a specific profile is the best configuration to keep the temperature low.



2

Design Development
Introduction

The following pages of this chapter illustrate the historical design and development of the Masdar Institute of Science and Technology (M.I.S.T.) so far. Through a series of open discussions, Foster + Partners and M.I.S.T have started to develop the visionary ideals of providing a unique research facility, whose sole purpose is to develop and provide some of the sustainable technologies of the future, set out within an interactive, collaborative and flexible campus.

It charts the studies into the various forms of university models currently employed today in campus designs, testing various configurations and interpretations conscious of the need to ensure that sustainability is married to providing an environment which is both attractive and enjoyable to live in. Investigations included looking into relationship models such as: -

- Functional neighbourhoods
- Faculty neighbourhoods
- Live/work/research environments
- Cross-functional layouts
- and network neighbourhoods.

Through an on-going process of models and workshops, Foster + Partners and M.I.S.T have been able to establish basic arrangements and associations and this has evolved through further discussions to the current thoughts and strategies of the conceptual design held within this document for a post-graduate facility that will also be the first insight into the sustainable city of the future…Masdar.

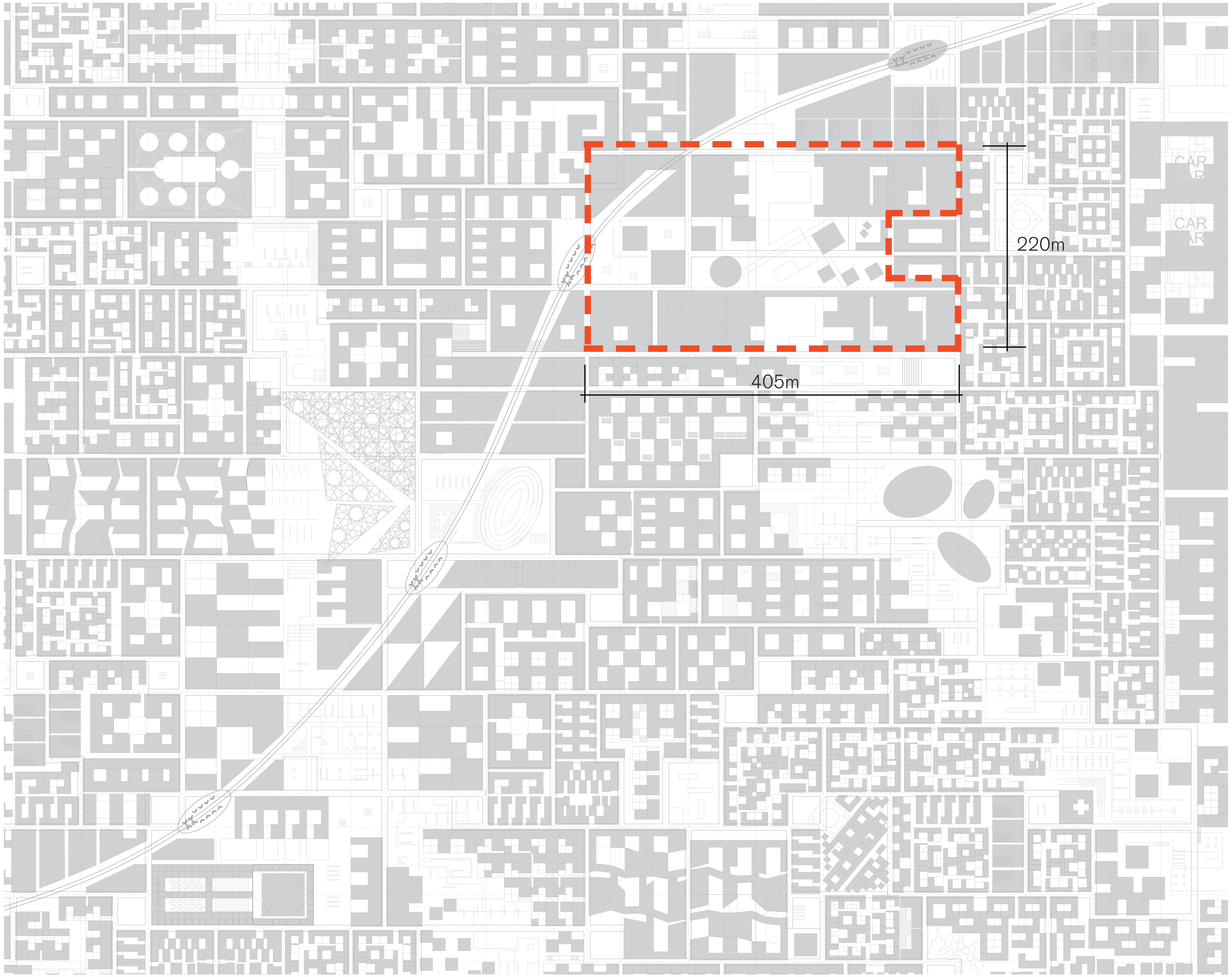
Design Development

Site Dimension

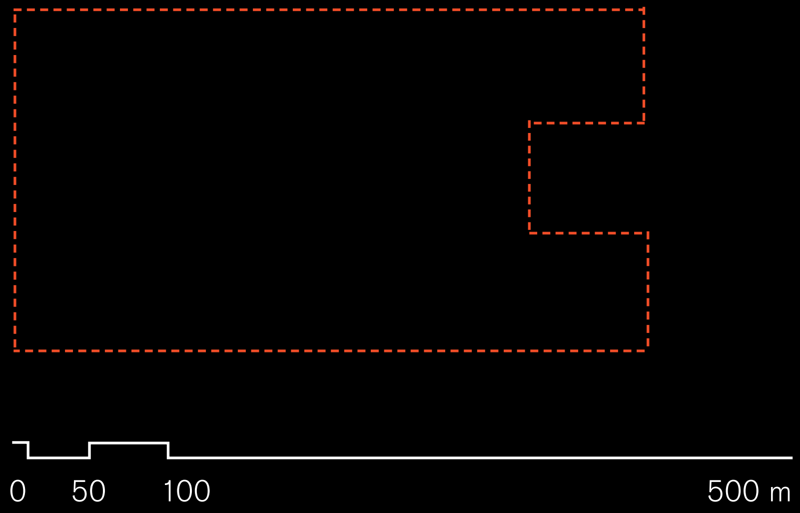
Location
Masdar, Abu Dhabi, United Arab Emirates

Scale
1:5000

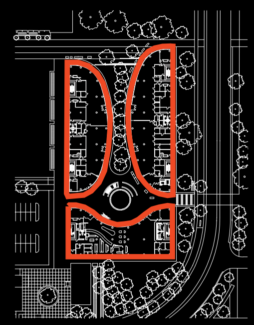
Students
800 (2015)



M.I.S.T, Abu Dhabi, U.A.E

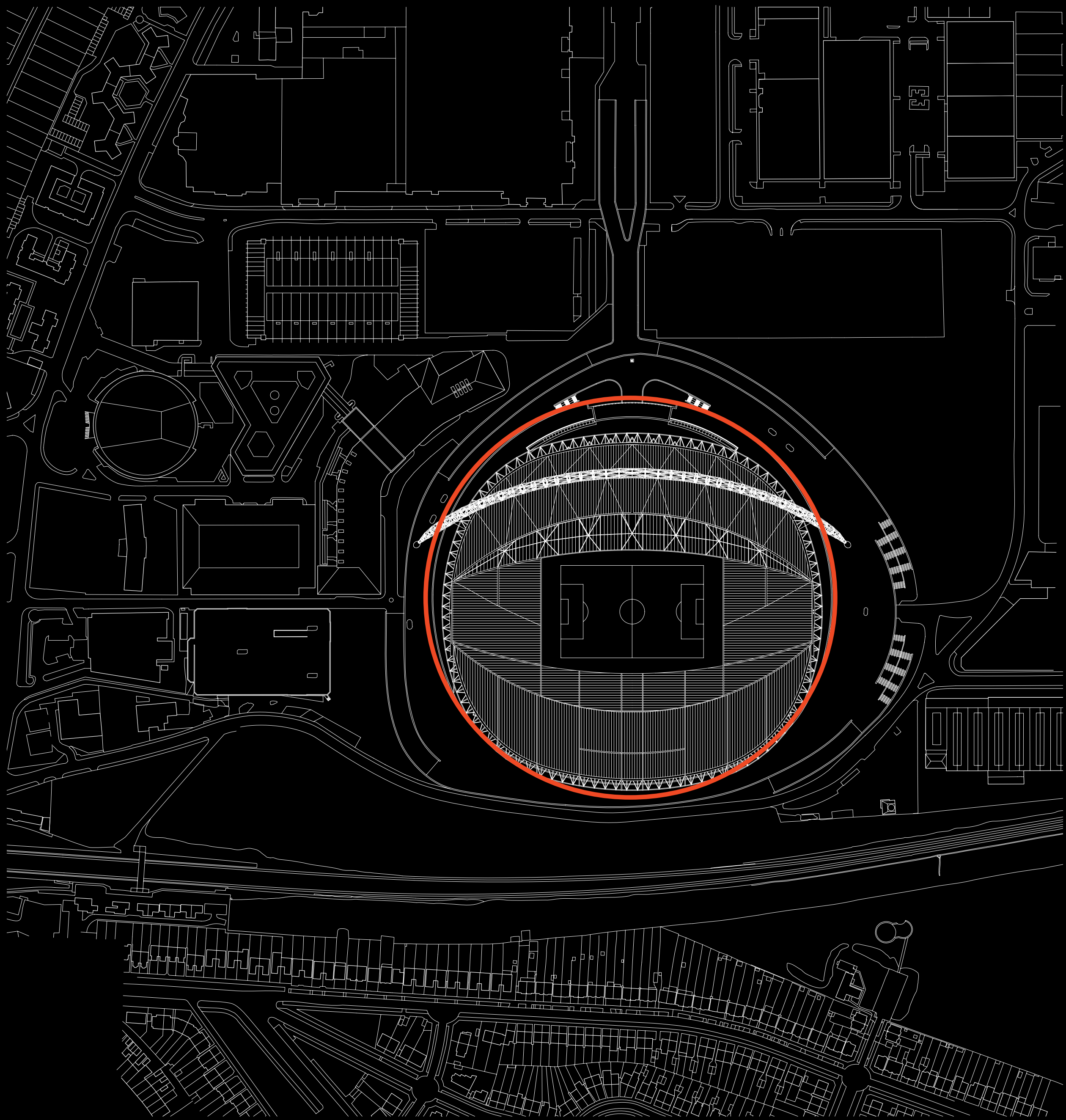


Clark Centre, Stanford University
California, U.S



Foster + Partners Studio and the Albion, London, U.K

Wembley Stadium, London, U.K



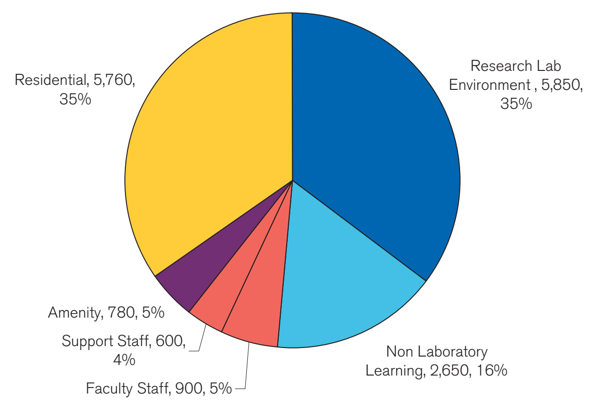
Design Development

Brief Phase 1A -Accomodation Requirements 2009

Students	100	
Programs	5	
Average Program Size	20	
Faculty Staff	30	
Support Staff	30	(not inc technicians)

Accommodation Type	No.	Size (m2) / per person/room	%age circulation	Size inc. shared Circulation (NIA)	%age Core	Gross Size	Total Gross Area (m2)
Research Lab Environment							
Lab Positions	80	11.90	0.15	14.00	30%	20.00	1,600
Write-up Positions	100	5.95	0.15	7.00	30%	10.00	1,000
Lab support space	80	14.88	0.15	17.50	30%	25.00	2,000
Special/machine lab space	1	178.50	0.15	210.00	30%	300.00	300
Clean Rooms	1	297.50	0.15	350.00	30%	500.00	500
Computer Labs	1	178.50	0.15	210.00	30%	300.00	300
Server rooms	1	89.25	0.15	105.00	30%	150.00	150
Non Laboratory Learning							
Classrooms	5	102.00	0.15	120.00	20%	150.00	750
Larger classroom	1	340.00	0.15	400.00	20%	500.00	500
Meeting rooms (10 person)	5	27.20	0.15	32.00	20%	40.00	200
Library positions	80	10.20	0.15	12.00	20%	15.00	1,200
Faculty Staff							
Academic staff cellular offices	30	20.40	0.15	24.00	20%	30.00	900
Academic staff open plan desks	0	10.20	0.15	12.00	20%	15.00	0
Support Staff							
Non-academic staff cellular offices	10	20.40	0.15	24.00	20%	30.00	300
Non-academic staff open plan desks	20	10.20	0.15	12.00	20%	15.00	300
Amenity Space							
Multipurpose Hall	0	2.72	0.15	3.20	20%	4.00	0
Catering facilities	160	2.04	0.15	2.40	20%	3.00	480
Sports and other shared facilities (inc prayer rooms)	100	2.04	0.15	2.40	20%	3.00	300
Mosque	0	2.04	0.15	2.40	20%	3.00	0
Residential							
Students to Accommodate	90		included		included	NA	NA
Student Accommodation-Single	76.5		included		included	60.00	4,590
Student Accommodation - with Spouse	9		included		included	80.00	720
Student Accommodation - with Family	4.5		included		included	100.00	450
TOTAL							16,540

Research Lab Environment	5,850
Non Laboratory Learning	2,650
Faculty Staff	900
Support Staff	600
Amenity	780
Residential	5,760
TOTAL	16,540



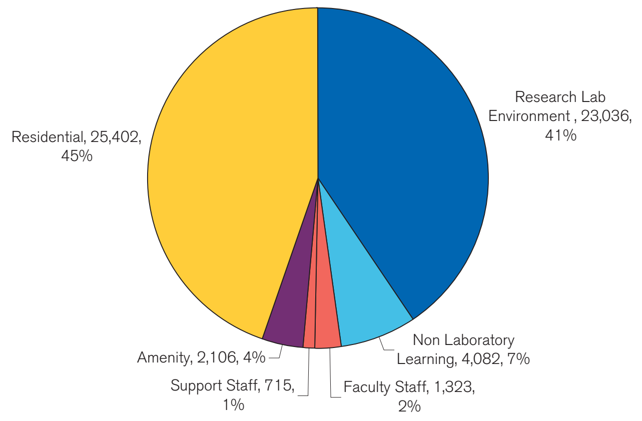
Design Development

Brief Phase 1B -Accomodation Requirements 2011

Students	441	
Programs	10	
Average Program Size	44	
Faculty Staff	44	
Support Staff	37	(not inc technicians)

Accommodation Type	No.	Size (m2) / per person/room	%age circulation	Size inc. shared Circulation (NIA)	%age Core	Gross Size	Total Gross Area (m2)
Research Lab Environment							
Lab Positions	353	11.90	0.15	14.00	30%	20.00	7,056
Write-up Positions	441	5.95	0.15	7.00	30%	10.00	4,410
Lab support space	353	14.88	0.15	17.50	30%	25.00	8,820
Special/machine lab space	6	178.50	0.15	210.00	30%	300.00	1,800
Clean Rooms	1	297.50	0.15	350.00	30%	500.00	500
Computer Labs	1	178.50	0.15	210.00	30%	300.00	300
Server rooms	1	89.25	0.15	105.00	30%	150.00	150
Non Laboratory Learning							
Classrooms	10	102.00	0.15	120.00	20%	150.00	1,500
Larger classroom	1	340.00	0.15	400.00	20%	500.00	500
Meeting rooms (10 person)	22	27.20	0.15	32.00	20%	40.00	882
Library positions	80	10.20	0.15	12.00	20%	15.00	1,200
Faculty Staff							
Academic staff cellular offices	44	20.40	0.15	24.00	20%	30.00	1,323
Academic staff open plan desks	0	10.20	0.15	12.00	20%	15.00	0
Support Staff							
Non-academic staff cellular offices	11	20.40	0.15	24.00	20%	30.00	330
Non-academic staff open plan desks	26	10.20	0.15	12.00	20%	15.00	385
Amenity Space							
Multipurpose Hall	0	2.72	0.15	3.20	20%	4.00	0
Catering facilities	261	2.04	0.15	2.40	20%	3.00	783
Sports and other shared facilities (inc prayer rooms)	441	2.04	0.15	2.40	20%	3.00	1,323
Mosque	0	2.04	0.15	2.40	20%	3.00	0
Residential							
Students to Accommodate	396.9		included		included	NA	NA
Student Accommodation-Single	337.365		included		included	60.00	20,242
Student Accommodation - with Spouse	39.69		included		included	80.00	3,175
Student Accommodation - with Family	19.845		included		included	100.00	1,985
TOTAL							56,663

Research Lab Environment	23,036
Non Laboratory Learning	4,082
Faculty Staff	1,323
Support Staff	715
Amenity	2,106
Residential	25,402
TOTAL	56,663



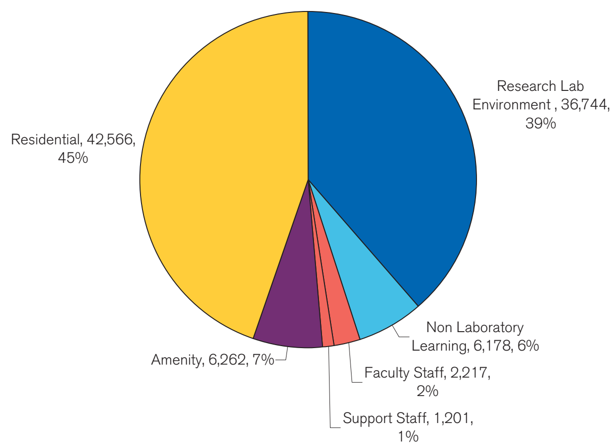
Design Development

Brief Phase 2 -Accomodation Requirements 2014

Students	739	
Programs	10	
Average Program Size	74	
Faculty Staff	74	
Support Staff	62	(not inc technicians)

Accommodation Type	No.	Size (m2) / per person/room	%age circulation	Size inc. shared Circulation (NIA)	%age Core	Gross Size	Total Gross Area (m2)
Research Lab Environment							
Lab Positions	591	11.90	0.15	14.00	30%	20.00	11,824
Write-up Positions	739	5.95	0.15	7.00	30%	10.00	7,390
Lab support space	591	14.88	0.15	17.50	30%	25.00	14,780
Special/machine lab space	6	178.50	0.15	210.00	30%	300.00	1,800
Clean Rooms	1	297.50	0.15	350.00	30%	500.00	500
Computer Labs	1	178.50	0.15	210.00	30%	300.00	300
Server rooms	1	89.25	0.15	105.00	30%	150.00	150
Non Laboratory Learning							
Classrooms	20	102.00	0.15	120.00	20%	150.00	3,000
Larger classroom	1	340.00	0.15	400.00	20%	500.00	500
Meeting rooms (10 person)	37	27.20	0.15	32.00	20%	40.00	1,478
Library	80	10.20	0.15	12.00	20%	15.00	1,200
Faculty Staff							
Academic staff cellular offices	74	20.40	0.15	24.00	20%	30.00	2,217
Academic staff open plan desks	0	10.20	0.15	12.00	20%	15.00	0
Support Staff							
Non-academic staff cellular offices	18	20.40	0.15	24.00	20%	30.00	554
Non-academic staff open plan desks	43	10.20	0.15	12.00	20%	15.00	647
Amenity Space							
Multipurpose Hall	300	2.72	0.15	3.20	20%	4.00	1,200
Catering facilities	437	2.04	0.15	2.40	20%	3.00	1,312
Sports and other shared facilities	800	2.04	0.15	2.40	20%	3.00	2,400
Mosque	450	2.04	0.15	2.40	20%	3.00	1,350
Residential							
Students to Accommodate	665		included		included	NA	NA
Student Accommodation-Single	565		included		included	60.00	33,920
Student Accommodation - with Spouse	67		included		included	80.00	5,321
Student Accommodation - with Family	33		included		included	100.00	3,326
TOTAL							**95,168**

Research Lab Environment	36,744
Non Laboratory Learning	6,178
Faculty Staff	2,217
Support Staff	1,201
Amenity	6,262
Residential	42,566
TOTAL	95,168



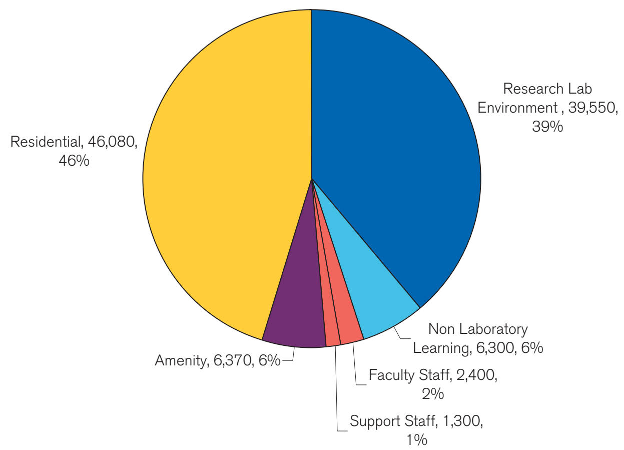
Design Development

Brief Phase 3 -Accomodation Requirements 2015

Students	800	
Programs	10	
Average Program Size	80	
Faculty Staff	80	
Support Staff	67	(not inc technicians)

Accommodation Type	No.	Size (m2) / per person/room	%age circulation	Size inc. shared Circulation (NIA)	%age Core	Gross Size	Total Gross Area (m2)
Research Lab Environment							
Lab Positions	640	11.9	0.15	14.00	30%	20.00	12,800
Write-up Positions	800	6.0	0.15	7.00	30%	10.00	8,000
Lab support space	640	14.9	0.15	17.50	30%	25.00	16,000
Special/machine lab space	6	178.5	0.15	210.00	30%	300.00	1,800
Clean Rooms	1	297.5	0.15	350.00	30%	500.00	500
Computer Labs	1	178.5	0.15	210.00	30%	300.00	300
Server rooms	1	89.3	0.15	105.00	30%	150.00	150
Non Laboratory Learning							
Classrooms	20	102.0	0.15	120.00	20%	150.00	3,000
Larger classroom	1	340.0	0.15	400.00	20%	500.00	500
Meeting Rooms (10 person)	40	27.2	0.15	32.00	20%	40.00	1,600
Library	80	10.2	0.15	12.00	20%	15.00	1,200
Faculty Staff							
Academic staff cellular offices	80	20.4	0.15	24.00	20%	30.00	2,400
Academic staff open plan desks	0	10.2	0.15	12.00	20%	15.00	0
Support Staff							
Non-academic staff cellular offices	20	20.4	0.15	24.00	20%	30.00	600
Non-academic staff open plan desks	47	10.2	0.15	12.00	20%	15.00	700
Amenity Space							
Multipurpose Hall	300	2.7	0.15	3.20	20%	4.00	1,200
Catering facilities	473	2.0	0.15	2.40	20%	3.00	1,420
Sports and other shared facilities	800	2.0	0.15	2.40	20%	3.00	2,400
Mosque	450	2.0	0.15	2.40	20%	3.00	1,350
Residential							
Students to Accommodate	720		included		included	NA	NA
Student Accommodation-Single	612		included		included	60.00	36,720
Student Accommodation - with Spouse	72		included		included	80.00	5,760
Student Accommodation - with Family	36		included		included	100.00	3,600
TOTAL							102,000

Research Lab Environment	39,550
Non Laboratory Learning	6,300
Faculty Staff	2,400
Support Staff	1,300
Amenity	6,370
Residential	46,080
TOTAL	102,000



Design Development
Area Breakdown

☐ 100 m²

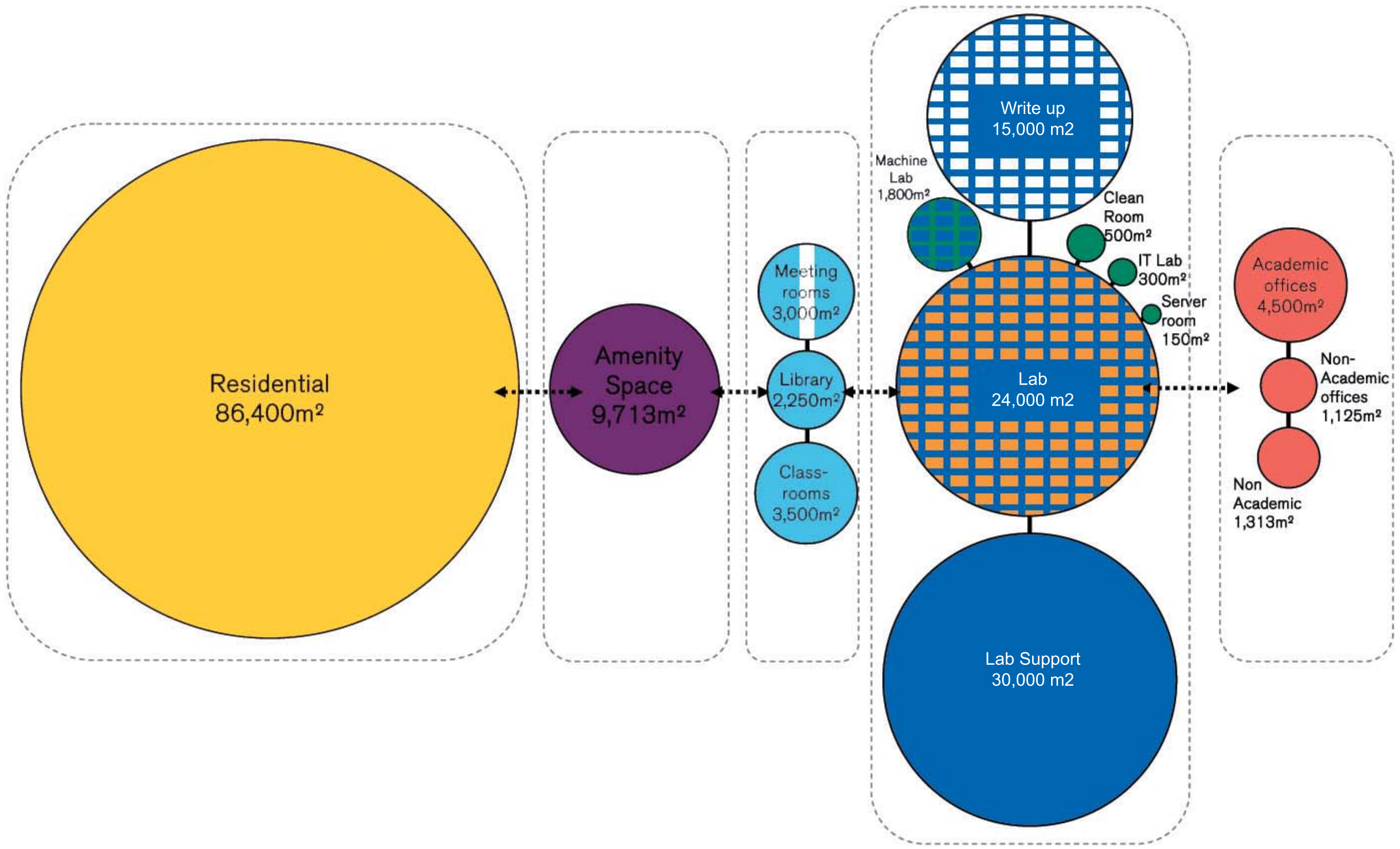
	Phase 1a 2009 — 100 students		**Phase 1b** 2011 — 441 students		**Phase 2** 2014 — 790 students		**Phase 3** 2015 — 800 students	
Lab related space - Lab positions - Write up positions - Lab support	+ 4600 m²	4600 m²	+15686 m²	20286m²	+13714 m²	34000 m²	+2800 m²	36800 m²
Special machine lab	+ 300 m²	300m²	+ 1500 m²	1800m²	+ 0 m²	1800m²	+ 0 m²	1800m²
Clean room	+80 m²	80m²	+ 80 m²	160m²	+ 340 m²	500m²	+ 0 m²	500m²
Computer lab	+ 300 m²	300m²	+ 0 m²	300m²	+ 0 m²	300m²	+ 0 m²	300m²
Server room	+ 150 m²	150m²	+ 0 m²	150m²	+ 0 m²	150m²	+ 0 m²	150m²
Classroom	+ 750 m²	750m²	+ 750 m²	1500m²	+ 1500 m²	3000m²	+ 0 m²	3000m²
Larger classroom	+ 500 m²	500m²	+ 0 m²	500m²	+ 0 m²	500m²	+ 0 m²	500m²
Meeting room	+ 200 m²	200m²	+ 682 m²	882m²	+ 596 m²	1478m²	+ 122 m²	1600m²
Library positions	+ 1200 m²	1200m²	+ 0 m²	1200m²	+ 0 m²	1200m²	+ 0 m²	1200m²
Academic staff cellular offices	+ 900 m²	900 m²	+ 423 m²	1323m²	+ 894 m²	2217m²	+ 183 m²	2400m²
Non-academic staff cellular offices	+ 300 m²	300m²	+ 30 m²	330m²	+ 224 m²	554m²	+ 46 m²	600m²
Non-academic open plan desks	+ 300 m²	300m²	+ 85 m²	385m²	+ 262 m²	647m²	+ 53 m²	700m²

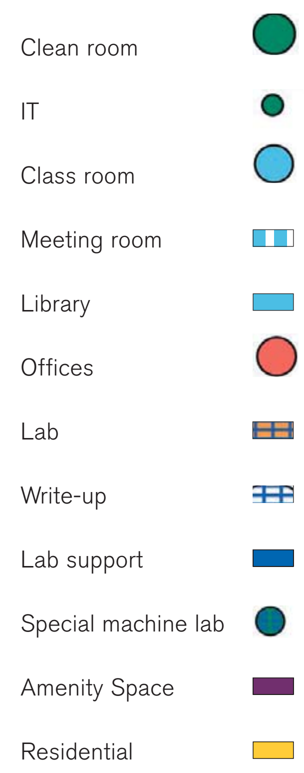
Design Development

Area Breakdown

	Phase 1a 2009 100 students	**Phase 1b** 2011 441 students	**Phase 2** 2014 790 students	**Phase 3** 2015 800 students
Multipurpose hall	0 m^2	0 m^2	+ 1200 m^2 / 1200 m^2	+ 0 m^2 / 1200 m^2
Catering facilities	+ 480 m^2 / 480 m^2	+ 303 m^2 / 783 m^2	+ 529 m^2 / 1312 m^2	+ 108 m^2 / 1420 m^2
Sports and other shared facilities	+ 300 m^2 / 300 m^2	+ 1023 m^2 / 1323 m^2	+ 1077 m^2 / 2400 m^2	+ 0 m^2 / 2400 m^2
Mosque	0 m^2	0 m^2	+ 1350 m^2 / 1350 m^2	+ 0 m^2 / 1350 m^2
Student accomodation single	+4590 m^2 / 4590 m^2	+15652 m^2 / 20242 m^2	+13678 m^2 / 33920 m^2	+2800 m^2 / 36720 m^2
Student accomodation with spouse	+720 m^2 / 720 m^2	+2455 m^2 / 3175 m^2	+2146 m^2 / 5321 m^2	+439 m^2 / 5760 m^2
Student accomodation with family	+450 m^2 / 450 m^2	+1535 m^2 / 1985 m^2	+1341 m^2 / 3326 m^2	+274 m^2 / 3600 m^2
Residential Floor Area	**5760 m^2**	**25 402 m^2**	**42 567 m^2**	**46 080 m^2**
Total Floor Area	**16 540 m^2**	**56 663 m^2**	**95 168 m^2**	**102 000 m^2**

Functional Neighbourhoods -Bubble Diagram



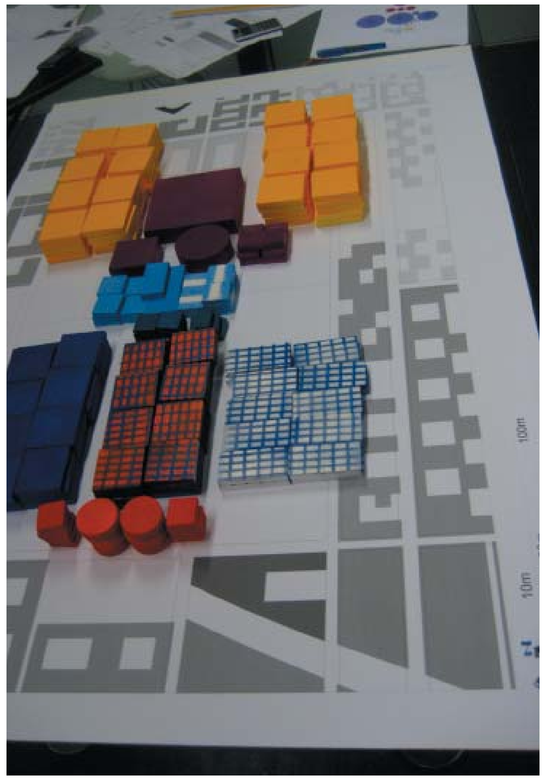


Total Gross Area: 183,550m²

Functional Neighbourhoods -Block Configuration

Option 1

Plan View



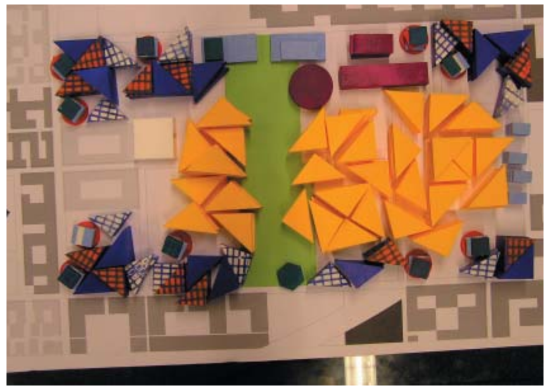
Perspective View

Option 2

Plan View

Perspective View

Option 3



Plan View

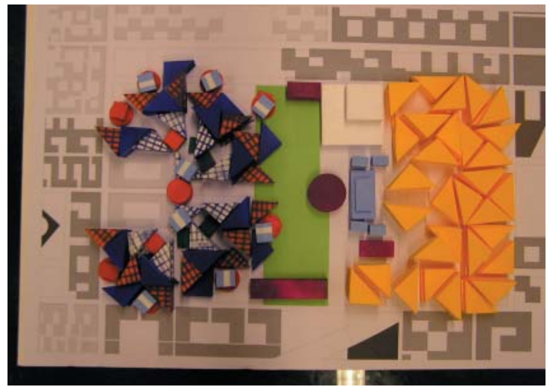
Perspective View

Option 4

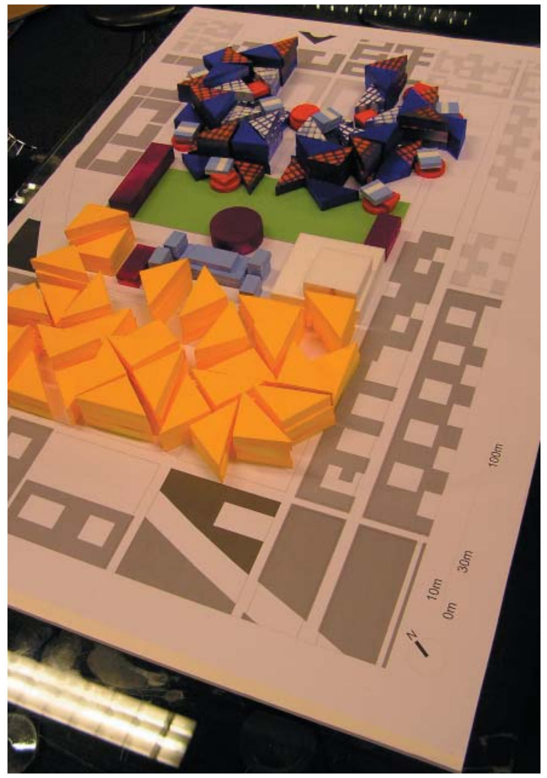
Plan View

Perspective View

Option 5



Plan View

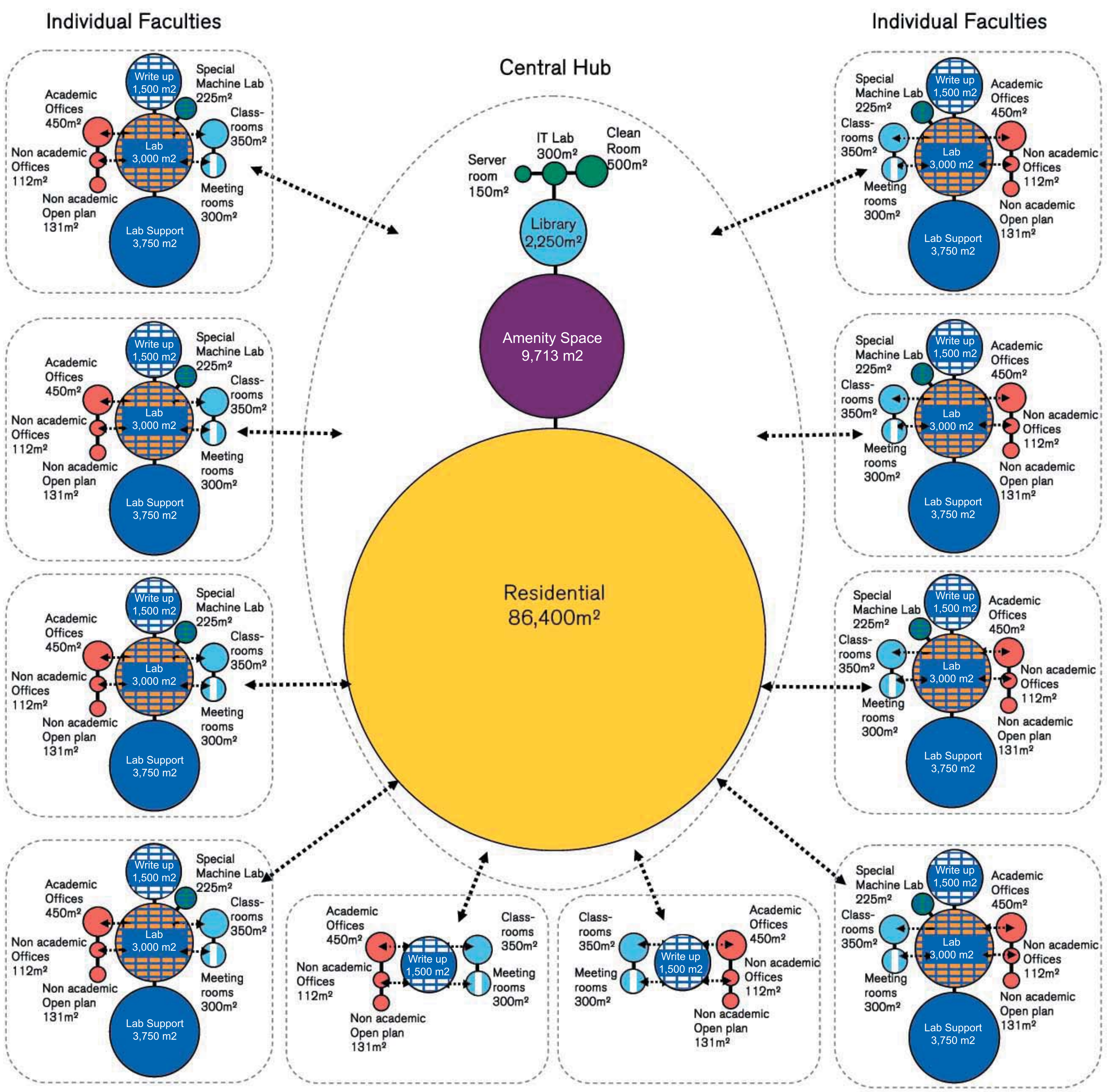


Perspective View

Design Development

Design Studies - Faculty Neighbourhoods

Faculty Neighbourhoods - Bubble Diagram



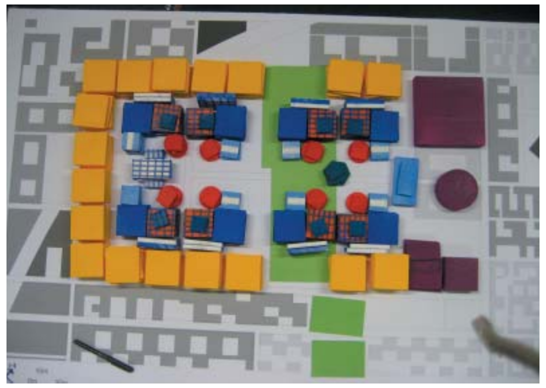
Total Gross Area: 183,550m²

Design Development

Design Studies - Faculty Neighbourhoods

Faculty Neighbourhoods Block Configuration

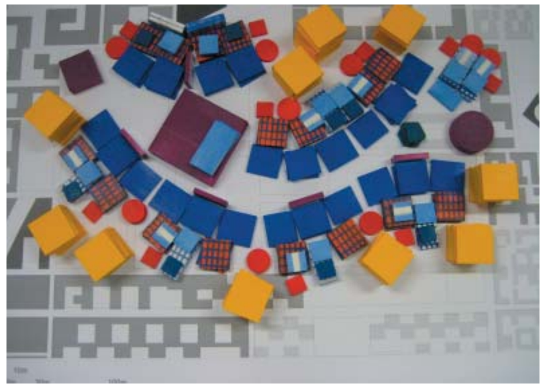
Option 1



Plan View

Perspective View

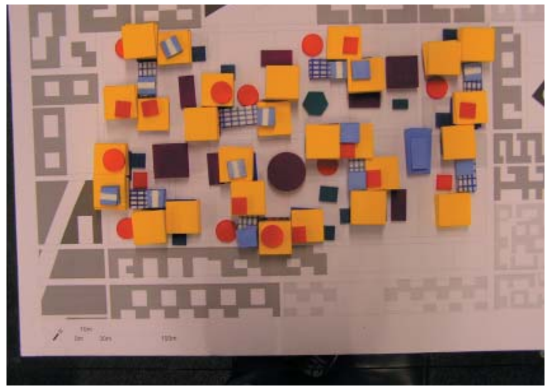
Option 2



Plan View

Perspective View

Option 3



Plan View

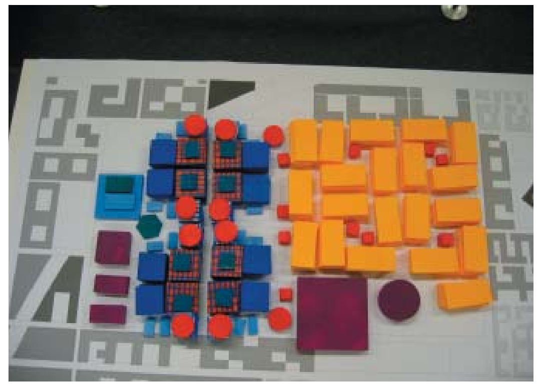
Perspective View

Option 4

Plan View

Perspective View

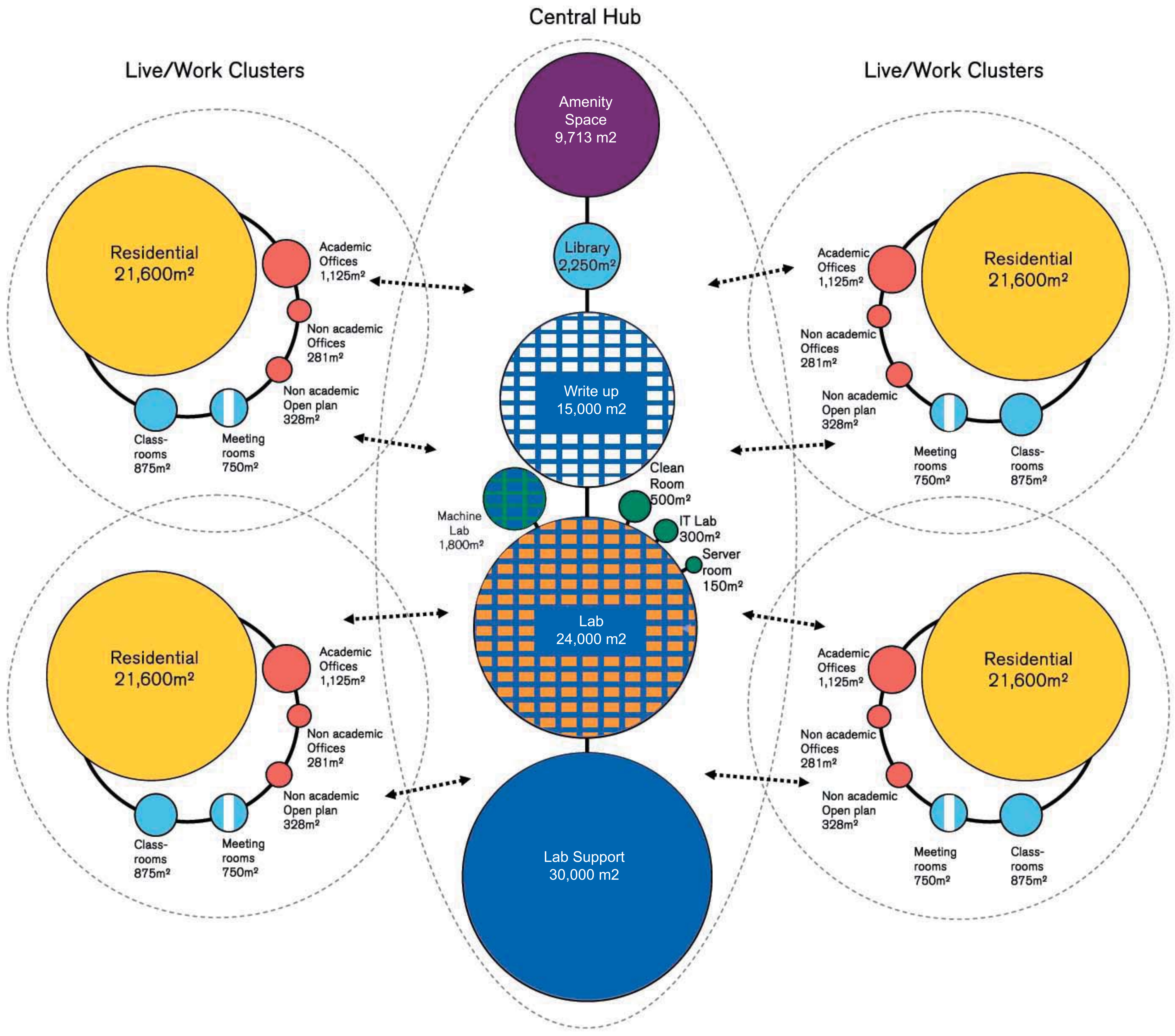
Option 5



Plan View

Perspective View

Live/ Work Neighbourhoods -Bubble Diagram



Total Gross Area: 183,550m²

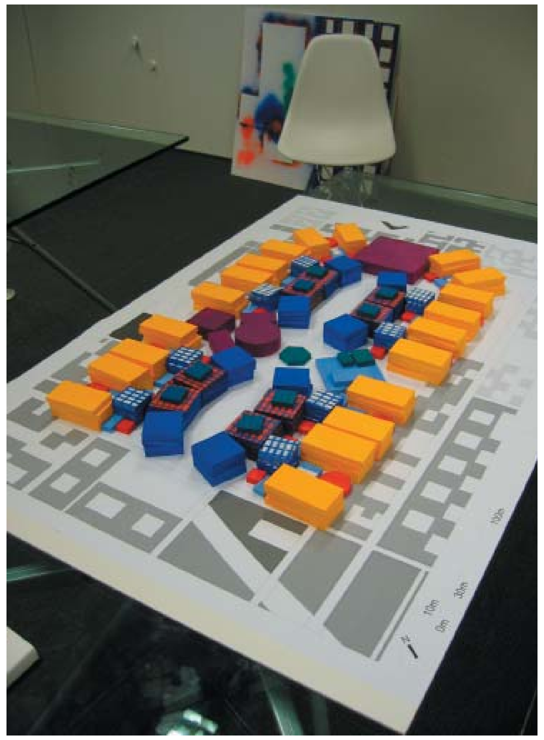
Design Development

Design Studies - Live / Work Neighbourhoods

Live/ Work Neighbourhoods -Block Configuration

Option 1

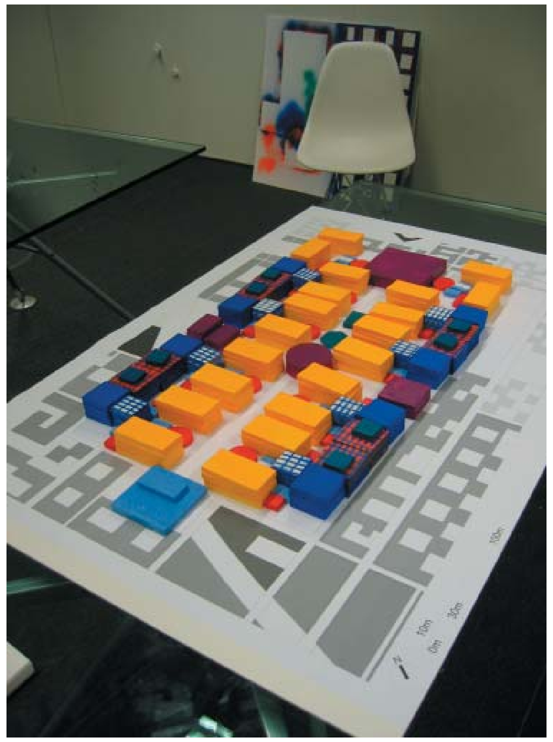
Plan View



Perspective View

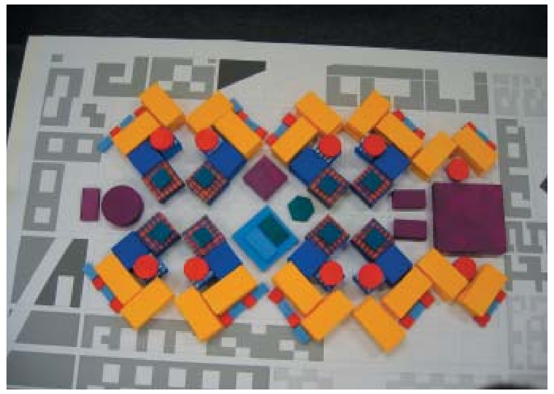
Option 2

Plan View

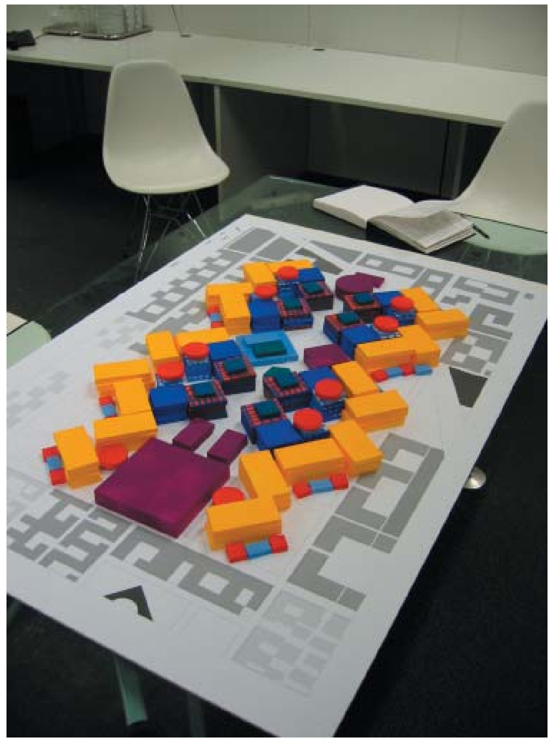


Perspective View

Option 3



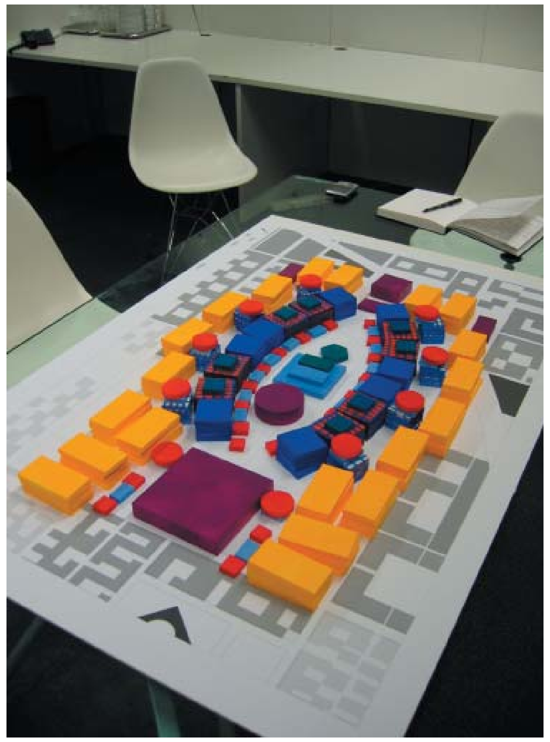
Plan View



Perspective View

Option 4

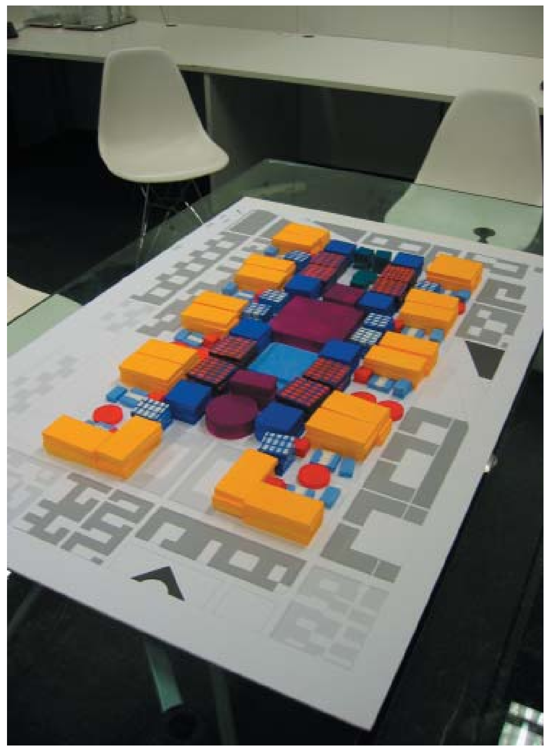
Plan View



Perspective View

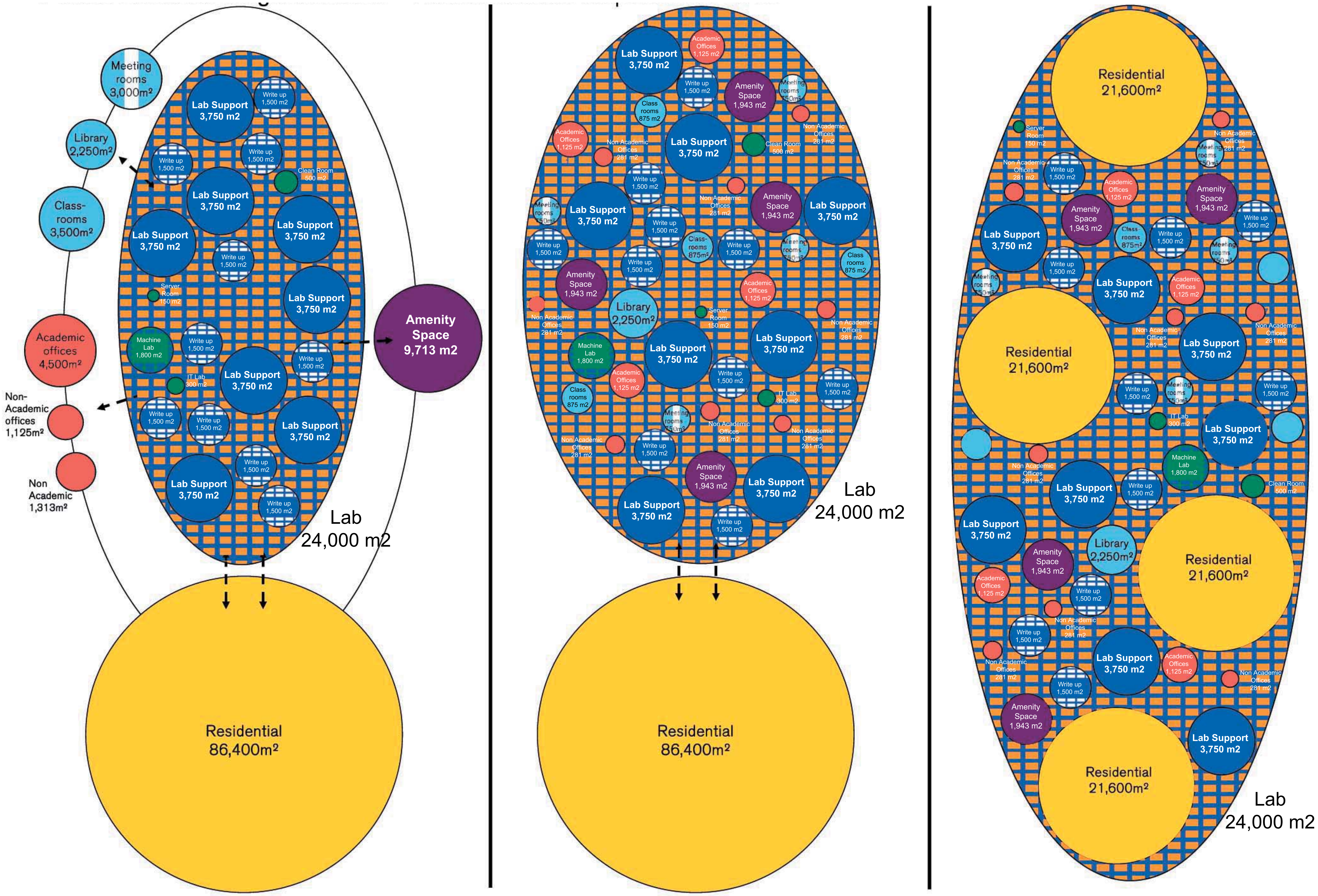
Option 5

Plan View



Perspective View

Cross Functional Neighbourhoods -Bubble Diagram



Total Gross Area: 183,550m²

Total Gross Area: 183,550m²

Total Gross Area: 183,550m²

Cross Functional Neighbourhoods -Block Configuration

Option 1

Plan View

Perspective View

Option 2

Plan View

Perspective View

Option 3

Plan View

Perspective View

Option 4

Plan View

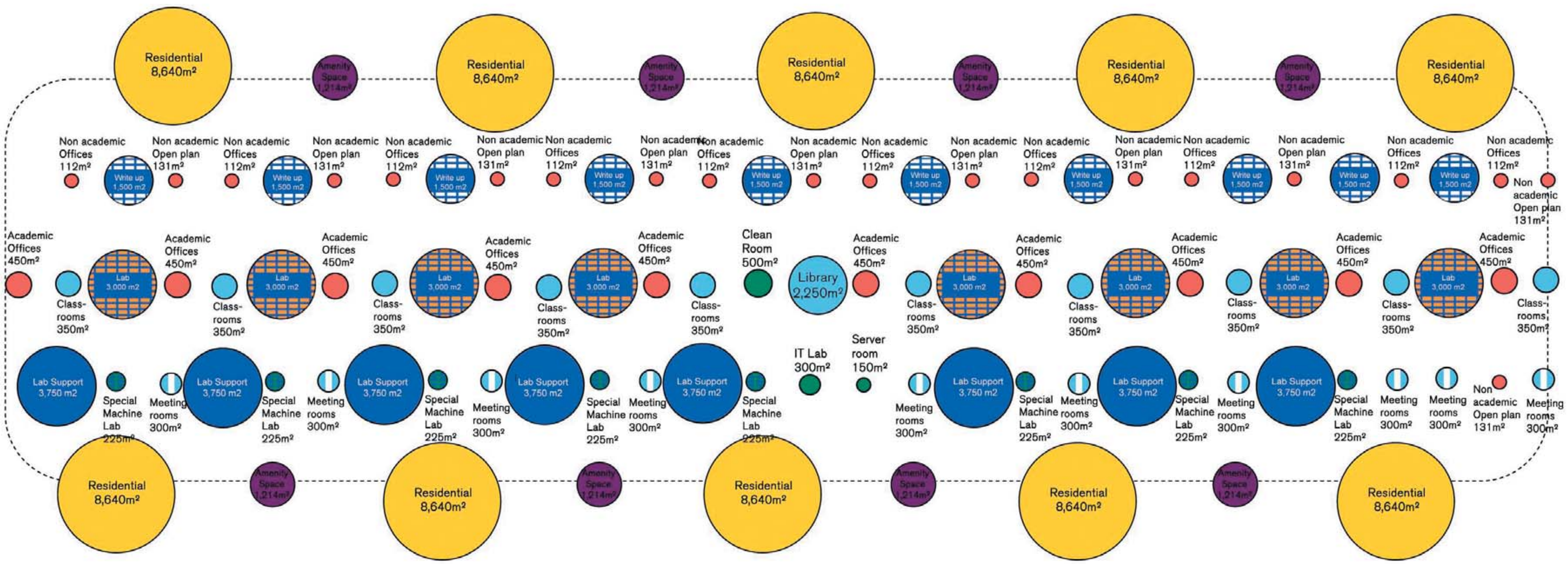
Perspective View

Option 5

Plan View

Perspective View

Networked Neighbourhoods - Bubble Diagram

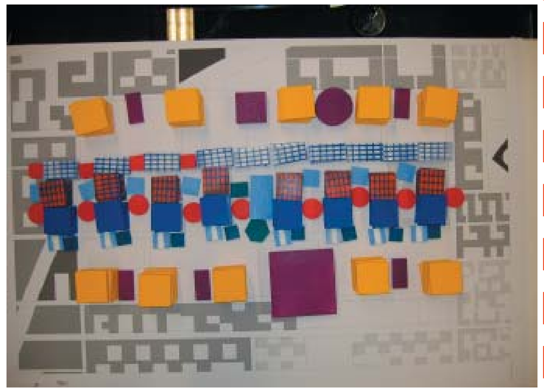


Total Gross Area: 183,550m²

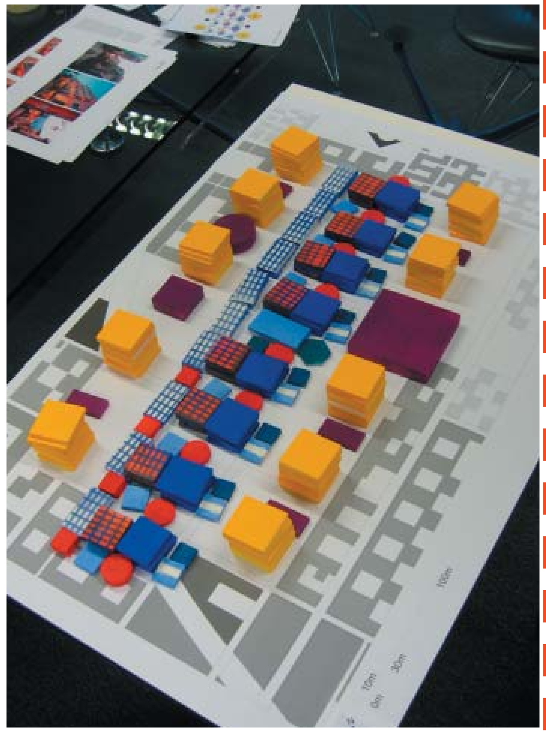
Networked Neighbourhoods Option 2+4
discussed in detail 5th December 2007
as preferred massing option

Networked Neighbourhoods -Block Configuration

Option 1

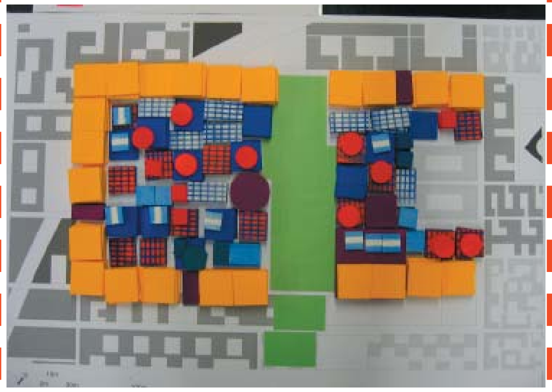


Plan View



Perspective View

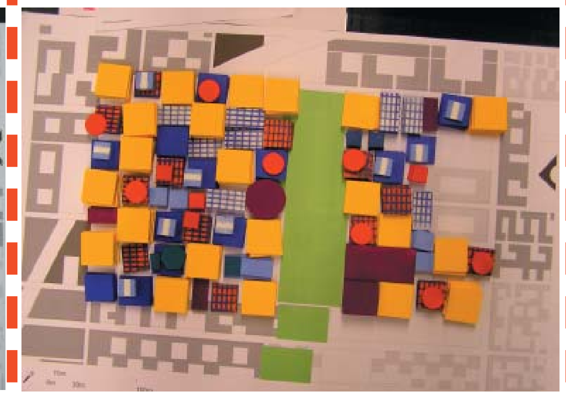
Option 2



Plan View

Perspective View

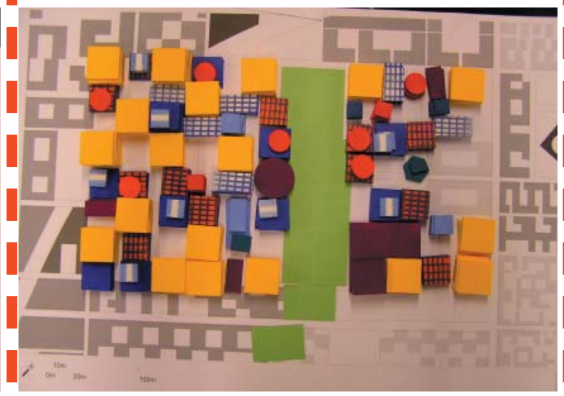
Option 3



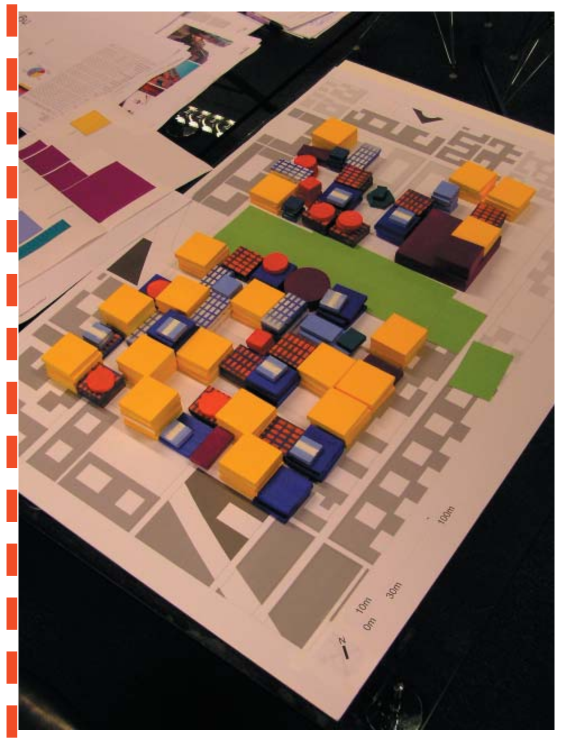
Plan View

Perspective View

Option 4

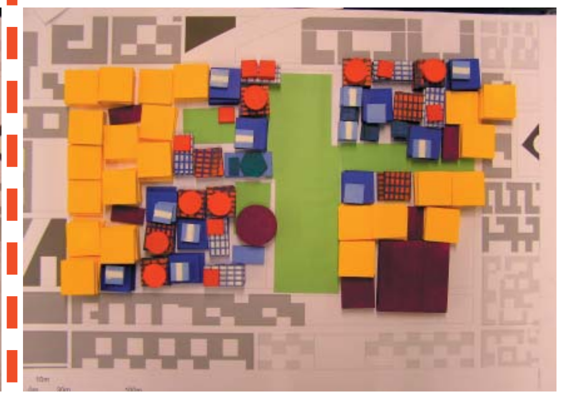


Plan View



Perspective View

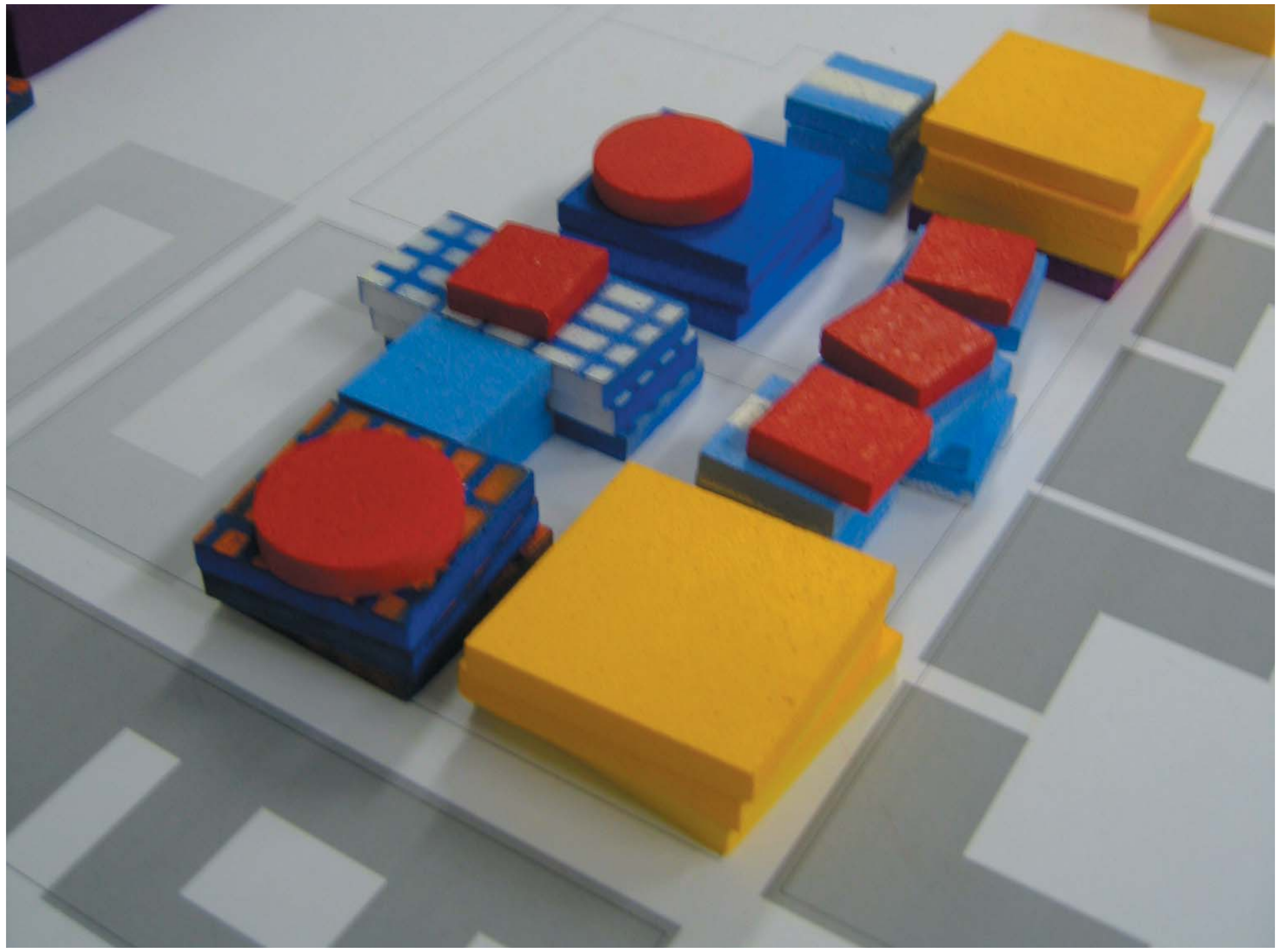
Option 5

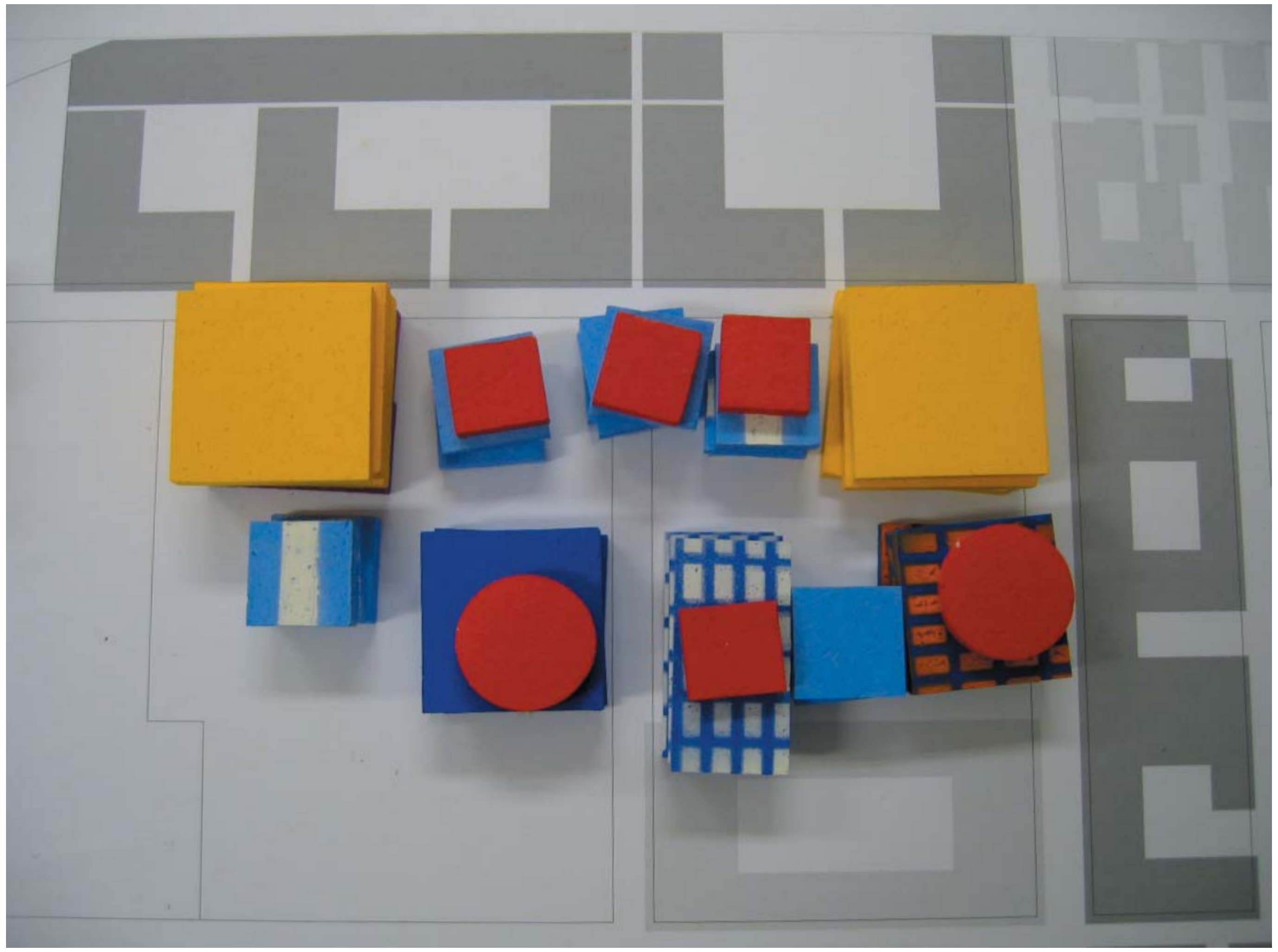


Plan View

Perspective View

Design Development
Building Workshop 5th December 2007

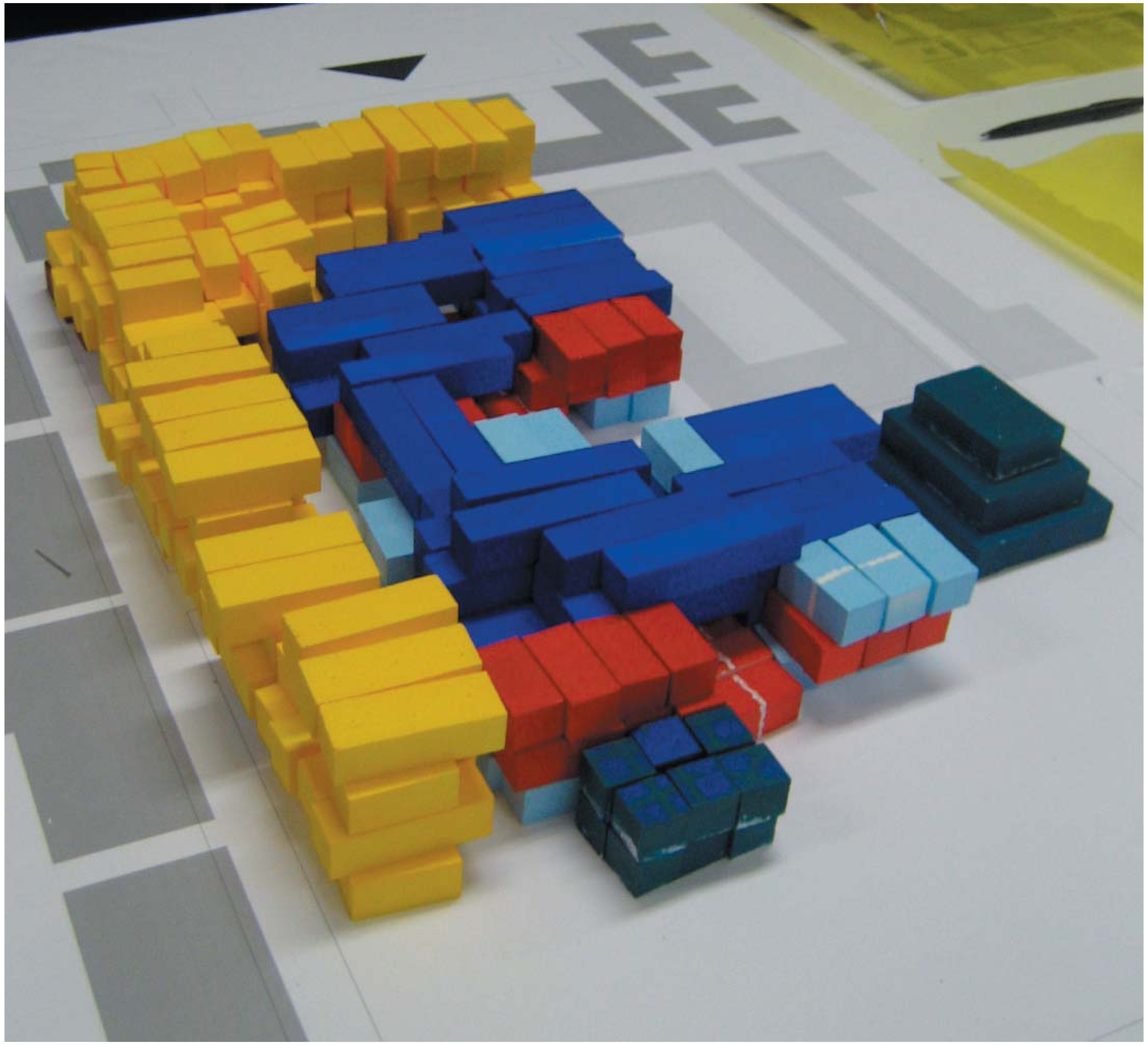


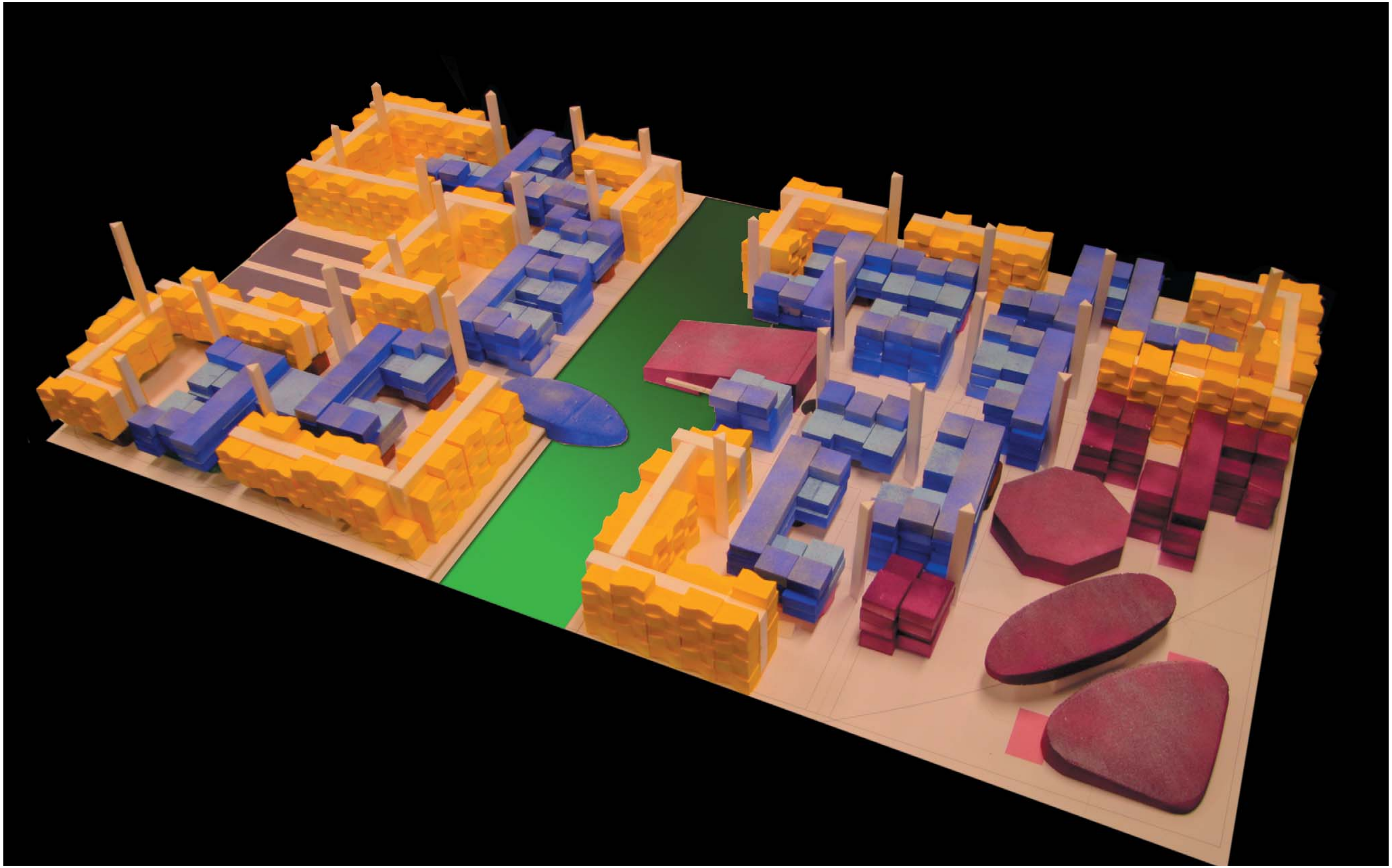


Agreed Phase 1

Size and mix of spaces to be developed further with floor plan depths/ width studies

Massing Model Study






N
0 4 10 20 50 m

Community

3

Community
Introduction

The people who will eventually live and work in M.I.S.T are the most important consideration in all design decisions. This section approaches the concept design from the point of view of the end user, and, in doing so, highlights many of the primary design goals for the project.

The following pages explore the importance of creating a university campus that not only responds to the needs and demands of a sustainable future but equally the needs and demands of the people and families who will be living there. To create an environment which is condusive to research, interaction, collaboration and innovation for students and researchers and an oasis where anyone can relax and socialise.

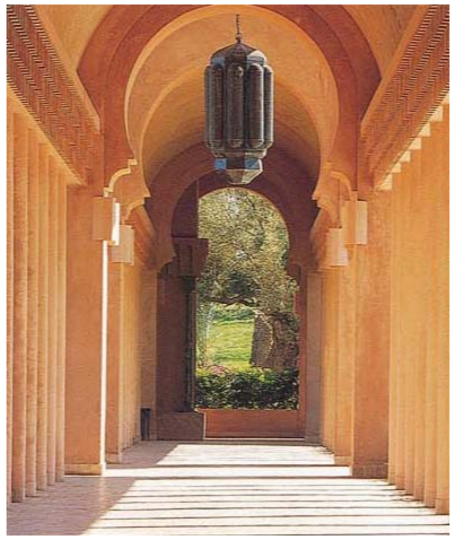
This section highlights the importance of creating an environment that uplifts the spirit and provides an attractive place to reside with shaded streets, lively active public squares, private courtyards and closely knit neighbourhoods. It has to reinforce a belief in the future, and re-iterate the fact that people do not need to be penalized to be sustainable, while re-establishing the strengths of the area's heritage using the modernity of the contemporary world.....a live-able sustainable community.

Community

Character and Spatial Experience - Public Spaces

Shared public spaces are the heart of the university plan. These are the places where students and academic staff meet, socialise, and interact. The character of these spaces is informed by the following design elements:

- **Local Heritage - narrow streets**
  - contained squares
  - courtyards
- **Transition Spaces**
- **Light and Shading**
- **Micro-Climate - wind towers**
  - plantings
  - water
  - thermal mass/ materials
- **Social Gathering**
- **24-Hour Activity**

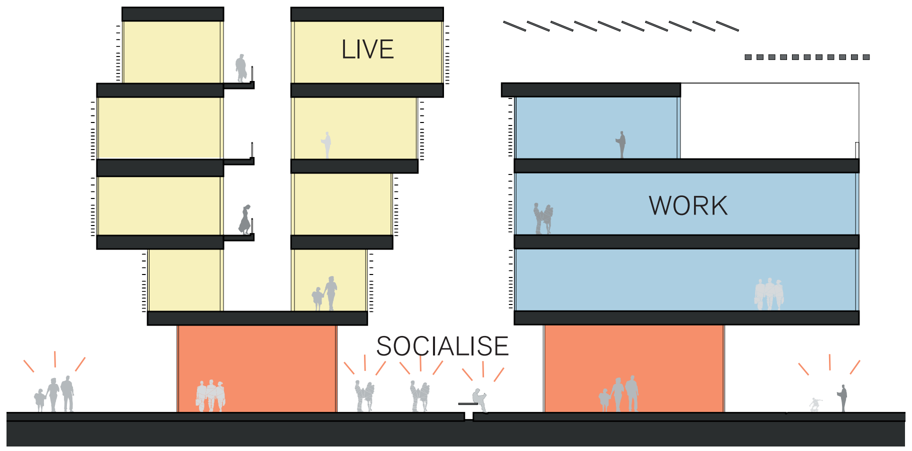


Transition Spaces Between Interior and Exterior

Traditional Islamic Urban Fabric Narrow Streets, Contained Squares

Wind towers bring breeze to public spaces

Public Space

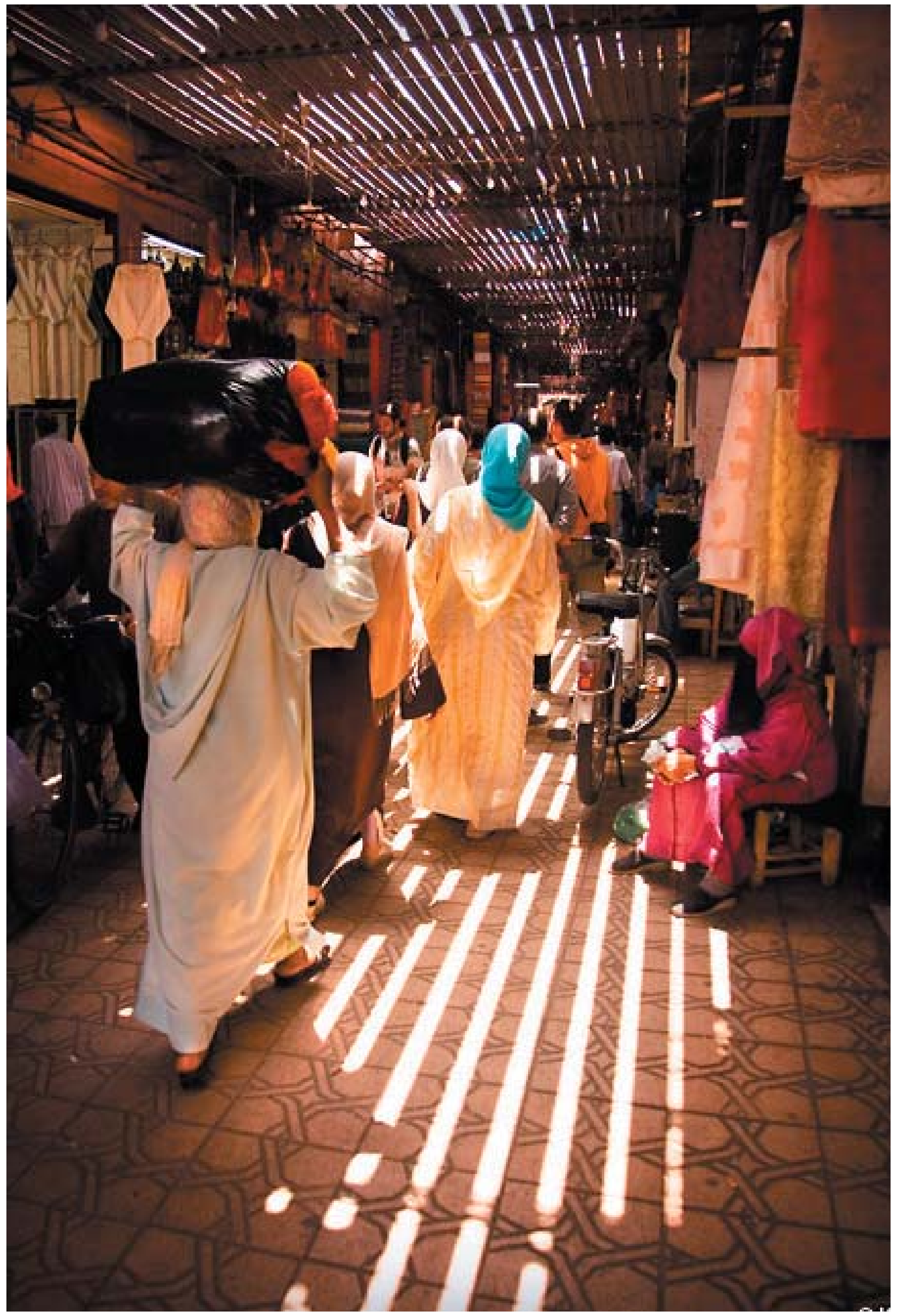


24 Hour Activity

Thermal Mass / Materials

24 Hour Activity

Un-planned Social Interaction



Traditional Space

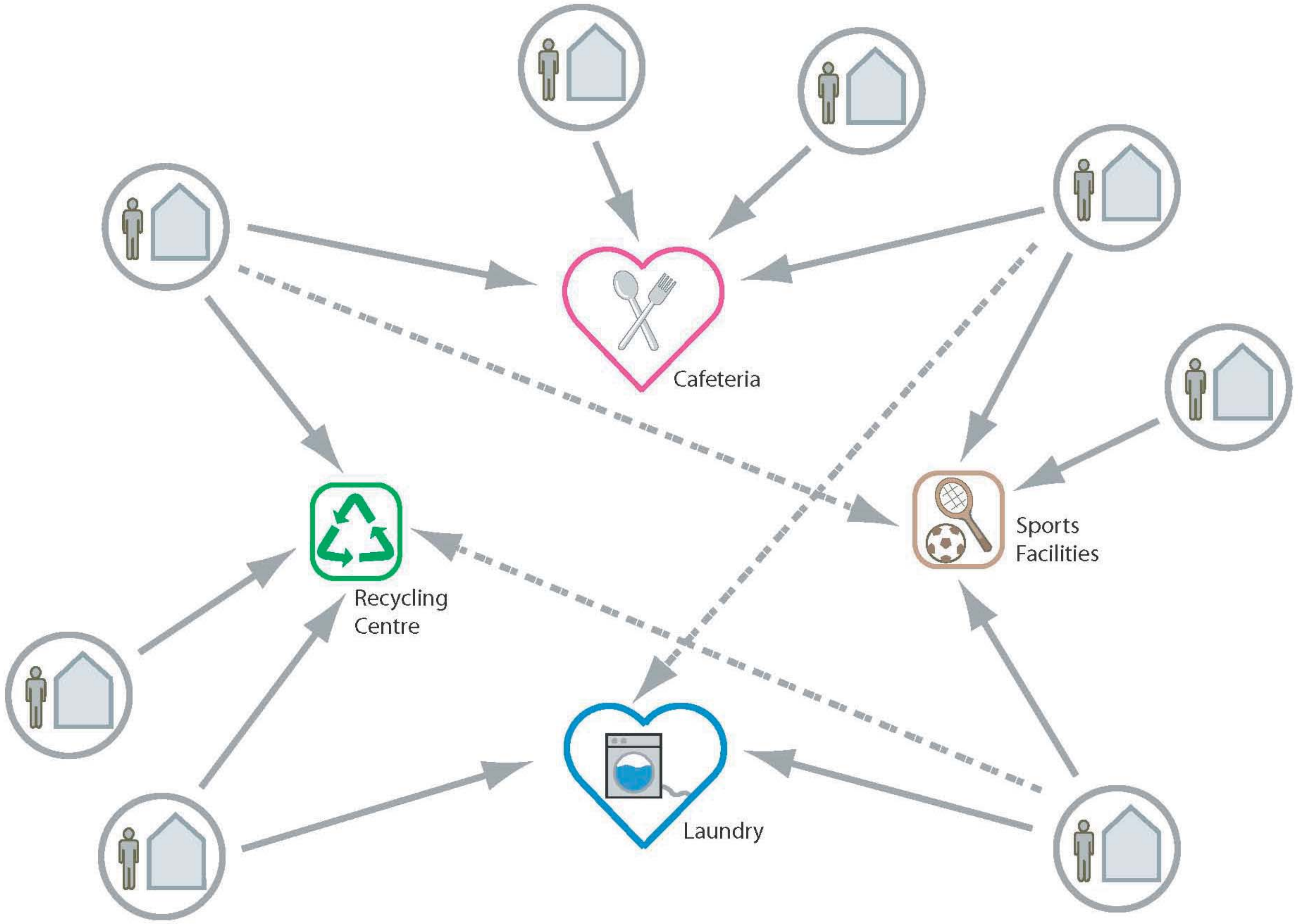
Modern Space

Active Streetscape

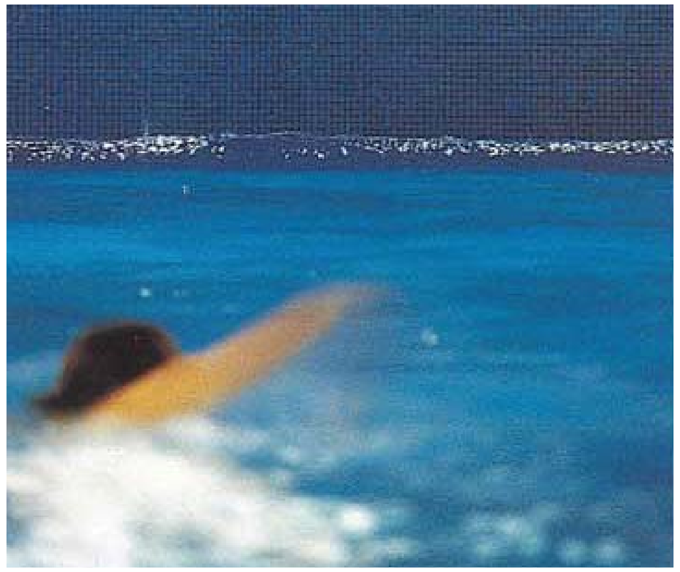
The concept for the first phase of the Masdar Institute of Science and Technology plans to create a public character that is:

- **Active**
- **Social**
- **Pleasant**
- **Comfortable**
- **Energetic**
- **Lively**
- **Sustainable**
- **Dynamic**
- **Developing**

The social arrangement of the residential units within the university makes use of community centres, or social hubs that act to bring people together and create human interactions and friendships. These hubs would be integrated, at various points, into the residential buidlings providing those who live nearby with a sense of ownership over their particular centre. However, these centres would also act as points of attraction for students all over campus, and thus become meeting and interaction spaces for the campus as a whole.

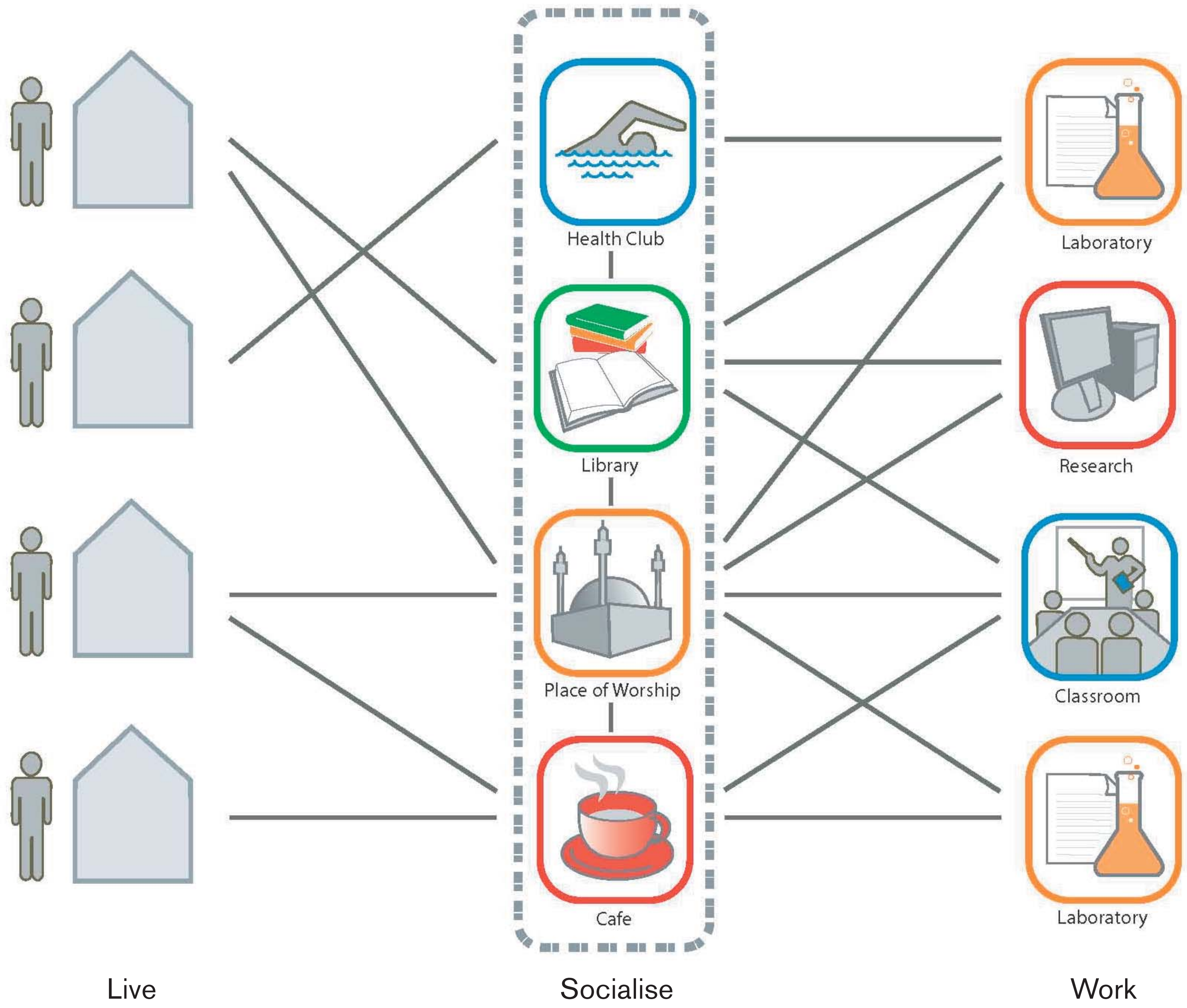



Internet Cafe


Swimming Pool


Gymnasium

Public amenities and other shared facilities will naturally act to draw students from all parts of the campus. In the university masterplan, these spaces are placed in conjunction with areas dedicted to living and to working to activate the space 24 hours a day. These facilities will also work to bring students together and create an atmosphere of interaction and cooperation.




Library

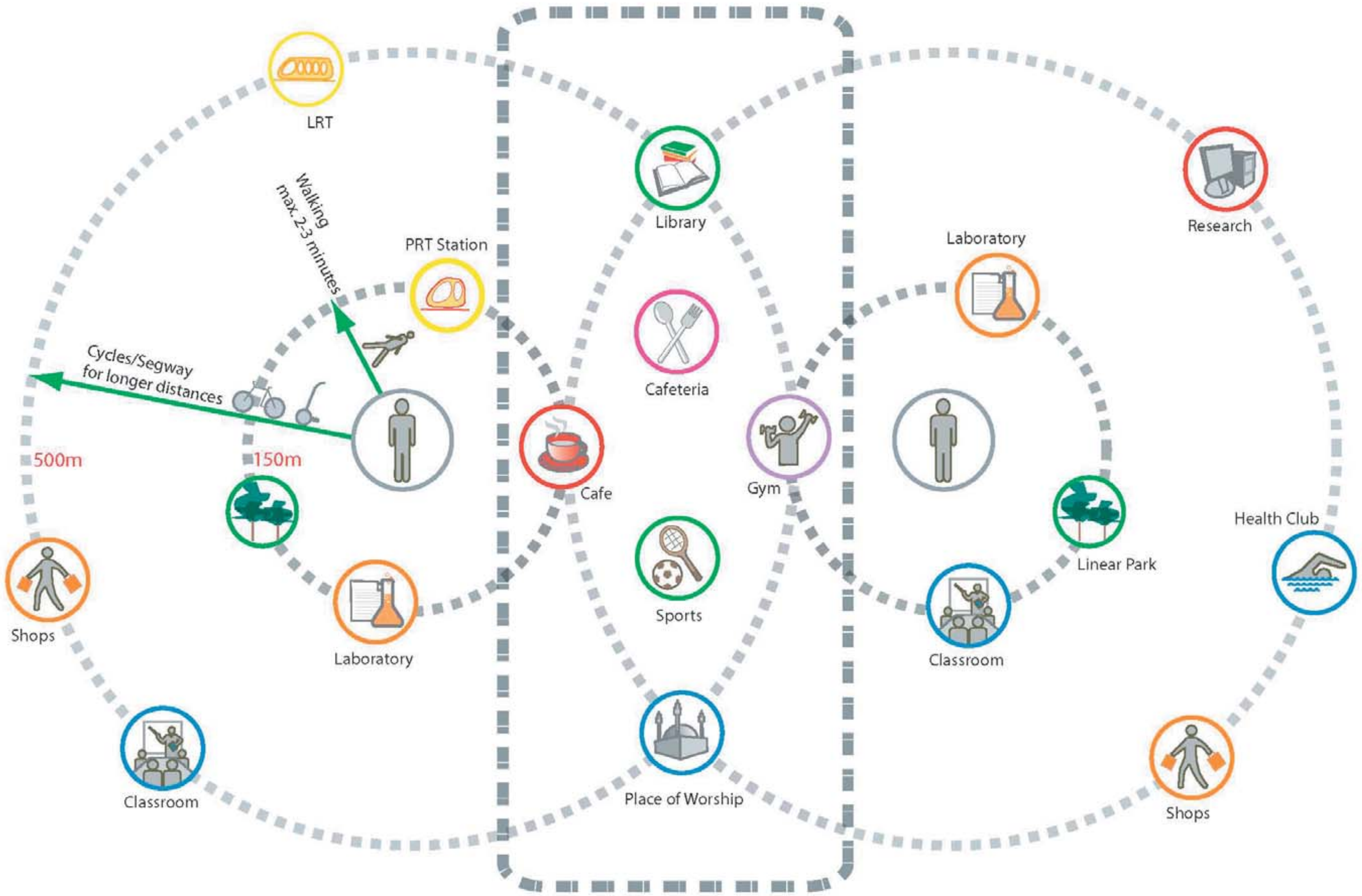

Cafe


Mosque

Community

Social Interaction -Horizontal

Spaces have been arranged within the masterplan to provide many oportunities for casual social interaction. Activity points have been intentionally placed near intersections in the main circulation routes, so that people naturally gather at these points, giving students many chances to live, work, and play together. These intersection points become logical locations for vertical circulation, as well.



Community Centres


Cafe

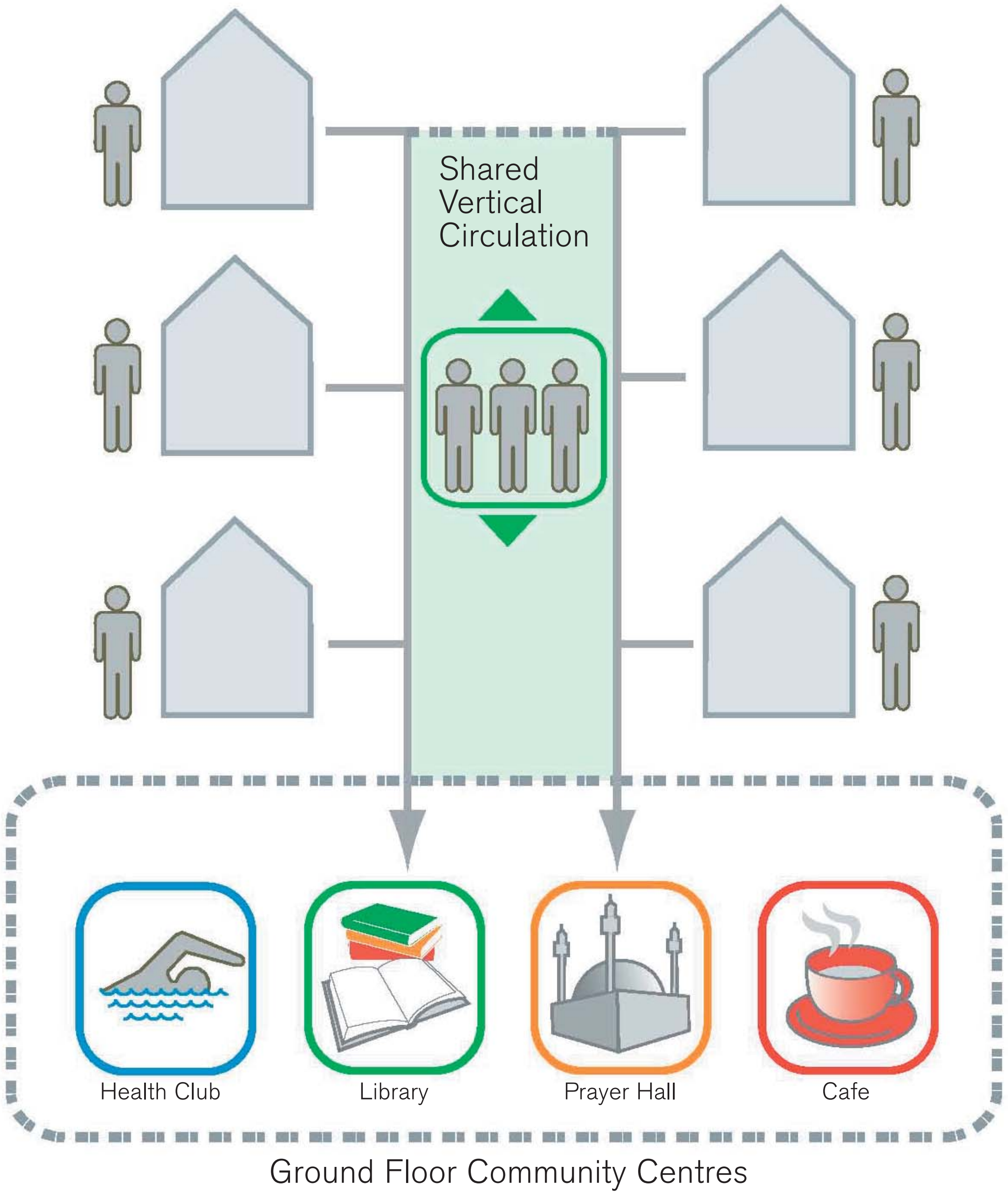

Library


Shops

Community

Social Interaction -Vertical

The vertical circulation throughout the institute also assists the creation of natural social interaction. The points of vertical circulation have been limited so that students must come together to move between levels. These circulation points are marked, on the ground floor, by shared activity spaces that increase the sense of identity and communtiy within each residential or laboratory building.




Lift


Shared Corridor


Ground Floor Public Space

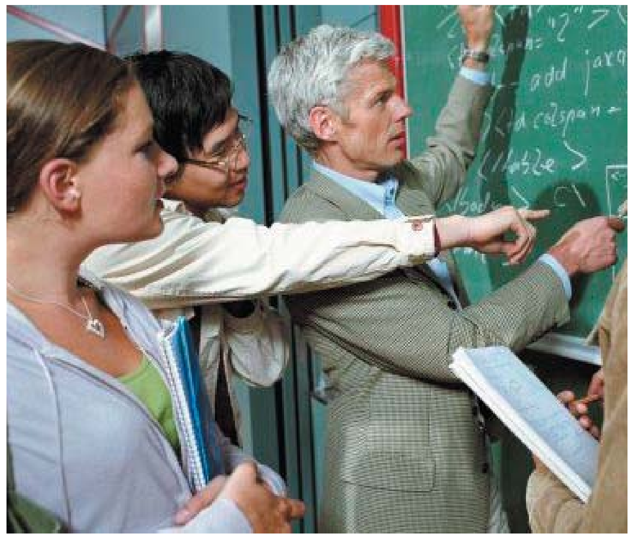
The laboratory spaces within the university should demonstrate a character that is:

- **Interactive**
- **Collaborative**
- **Forward-Thinking**
- **Stimulating**
- **Bright**
- **Creative**
- **Relaxing**
- **Fun**
- **Comfortable**
- **Flexible**

Bright

Collaborative

Comfortable



Interactive

Informal

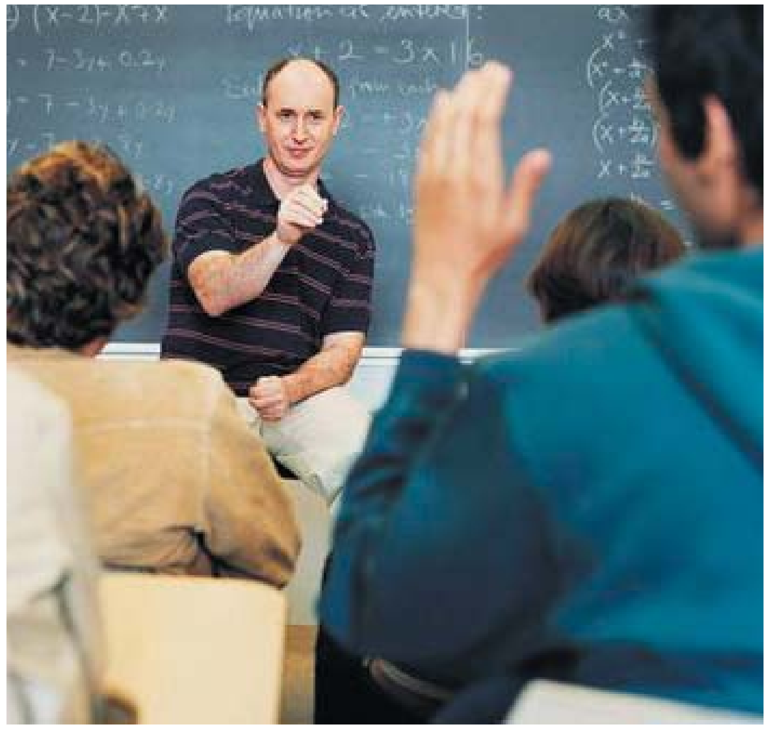
Community

Character and Spatial Experience - Laboratories

Flexible

Creative

Interactive

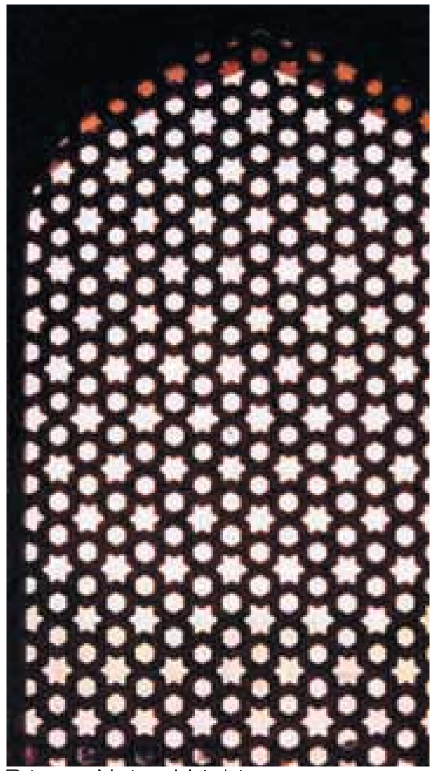


Stimulating

Comfortable

The residential spaces within the university should demonstrate an atmosphere characterised by:

- **Respect**
- **Community**
- **Mix of Cultures**
- **Religion**
- **Gender Segregation (To Suit Cultural Needs)**
- **Privacy**
- **Comfort**
- **Security**
- **Indirect Natural Light**
- **Natural Ventilation**
- **Passive Means of Cooling**
- **Materiality**
- **Life-Style Sustainability**



Privacy, Natural Light

Sustainable Life-Style

Community, Cultural Mix

Privacy, Security

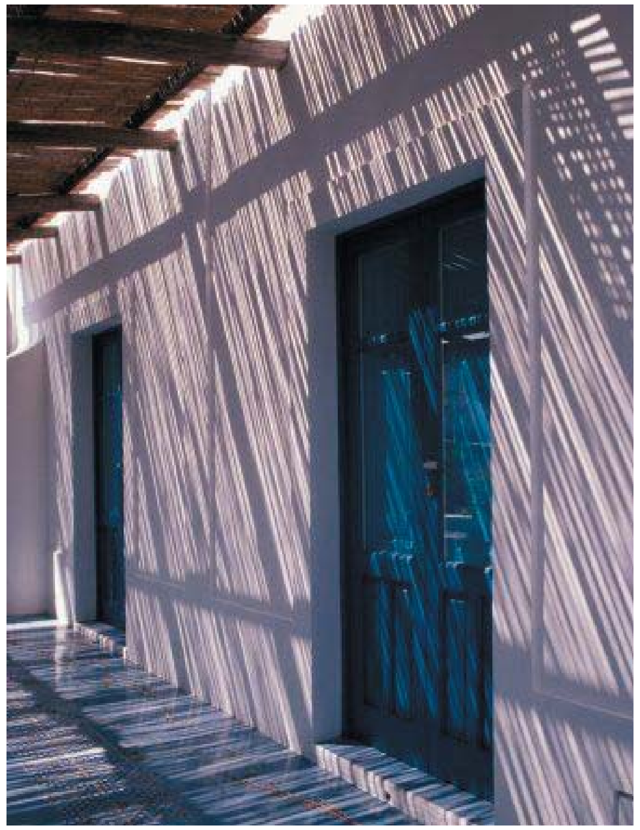
Comfort

Natural Ventilation

Family

Family, Privacy

Comfort

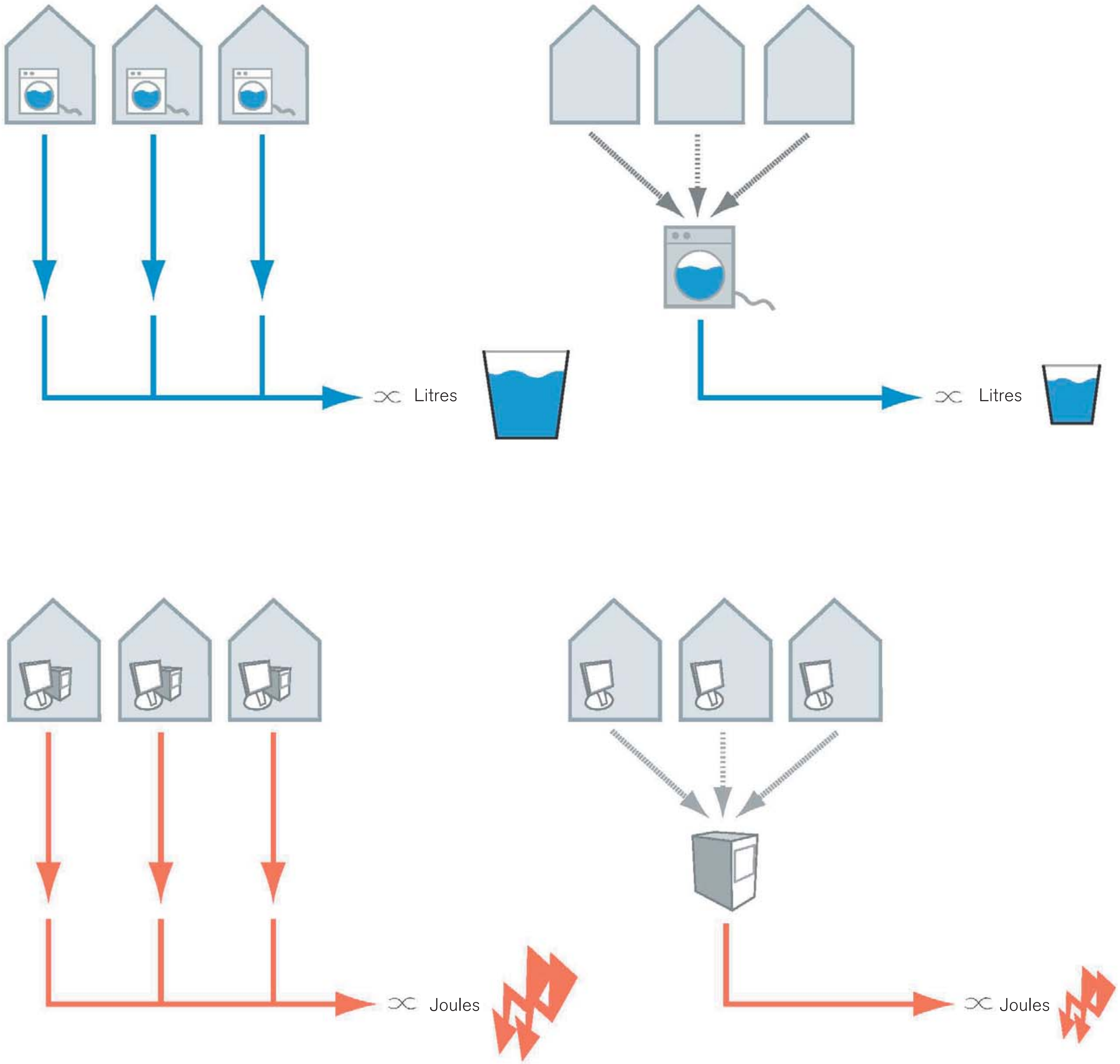


Indirect Natural Light

Community

Sustainable Lifestyle - Water and Energy

It is the team's target for this project to reduce the amount of energy used by each individual within the university. However, this reduction must be accomplished while still improving the quality of life for those who live and work at the institute. It is a principle of this practice that people should not be penalized to be sustainable.

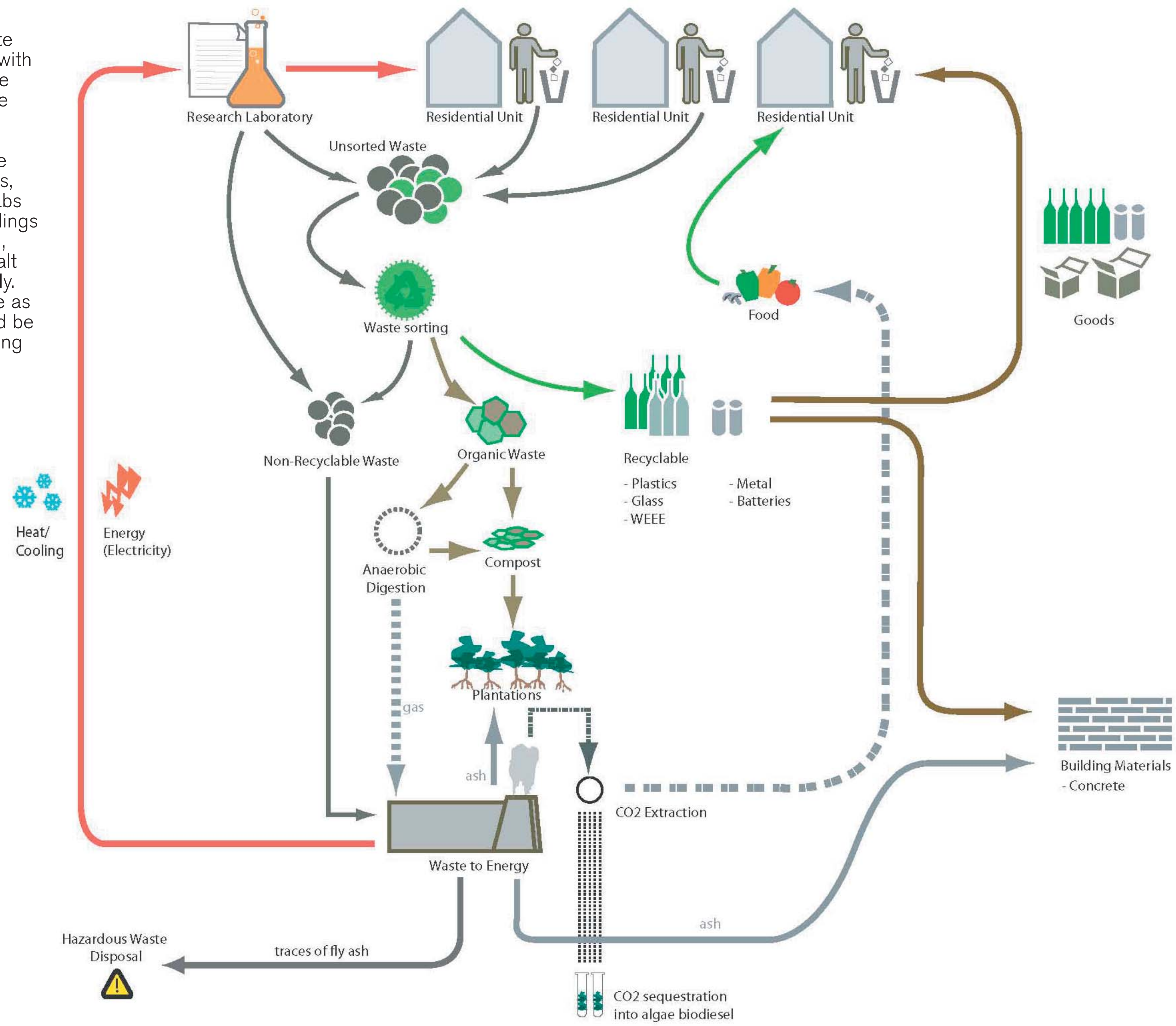



Cooking


Washing


Working

Within the university, waste must be dealt with in a responsible and sustainable manner. This means that refuse from the residential units, the research labs and other buildings is consolidated, sorted, and dealt with accordingly. As much waste as possible should be sent for recycling or composting.



Laboratory

4

Laboratory
Laboratory Concept-CCSR, Stanford University

Laboratory CCSR
- Efficient wet lab layout
- Segregated offices and write up areas

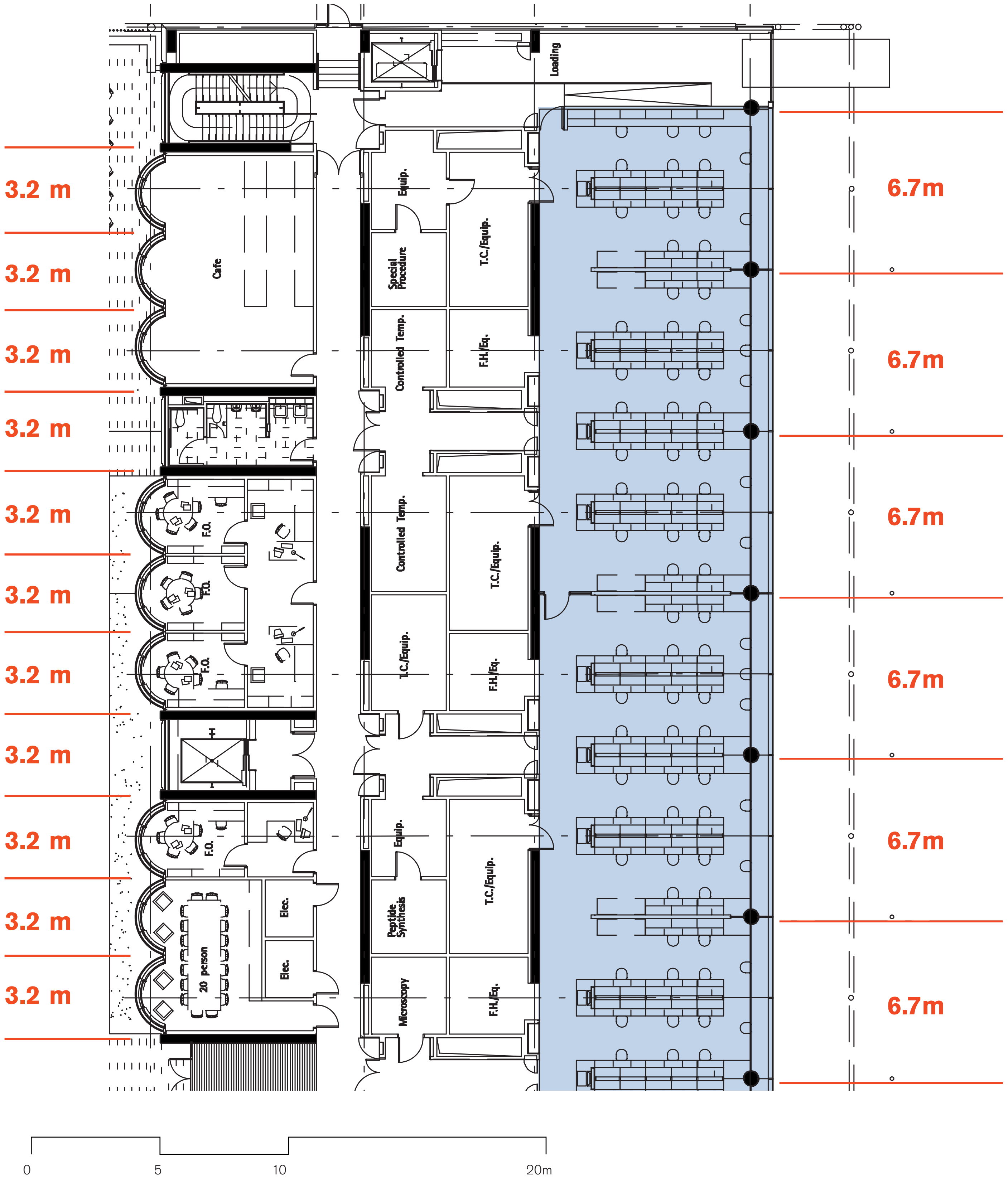
VIEW RELATIONSHIP
TOWARDS OUTSIDE

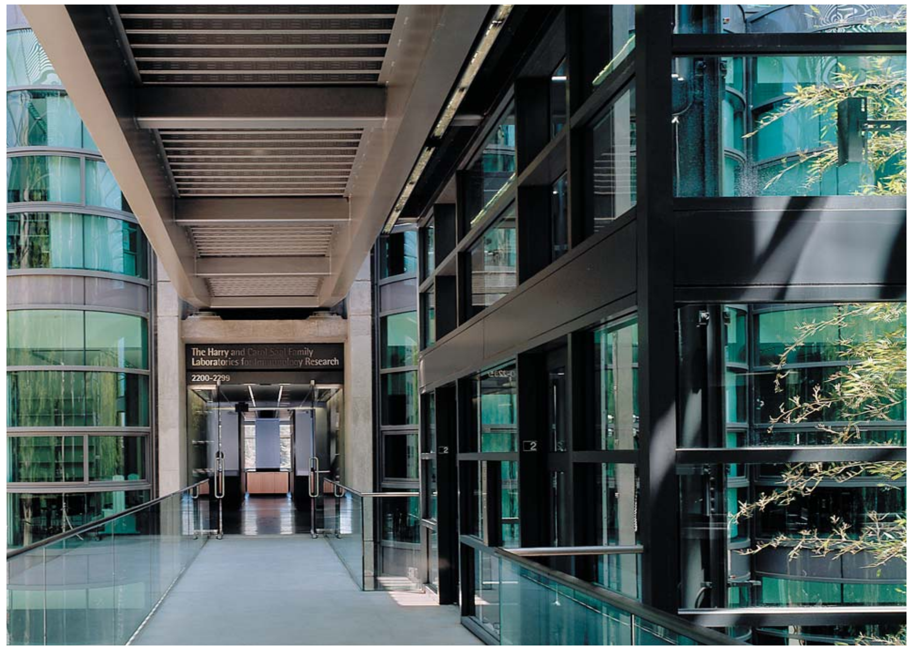

View of the exterior


Looking into the central courtyard - the social hub of the building

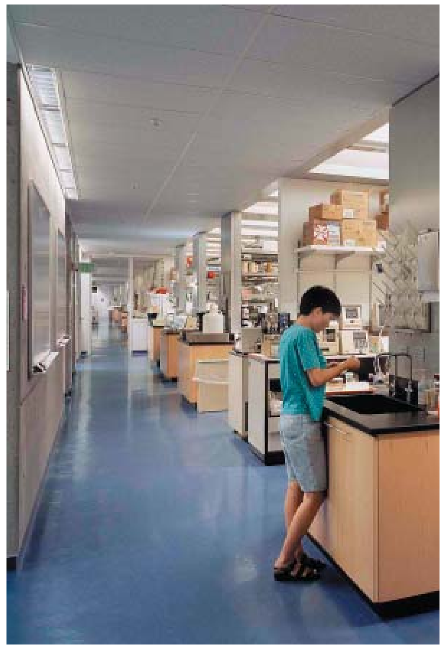
Laboratory

Laboratory Concept-Lab Layout Modules CSSR





external corridor



laboratory space

office with bay window

Laboratory Clark Center

- flexible lab layouts
- services set at ceiling level
- integrated offices and write up areas
- collaborative network

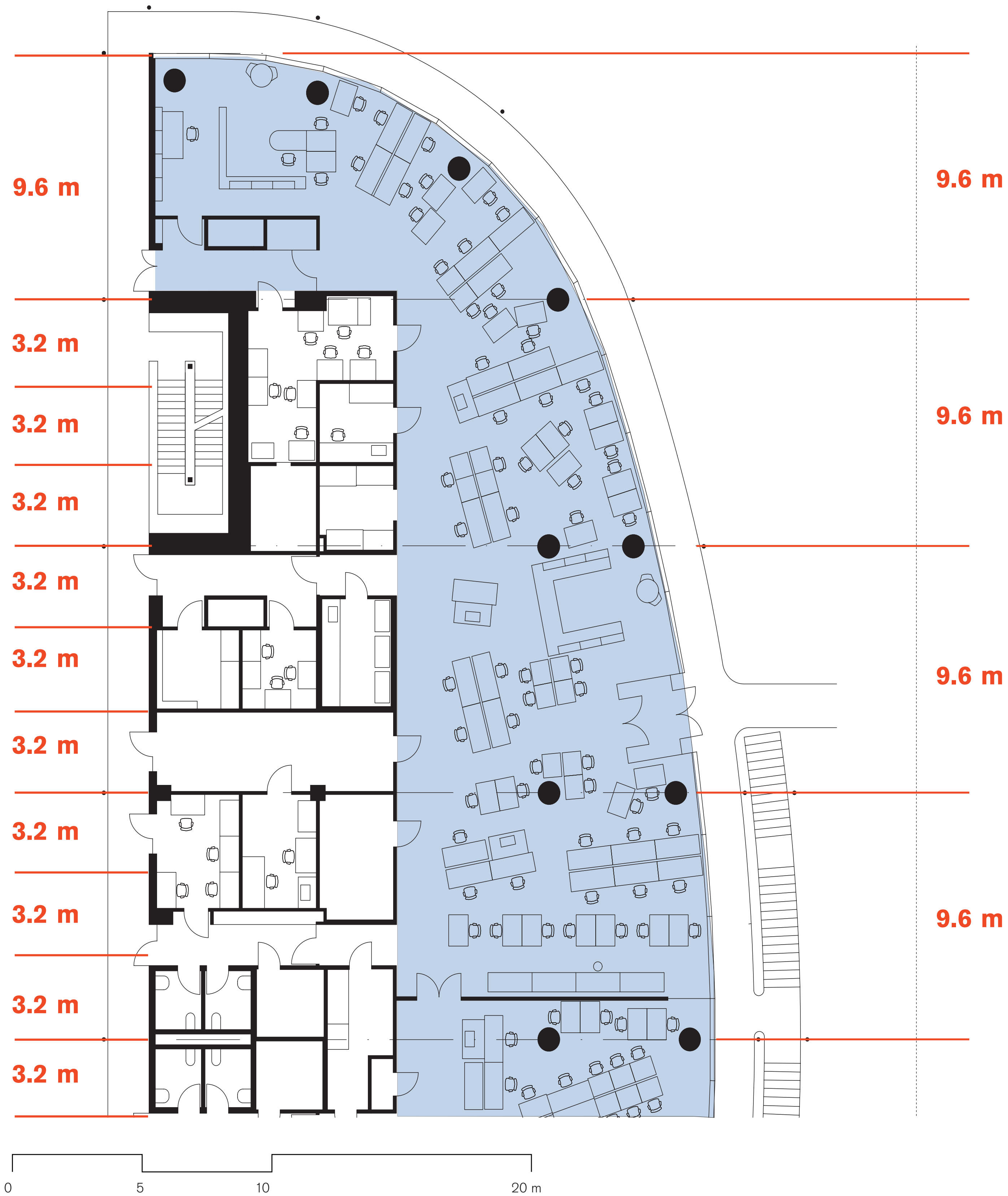
VISUAL CONNECTION PROVIDES SOCIAL INTERACTION


main forum at night


view from outside into labs and offices

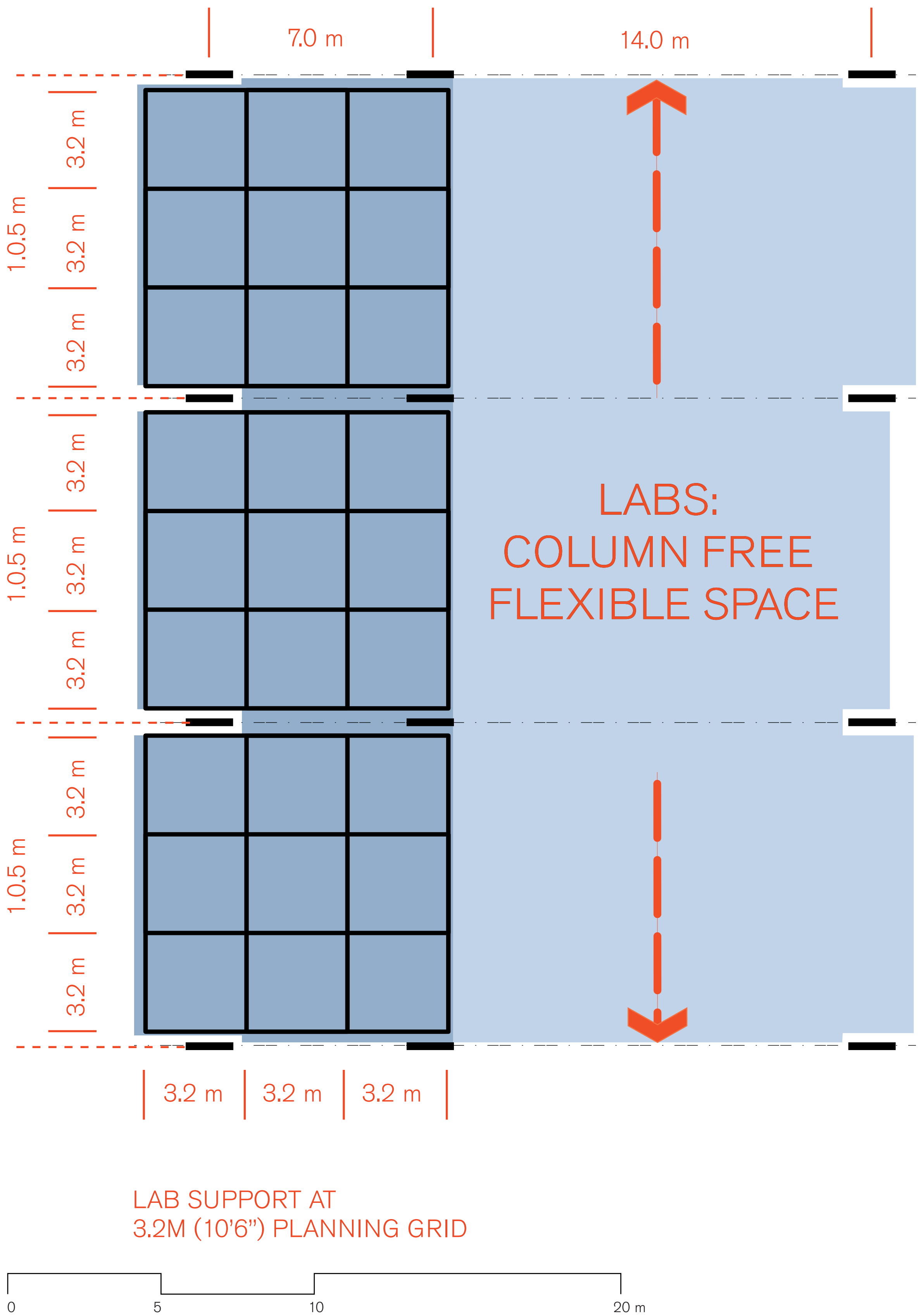
Laboratory

Laboratory Concept-Lab Layout Modules Clark Centre



write up posistions IT laboratory

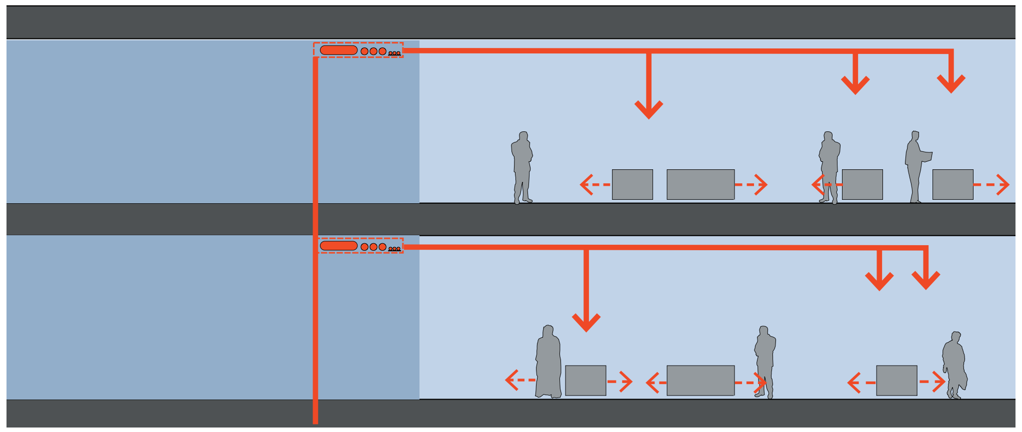
flexible lab spaces and write up positions that can be reconfigured to meet special needs



LAB SUPPORT AT
3.2M (10'6") PLANNING GRID

Service Principles

ALL SERVICES FROM ABOVE
ALLOW FLEXIBLE LAB ARRANGEMENTS



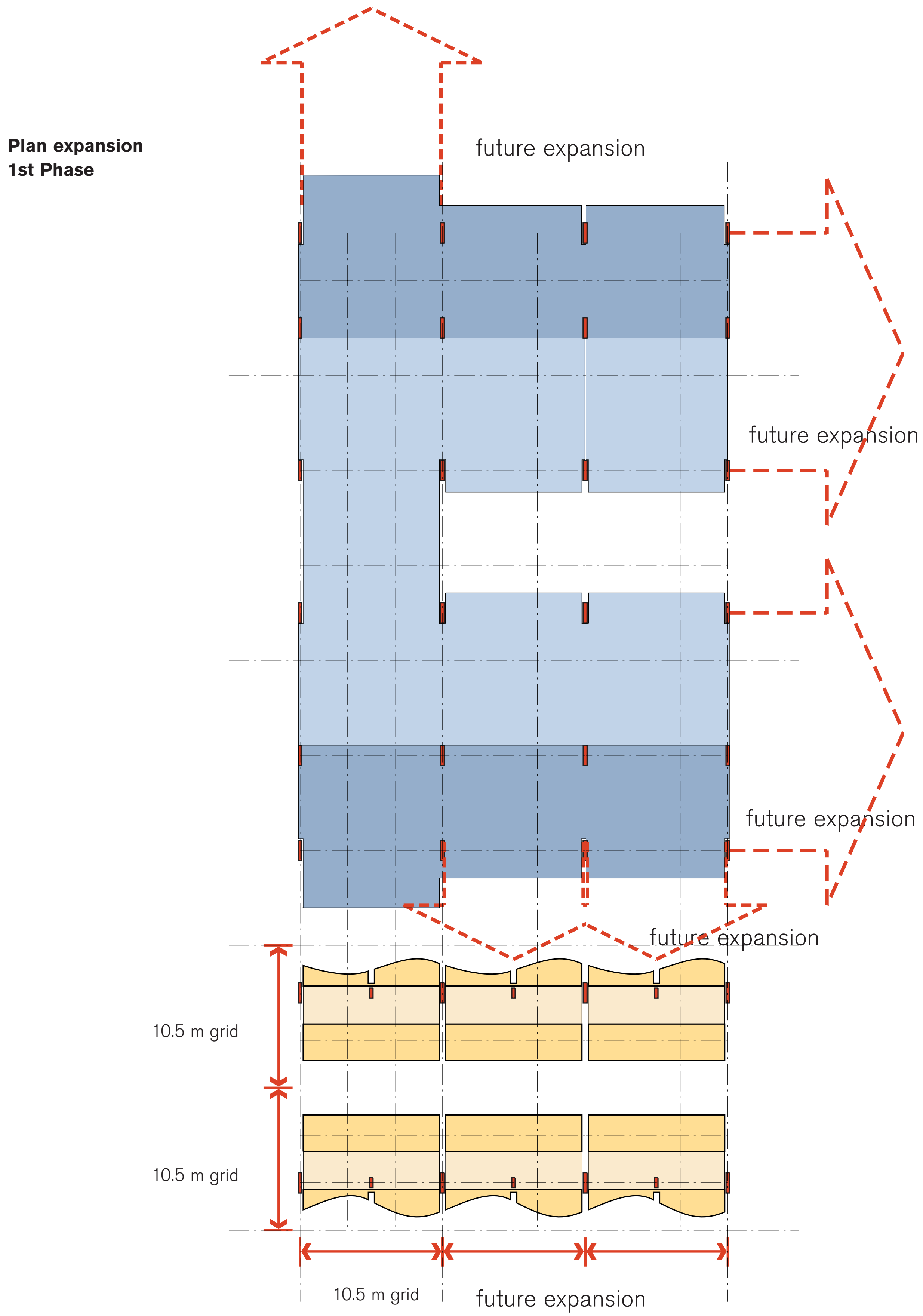
- large column free lab
- flexible lab layouts
- services from ceiling
- visual interaction between labs
- social interaction
- natural light through fiber optic technology
- lab support at suitable grid
- expandable space
- horizontal circulation between residential and lab reduces use and number of lifts
- special cladding design
    - allowing light
    - allowing views
    - minimizing solar gain

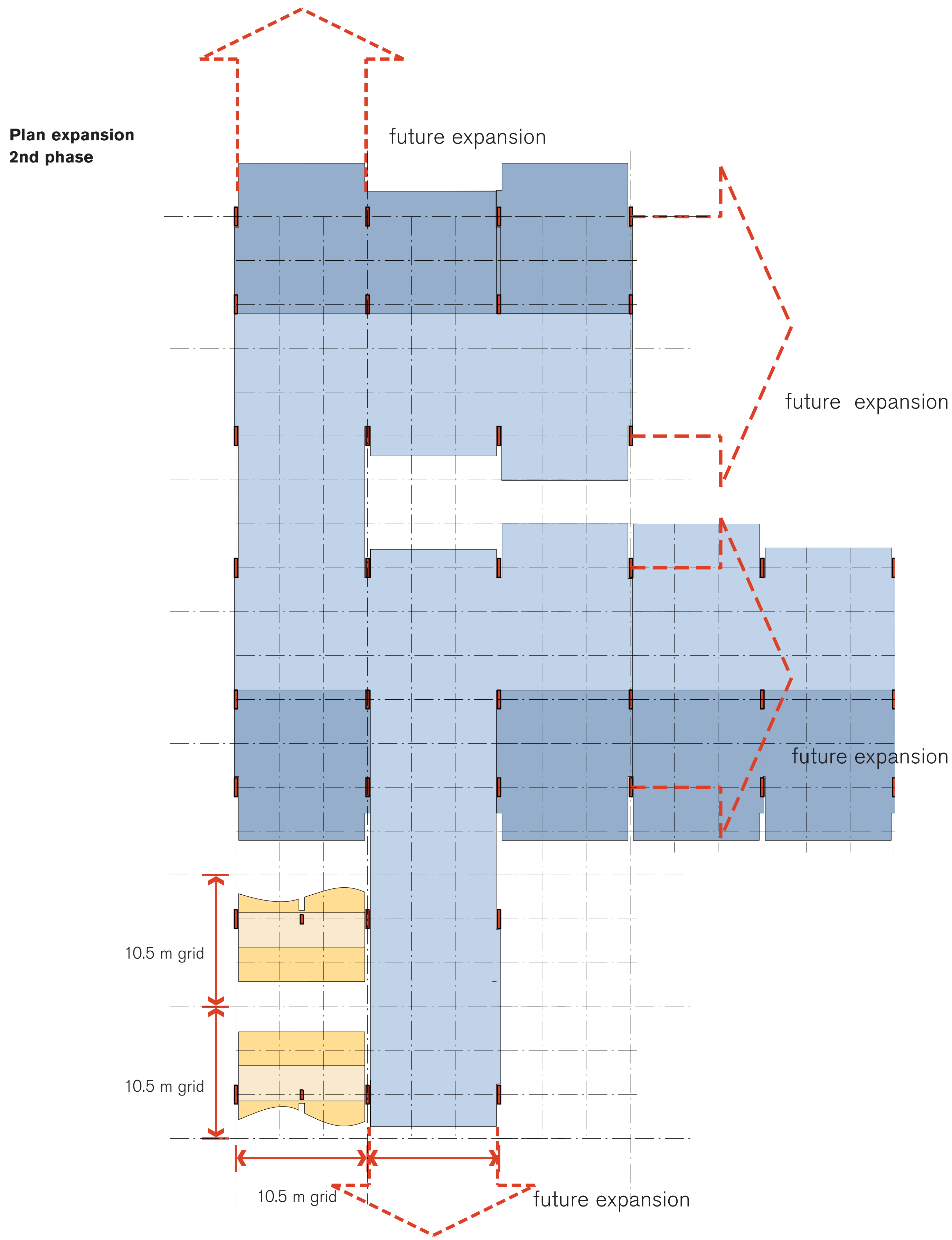
robotics open lab area on the first floor

write up zone located next to the floor-length windows

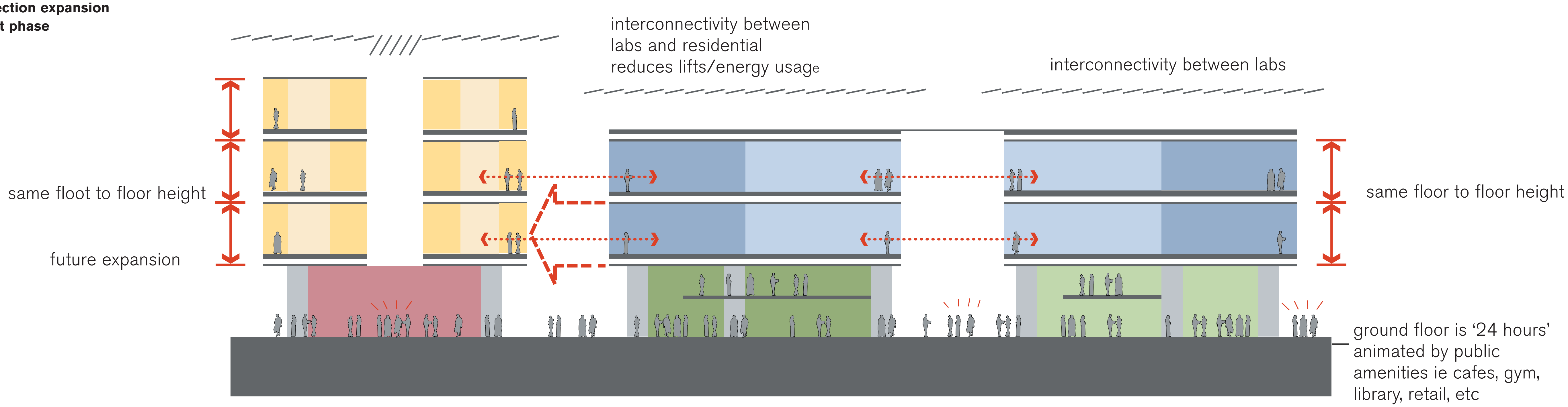
Laboratory

Expansion Diagrams - Plans

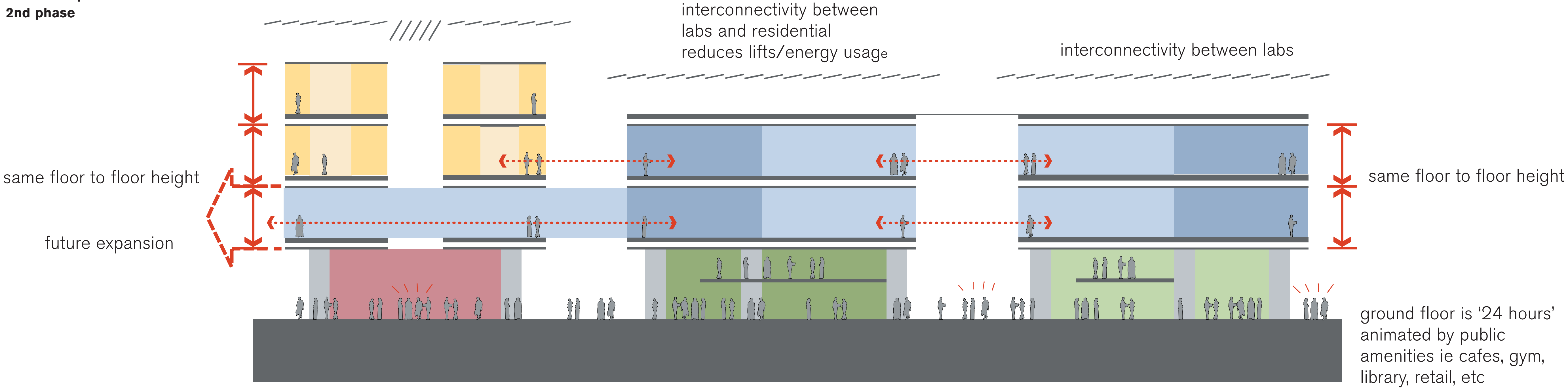




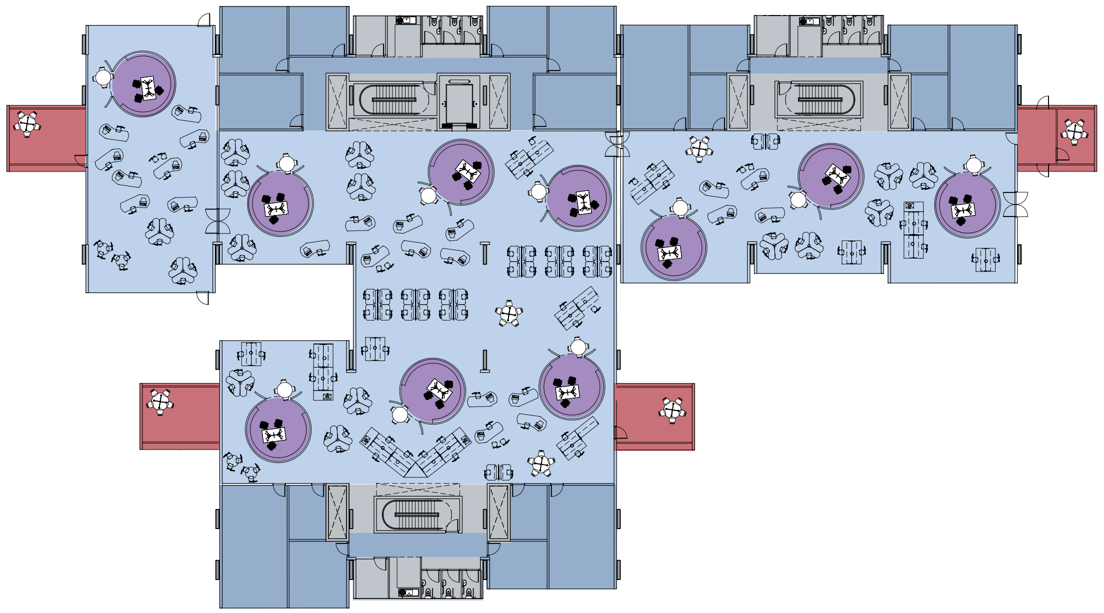
Section expansion
1st phase



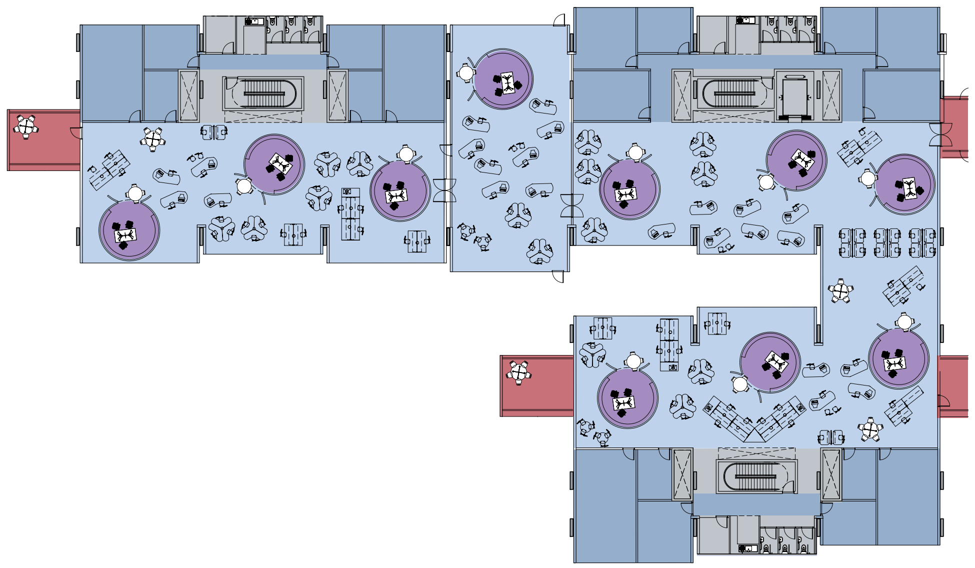
Section expansion
2nd phase



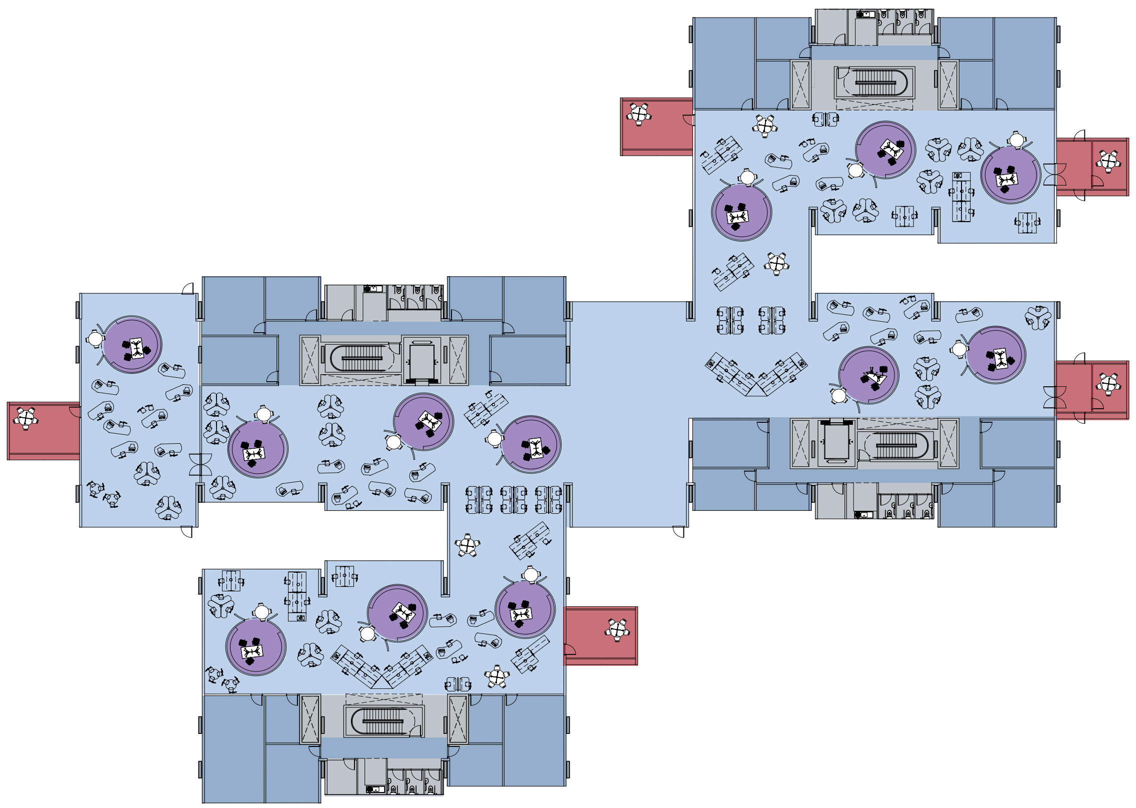
Lab Plan - Option 1



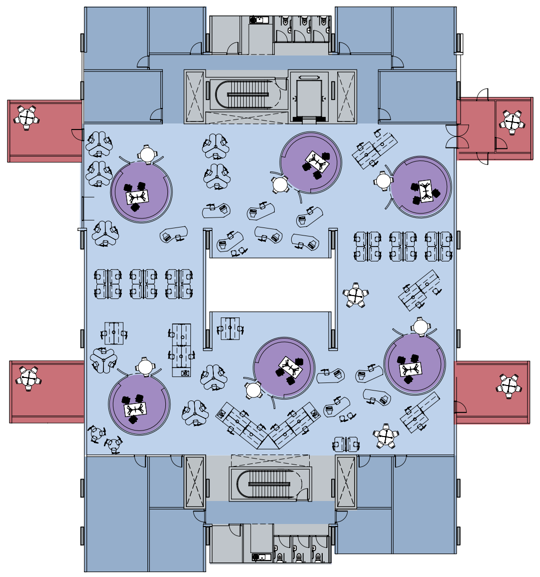
Lab Plan - Option 2

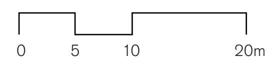


Lab Plan - Option 3

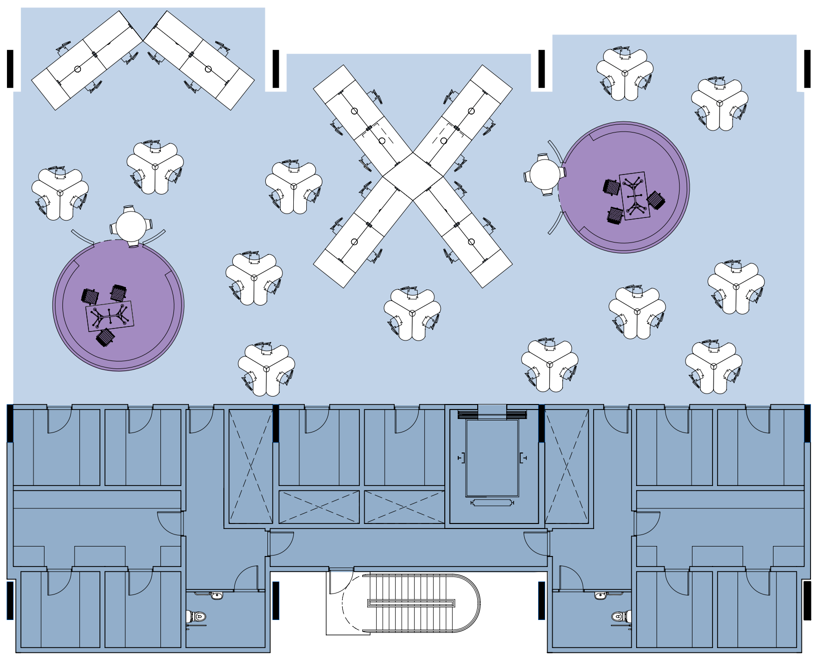


Lab Plan - Option 4

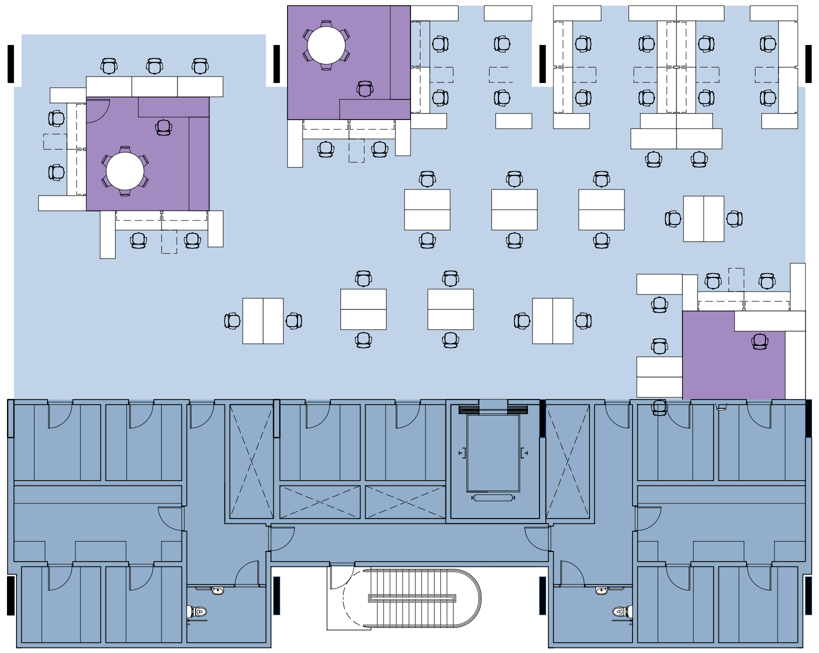




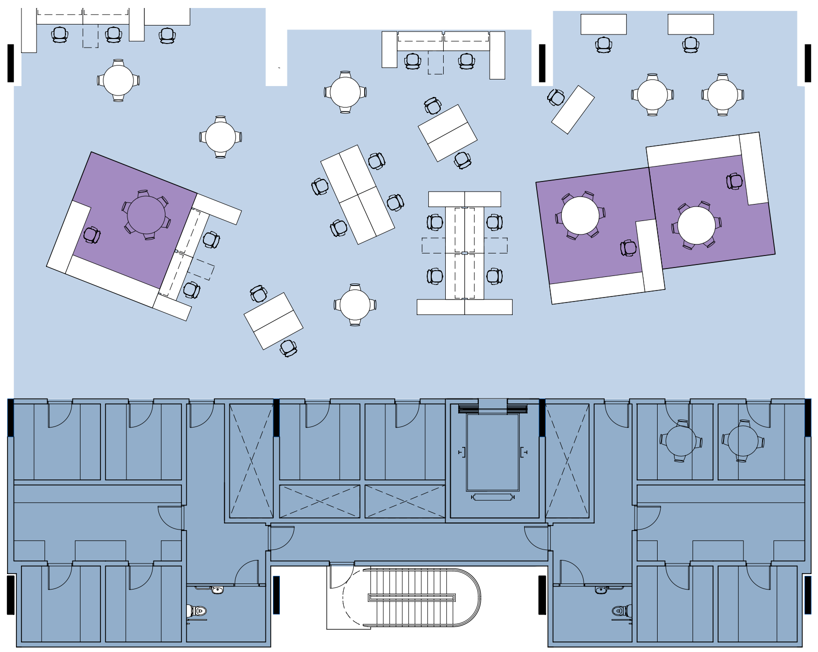
Laboratory
Potential Layout



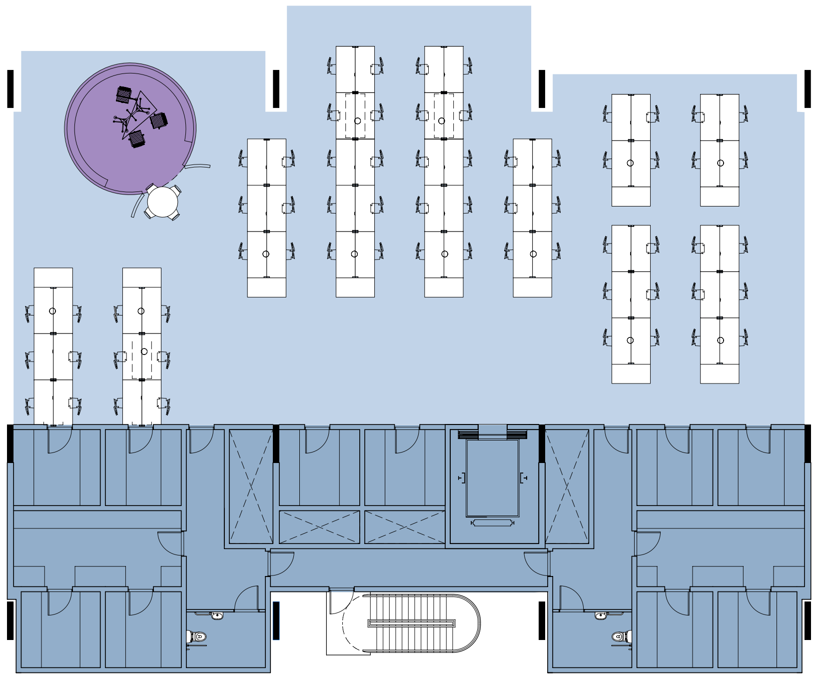
Lab Plan - Option 1



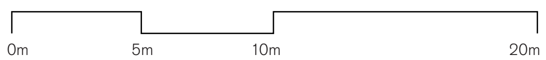
Lab Plan - Option 2



Lab Plan - Option 3



Lab Plan - Option 4



Unlike traditional laborotories, which are internally divided and enclosed by systems of internal circulation, the laboratories of M.I.S.T. are focused on providing openess and adaptability of the internal floorplates. These unencumbered floorplates allow the user to define the internal layouts that best suit their form of research.This strategy provides a space which can be configured in a number of ways ranging from the bench model traditionally seen in most research facilities, to the more relaxed approach employed at the Clark Center to a combination of the two.

cellular offices Clark Center, Stanford University

flexible lab spaces and write up positions, Clark Center

flexible and movable benches and desks in the laboratories

Laboratory

Laboratory Development

In order for different types of research to occur adjacent to each other and within the same space, the MIST laboratories design must be such that it can meet both the servicing and space planning requirements of the various research cultures.

The buildings servicing systems and specific laboratory service must designed to provide all the services required at the lab bench and allow for adaptability and variation. Moreover, in order to not restrict a researcher's changing needs, it is very important that any reconfiguring of casework, services and equipment, is as simple and cost effective as possible.

Specifically the building design must enable a level of adaptability within the laboratories for both 'wet' and 'dry' research to occur. The exact ratio's of the different type of research will vary over time, so we have proposed a conceptual laboratory section that provided the flexibility required to allow both types of research to occur anywhere on the floor plate.

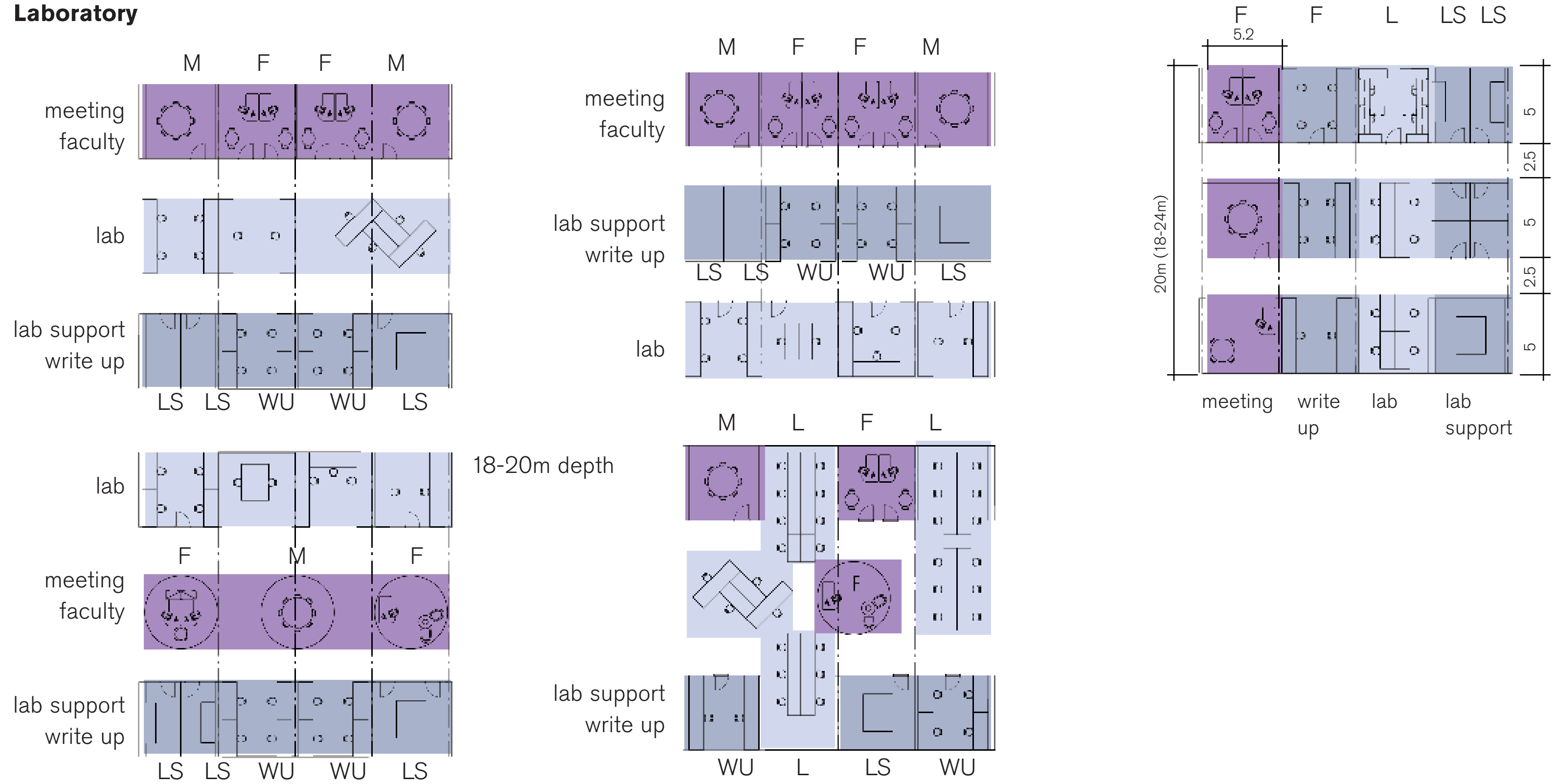
Based on our experience designing other laboratories, we are proposing a common ceiling height for the laboratories of nominally 3.5m. The exact final ceiling height will need to be fine tuned during scheme design, however it is envisaged that this height will allow for the immediate and future functions of the laboratory spaces.

The requirement to provide multiple different services to a variety of different research types on any individual floor plate has lead us to propose that all services come from above. The laboratory floor is proposed to be a fully sealed liquid tight surface for two main reasons. Firstly this is a requirement for 'wet' research types and secondly, is provides a flat robust floor surface free that will allow for equipment and casework to be easily moved on wheels. Our laboratory design proposal is that all casework, work stations, chairs and equipment have lockable wheels. This approach allows for the rapid reconfiguration of space in the laboratories even with heavy equipment. Quick disconnects for all piped services, power and data will allow for the spaces to be changed free from traditional constraints created by services.

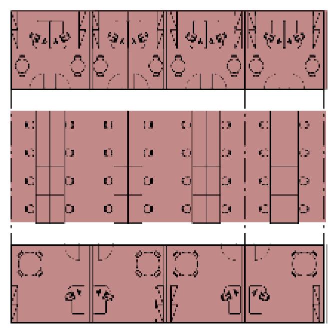
These types of services are as found typically in many hospitals, and manufacturing spaces, where they are a necessity for rapid and efficient work methodologies.

We are now developing the detailed concept design proposals with the appointed consultant teams, to ensure that the laboratory structural, servicing and sustainability concepts are fully integrated to make the design as efficient as possible. We are looking at the use of piped sunlight for both background and task lighting, and a concrete structure that could be exposed to provide thermal mass storage.

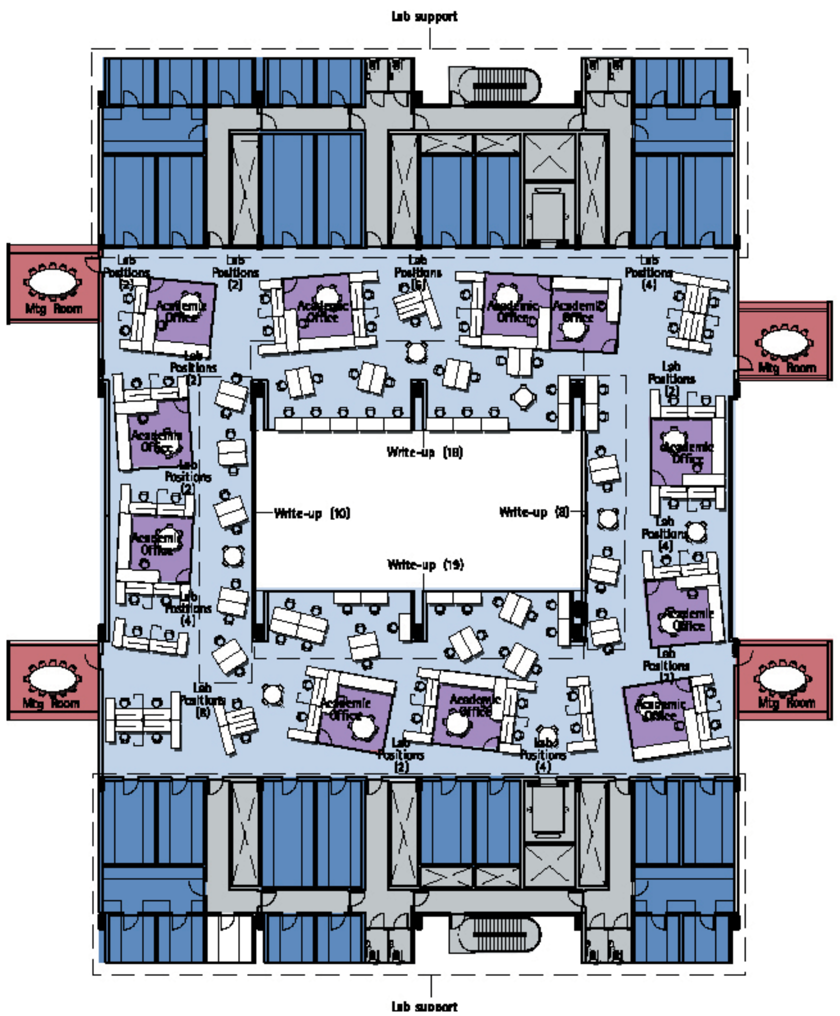
Laboratory



Administration Offices

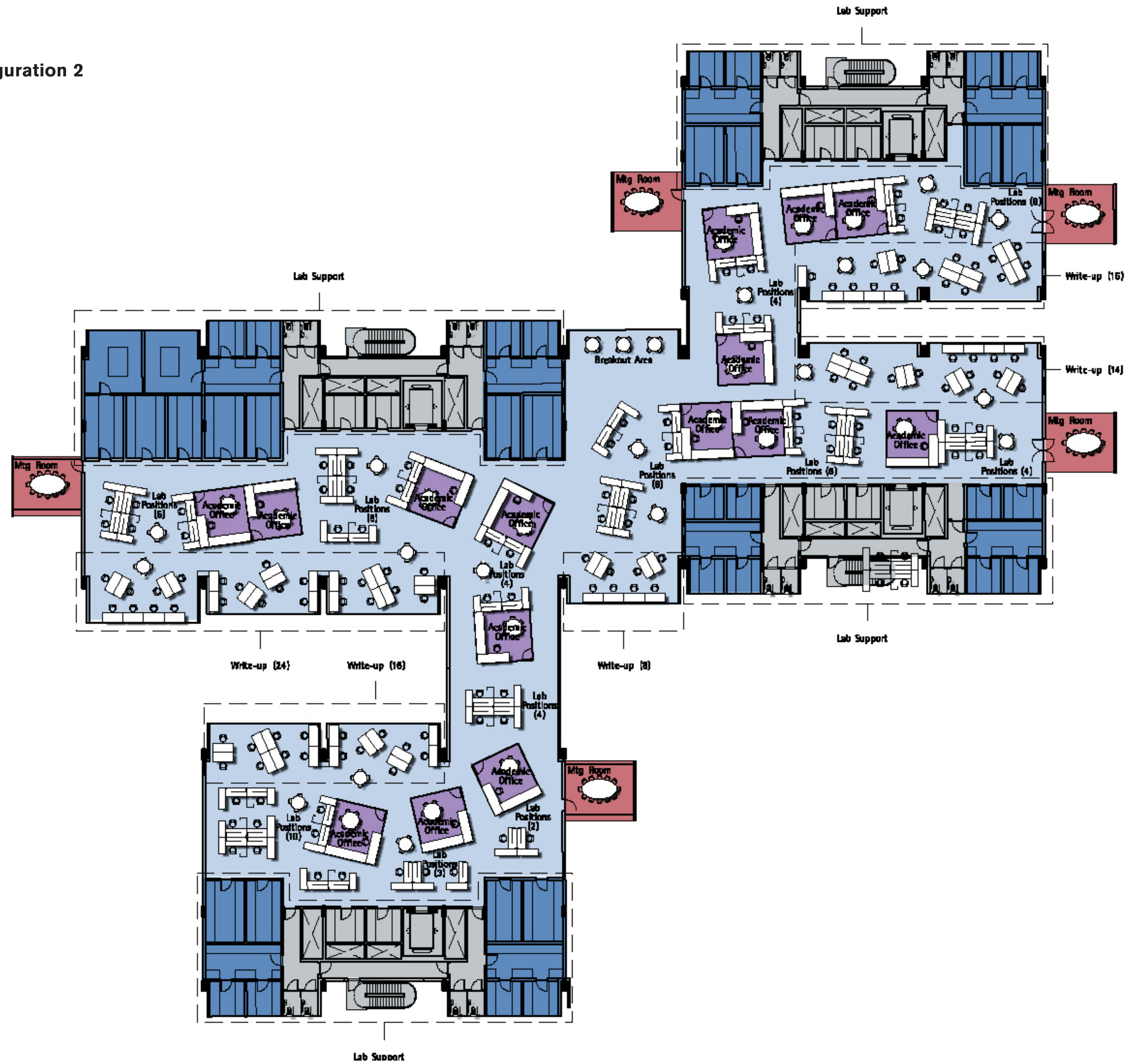


Configuration 1



lab positions - 44 (44 required)
write- Up positions - 55 (55 required)
meeting rooms - 4 (3 required)
academic staff cellular offices 11(11 required)
lab support spaces - 801sqm (771sqm required)

Configuration 2



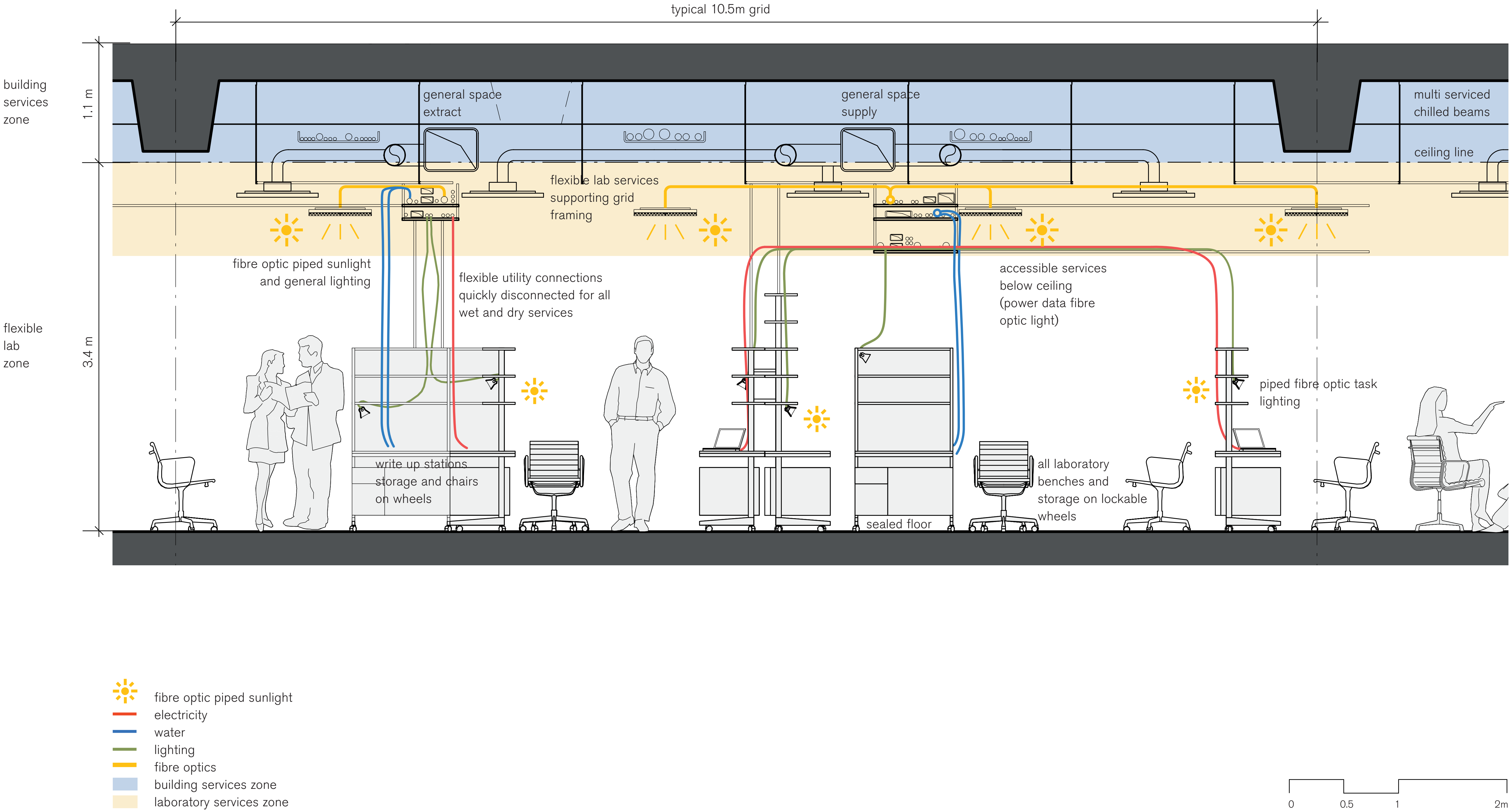
lab positions - 65 (61 required)
write- up positions - 77 (77 required)
meeting rooms - 5 (4 required)
academic staff cellular offices - 15 (15 required)

0 1 5 10m

Laboratory

Laboratory Concept Section

Section/ Services Design



Laboratory

Lab Planning: Zoning

The M.I.S.T. laboratory floor plates have been zoned into specific areas, for different functions. There are three main zones according to use on any typical laboratory plan module, as shown in the diagram. The three main zones are:

1. Open Plan Flexible Laboratory Zone
2. Enclosed Lab Support Zone
3. Building Core Zone

There are different functions included within each zone, all of which are integral to the functioning of the laboratory spaces.

Open Plan Flexible Laboratory Zone: All general types of laboratory research will occur in this space. The space has been designed to be as column free as possible, with columns on a 10.5m structural grid. This large grid dimension provides large open laboratory spaces free from obstructions that would normally occur with smaller column grids. The open plan zone is designed to accommodate both 'wet' and 'dry' types of research, and to allow for the laboratory casework and equipment to be arranged in any plan configuration to suits the scientists specific working methodology. Ease of access to the services is provided from the services infrastructure in the ceiling above.

The open plan zone includes three elements of the client brief, laboratory space, write up desk space and faculty offices. These spaces are often typically separated in laboratories. The intention at M.I.S.T. however, is that the faculty have immediate access to their researchers through close proximity – and visa versa. Dedicated workstations will be used for the student write up spaces within the laboratories, the layout of the workstations in relation to the lab benches will be positioned to suit the individual faculty requirements.

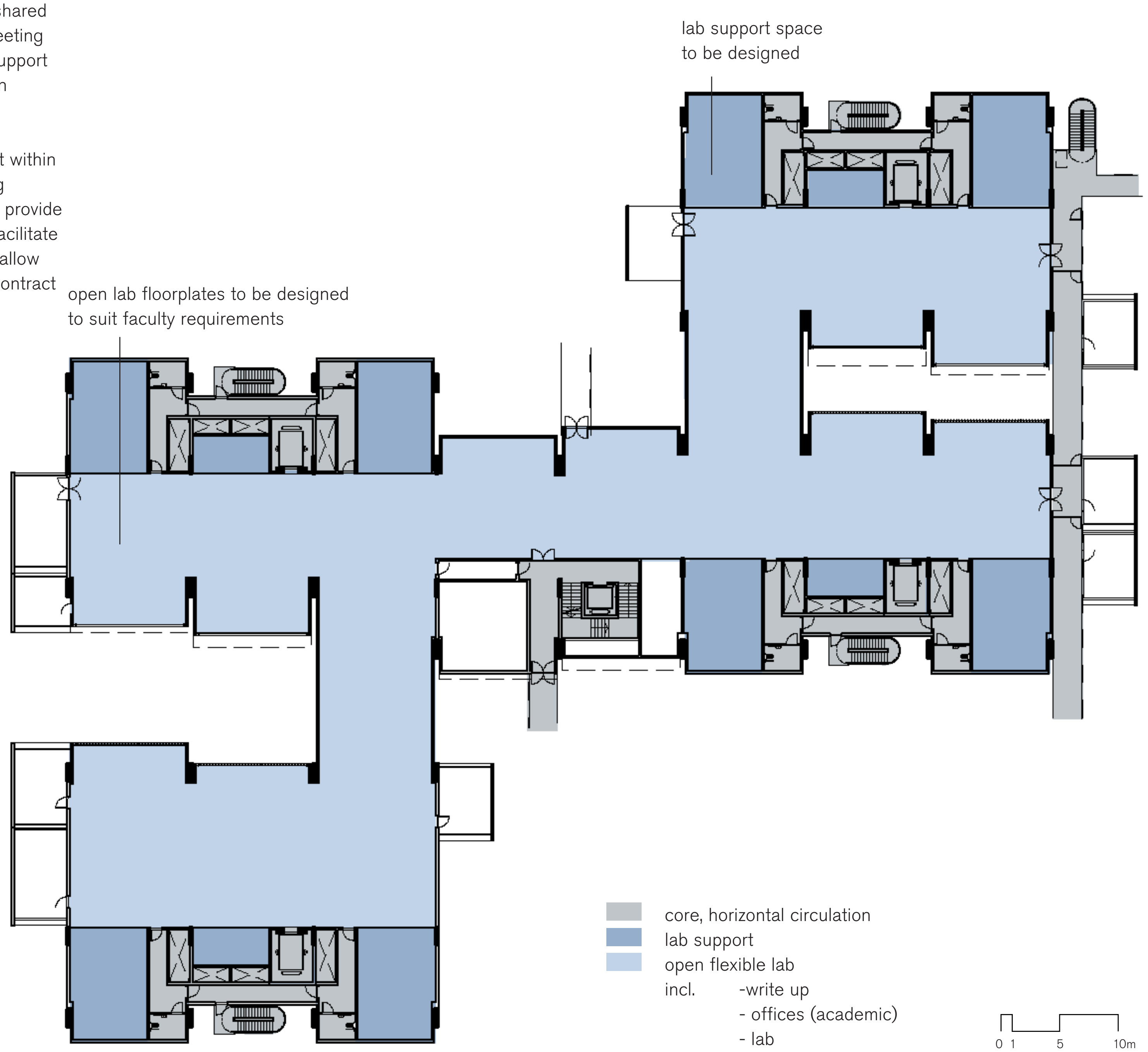
Enclosed Lab Support Zone: All research spaces that require some form of enclosure are included in this zone. Spaces that would typically be included are for functional reasons including noise control; lighting control; temperature control; security; cleanliness; and safety. Within these spaces laboratory support space would be provided, such as equipment spaces; cold rooms, dark rooms; fume hoods etc. These support spaces are typically cellular, and we have designed this zone to be planned on a 3.5 m square grid. The extent of the enclosed space, and their size will depend on the specific research requirements. However due to the similar type and size of equipment and the way these spaces are typically used, generic plan types could be proposed. This is a zone that includes all typical general building functional and service spaces including, escape stairs, egress corridors, service risers, goods lifts, toilets, etc.

Building Core Zone: This zone include all spaces that are essentially 'fixed' items that are required for the laboratories to function. The spaces include, egress stairs, egress corridors; goods lifts; service risers (typically, general building services air distribution, fume hood extracts, proscsess piping, power and data) toilets etc. The detailed layouts of these spaces will be refined through collaboration between the consultant teams.

The exact design and functional performance of the building within each zone will be developed further during the Schematic design development phase. We recommend that a series of space planning sessions are held with the MIST faculty, Facilities and Project management teams to test and develop the layouts of the Open and enclosed lab zones. These exercises will be invaluable in understanding the scientist requirements for their spaces, and form the brief for the development of the laboratory casework systems.

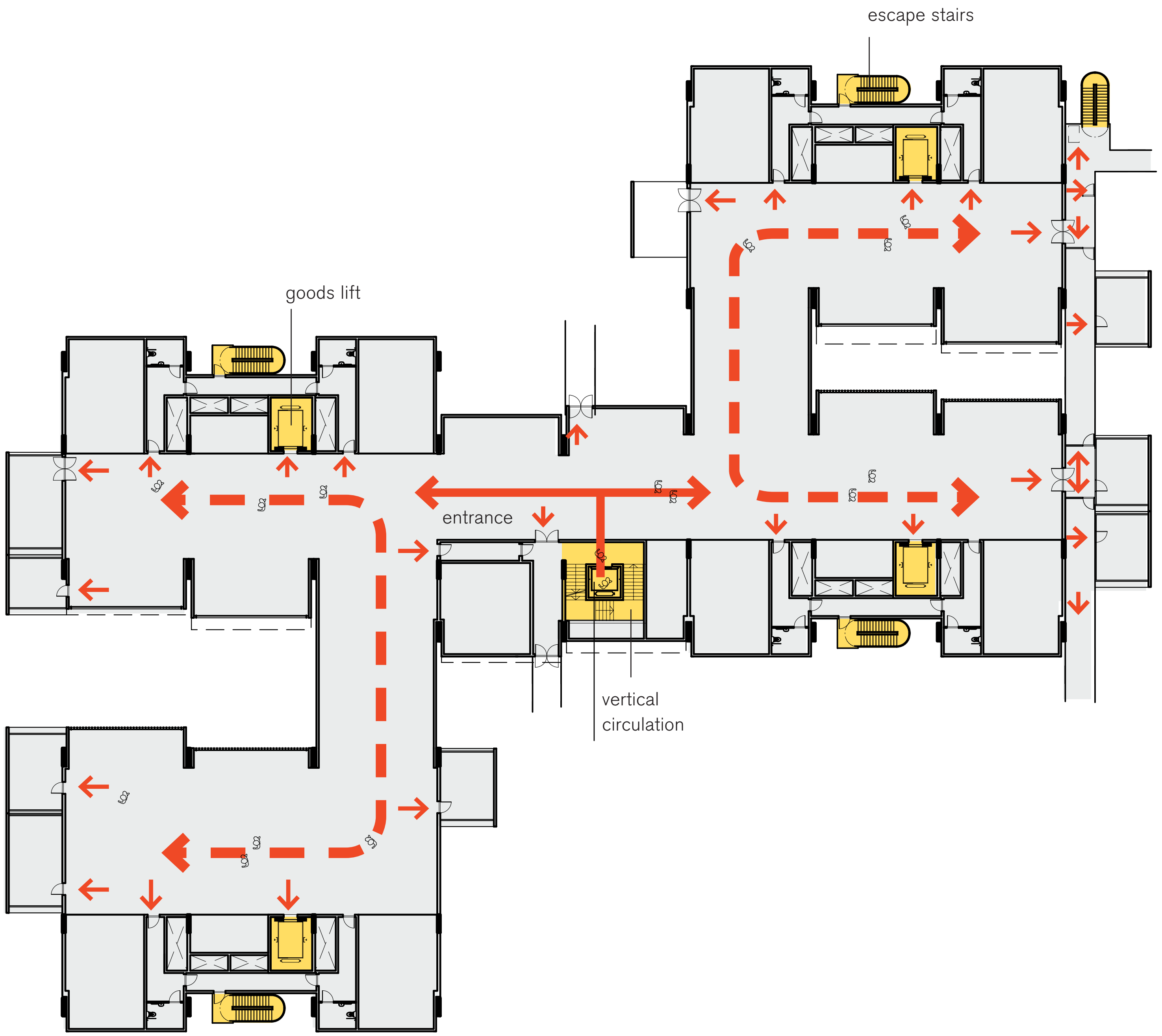
The different lab plan modules are typically joined together by a circulation zone. This forms essentially the main entrance to the laboratories at each floor level. Within this central zone all vertical circulation between floors will occur, with a lift and access stairs. The design concept is that this zone links the laboratories and would be planned to suit the requirements of typically shared space. The uses envisaged are meeting rooms / Faculty offices / admin support staff or simply additional open plan laboratory space.

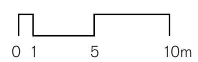
The primary design concept is that within each zone the utilities and building systems are carefully designed, to provide as much flexibility as possible to facilitate change of use. This approach will allow scientific programs to expend or contract



Laboratory
Laboratory Planning: Circulation

The circulation concept has been to develop open plan laboratory spaces with the minimum amount of corridor space as possible. This is achieved by having a compact plan, and includes the circulation within the open lab plan spaces. Main entrance access to the laboratories is via a dedicated entrance at the podium level which then forms the vertical circulation linking the laboratories together. The fire egress circulation will be developed with the fire engineering consultant, however the essential concept is that short corridors provide egress routes to dedicated external fire stairs. These short corridors are then used to provide additional access, and flexibility in the configuration of the lab support spaces. These zones also include the toilets and access to the vertical service shafts.

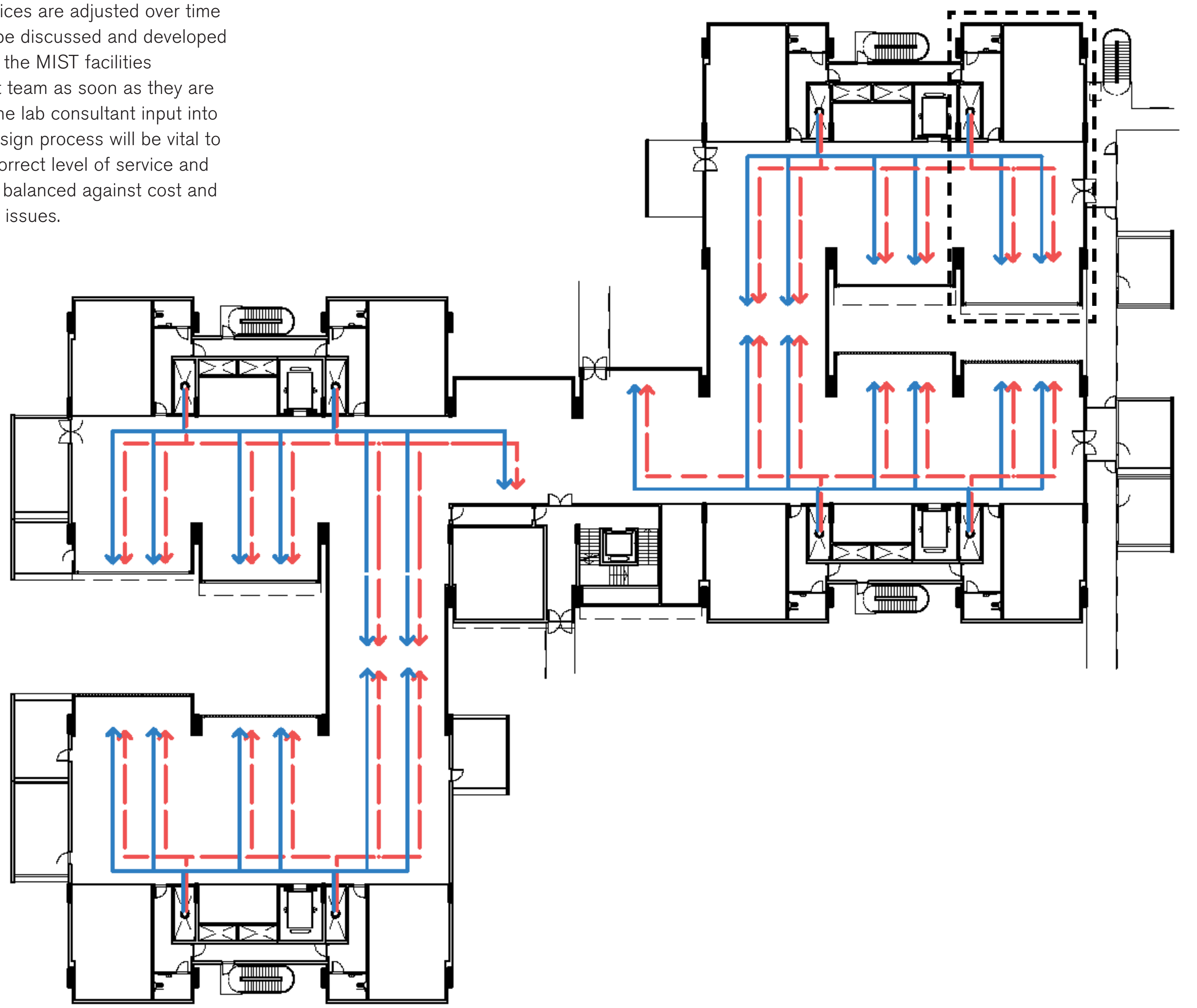


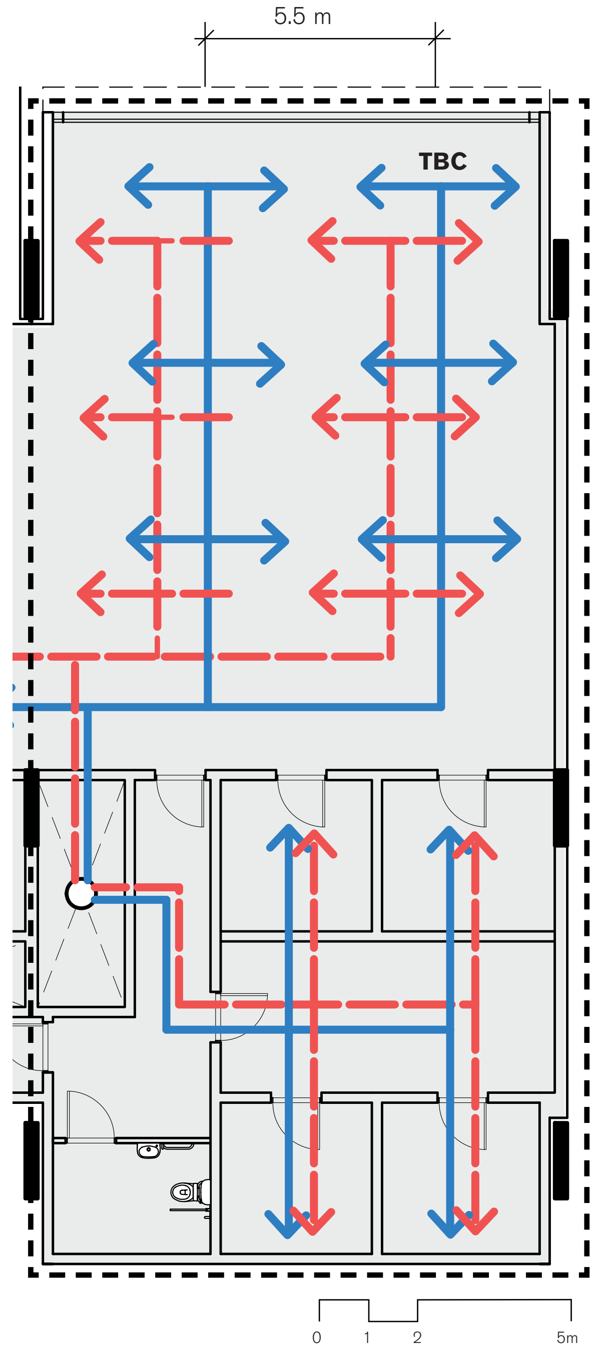


Laboratory

Lab Utility Infrastructure

The utilities concept is that services are divided into two types; building services, and laboratory services.
The building services are the services that supply and support the essential environmental and safety systems.
These services are likely to include the air conditioning / air supply and extract system, the sprinkler and fire detection systems, acoustic insulation, general lighting and fume hood extract main services. As established in the Laboratory Section Concept, all these services will be incorporated either into or above the laboratory ceiling.
All services that the scientists potentially require at their lab benches, casework of offices are to be located below the level of the ceiling plane. The services are proposed to be fully exposed and will include all processed piping, data wiring and power connections. Processed piping types need to be confirmed, but are likely to include: Compressed air; process vacuum; industrial hot and cold water; de-ionised water; domestic hot and cold water; natural gas. A detailed assessment of the sustainability of each system and any options of fully centralised vs more localised systems will be required.
Our proposal is that the laboratory services are suspended off a metal frame Halfen type continuous channel grid. This grid will be fixed to the building structure, designed to support the building services and other potential dead loads that the laboratories may need for storage racks or lifting. Connections will be made through droppers and support frames to benches and equipment on an as needed basis.
The main laboratory services will be separates, with the data wiring and power running above the processed piping.
The services will run the length of each laboratory, to form a main services spine supplying to each side, the open laboratory and the enclosed laboratory support zones.
The appropriate level of distribution of the building services will need to be developed in detail with the input of the MIST faculty and Laboratory consultants.
The ratio of 'wet' and 'dry' research will influence the level of services infrastructure installation, however we believe that service runs and connection valves for each piped service off the main utilities spine, should be probably be provided at 5.25m centres.
The management of the services and how the services are adjusted over time will need to be discussed and developed in detail with the MIST facilities management team as soon as they are appointed. The lab consultant input into this detail design process will be vital to ensure the correct level of service and flexibility are balanced against cost and maintenance issues.





Laboratory

Meeting Rooms and Faculty Offices

The detailed planning of each laboratory floor plate, will need to be developed with the individual Faculty and students that will ultimately work in the space.There are a number of important issues that will need to be discussed with each group. Two particular issues that will effect the working methods and are likely to vary to suit the Faculty specific requirements for each floor plate are the location and design of the Faculty offices, and the conference rooms.

Faculty Offices:
The main design influences for the detailed design and position of the Faculty offices are the users requirements for three issues - degree of enclosure (or transparency) for privacy, proximity to their students, and acoustic privacy. There may also be a desire for offices to be located near perimeter to obtain view out of the laboratory.
Within our current design there are a number of conceptually different positions that the offices could be located, that would give a very different feel and character to the space. The main options for positions are as follows:

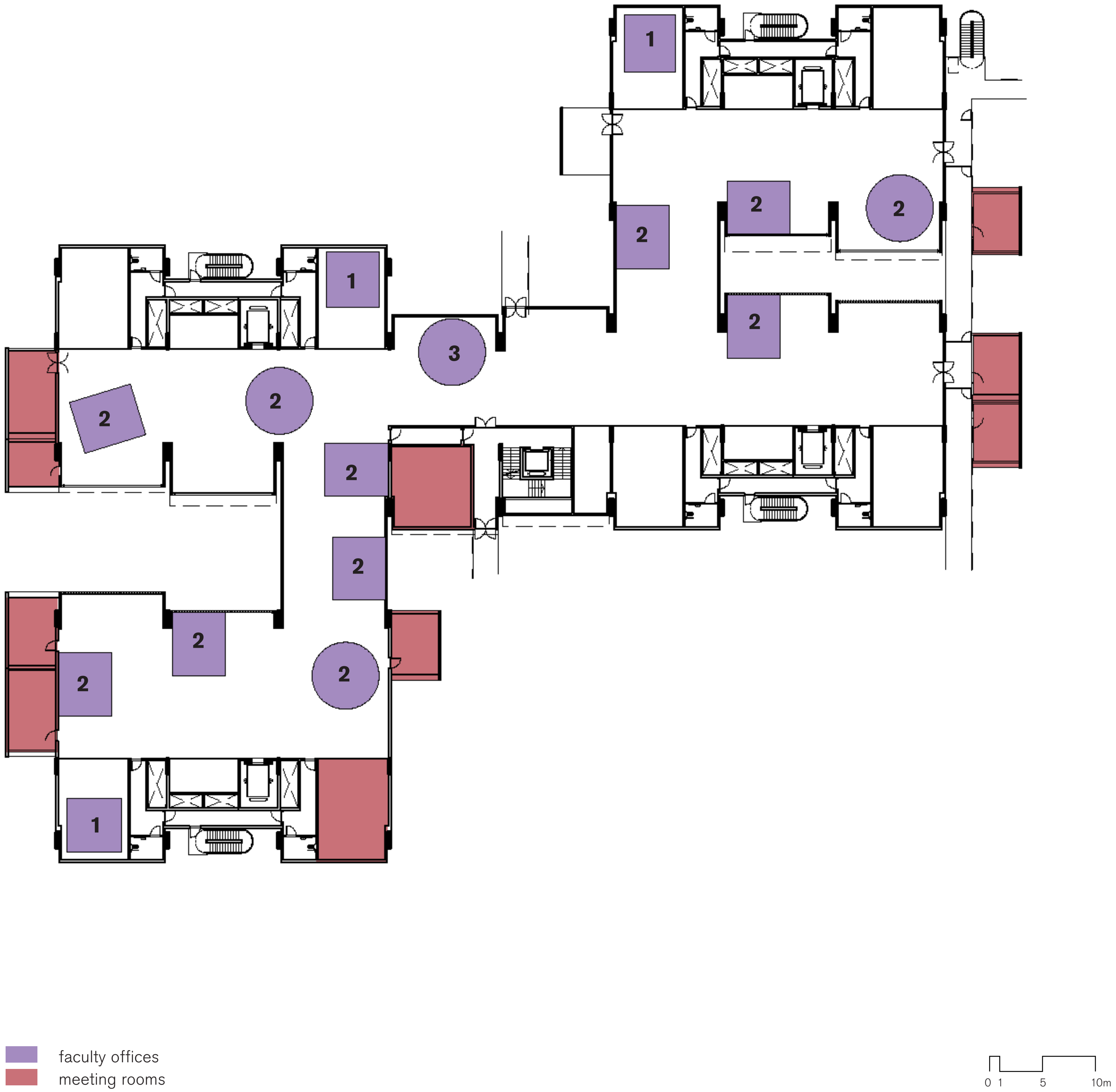
• Within the enclosed Lab Support zone: Offices in this zone would be like a traditional office, and essentially enclosed with solid walls. (location **1**)

• Within the open laboratories: Offices can be positioned and orientated anywhere on the floor plate, either deep in the plan, or near the external windows where they can be orientated to gain views. (location **2**)

• Within the shared spaces linking between the laboratories: These positions would be more remote from the students, but would position the Faculty within an active area. (location ***3***)

Conference Rooms:
Conference rooms could also be positioned in a similar way to the Faculty Offices. The type of science occurring on the floor plate may also effect the decision on where the conference rooms should be located. This will depend on the intended use of the room, who would be likely to use the room, and any safety / security concerns.

Acoustics:
The acoustic performance of the offices, meeting rooms and laboratories in general are critical to the success off the buildings. The open lab concept, will inevitably have less acoustic privacy than traditional labs where separate rooms are used for each type of space. From our extensive experience on other laboratories we know that the need for acoustic privacy as well as visual privacy for certain functions is a requirement for the users of the building. However each user will have different requirements, especially as we will have a mix of different research cultures within the same laboratory spaces in MIST. The detailed design for options on how these issues can be met with different office and conference room designs will need to be developed in collaboration with the acoustic consultant. The ultimate aim will be to develop design that maintain visual openness and transparency in the laboratories, whilst also addressing the performance requirements.

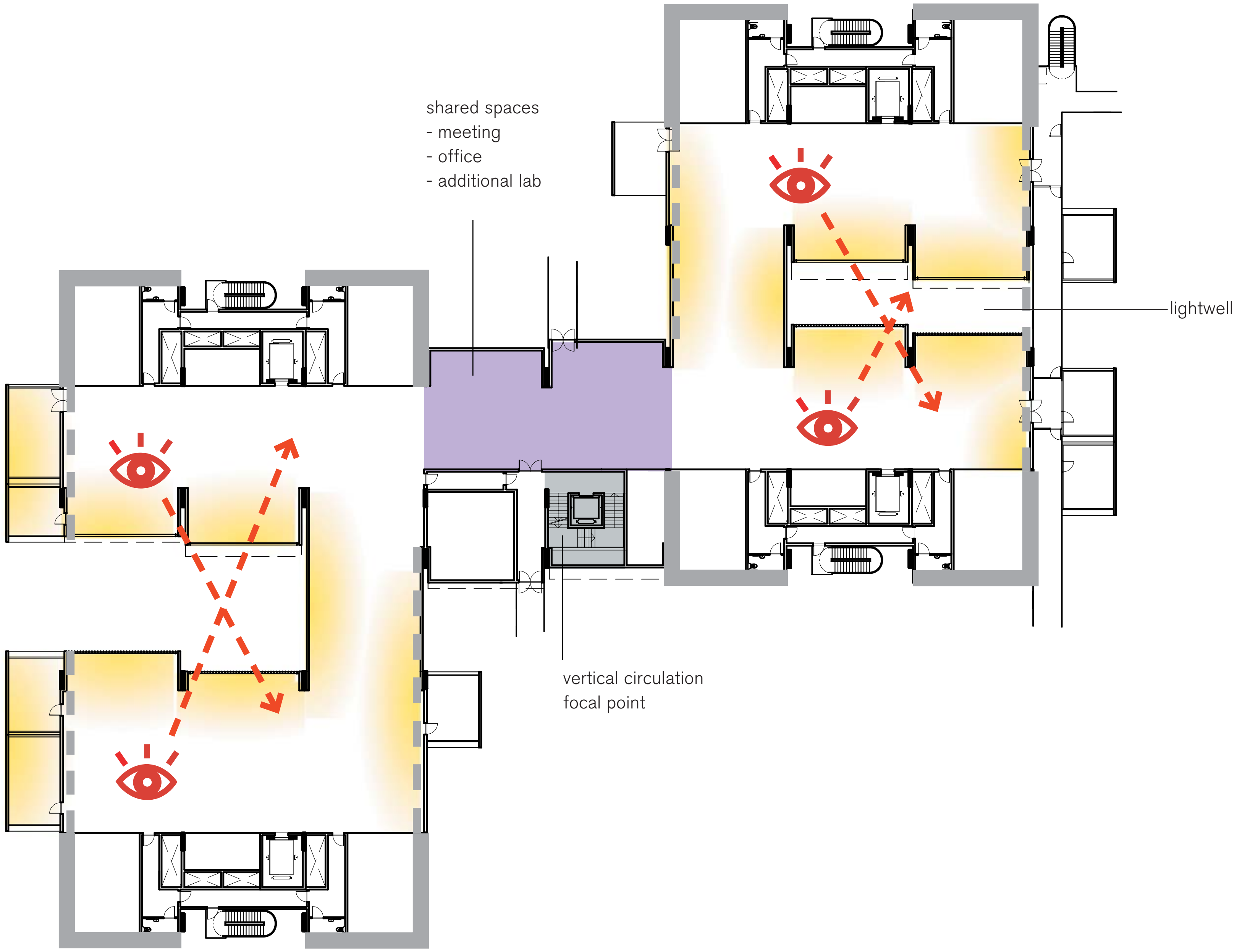


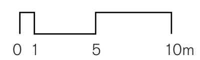
Laboratory

Laboratory Building Concept

The concepts proposed for M.I.S.T. have lead us to reconsider the laboratory planning. The challenge has been to develop a laboratory floor plan that is as open and flexible as possible, that creates interaction between researchers whilst minimising energy use. In particular the introduction of natural light into the laboratories, within the context of the Abu Dhabi climatic condition has been an important influence on the design. This has lead us to develop a floor plan where the laboratories are wrapped around a narrow courtyard, allowing light into the plan, whilst allowing views across between each side of the laboratory. This cental void also will provide allow views to the street and courtyard spaces below. The solid elements of the plan, the cores and enclosed lab support spaces have been arranged along each external side of the floor plate linearly, so that the lab support spaces are arranged in a functionally efficient layout immediately adjacent to the open laboratory spaces. The generic lab space forms a 'C' plan shape, and these lab modules are joined back to back with the flexible vertical circulation zone. Faculty and students will pass through this zone as they move between laboratories; whether on the same level, or between laboratories on different floors.

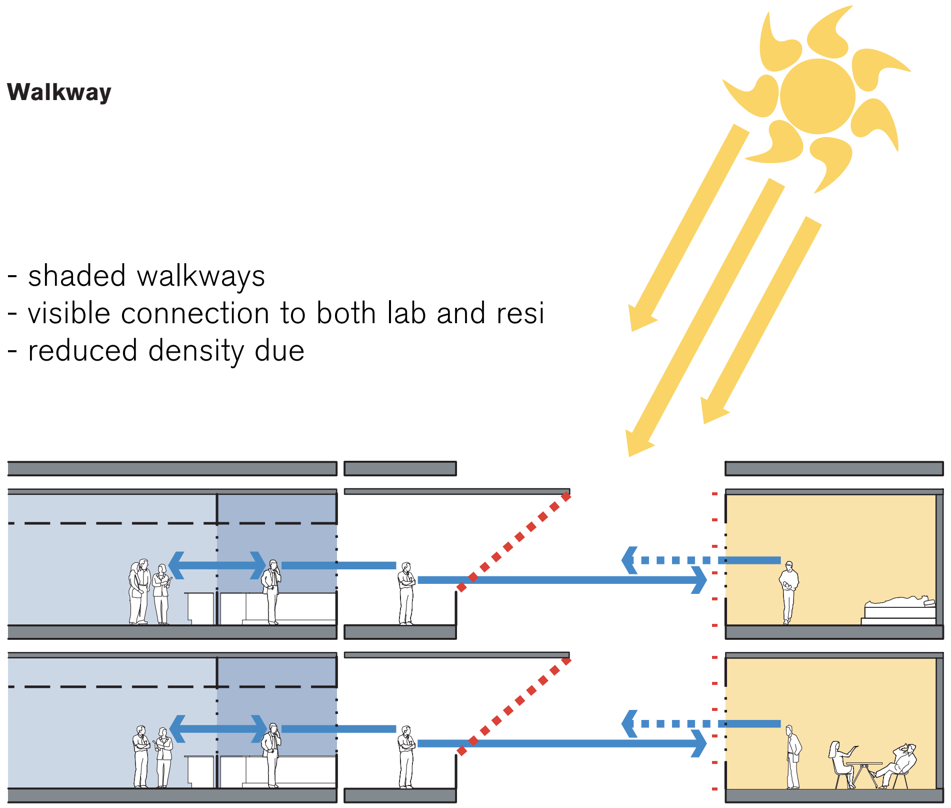
The detailed design of the lab plan will be developed in scheme design with the input of Fire, Laboratory and Acoustic consultants. The aim is to develop highly functional, flexible and interactive laboratory environments, which are more adaptable to the changes in science over time.



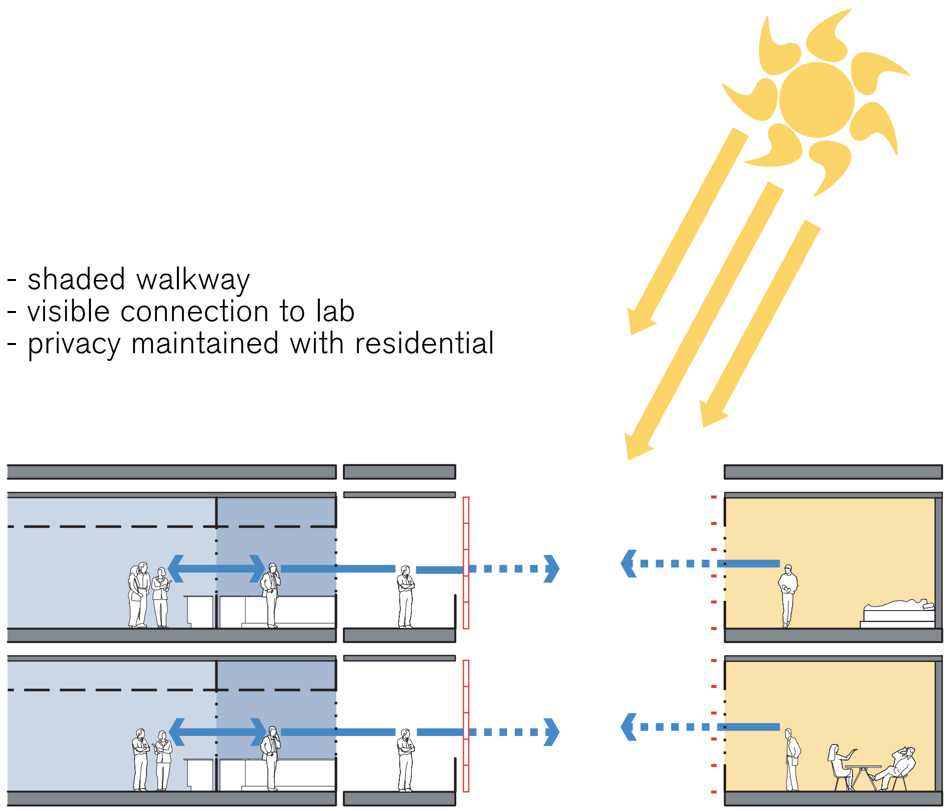


Walkway

- shaded walkways
- visible connection to both lab and resi
- reduced density due

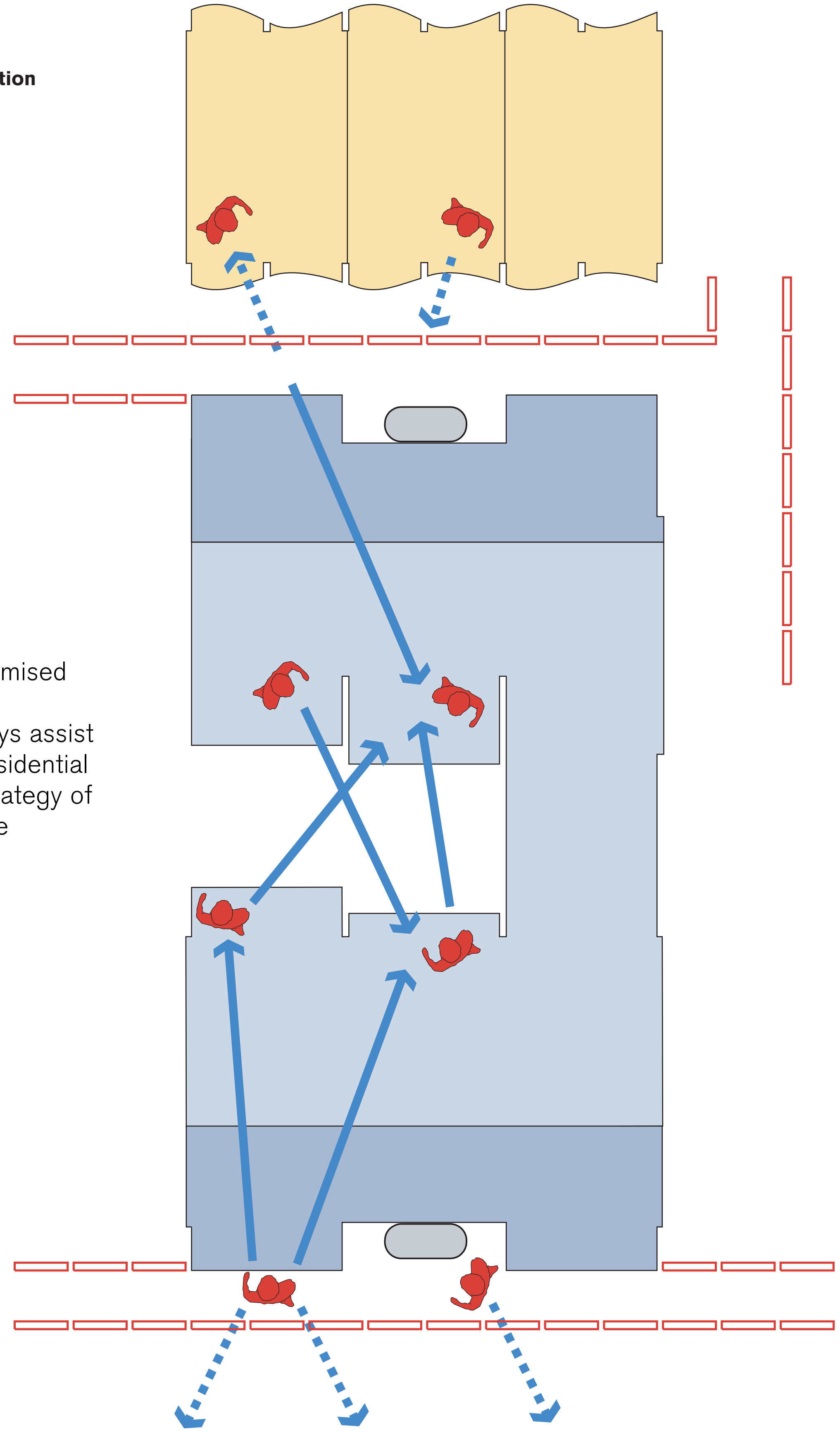


- shaded walkway
- visible connection to lab
- privacy maintained with residential



Walkways -Privacy vs. Circulation vs. Connectivity

- visual connectivity maximised between laboratories
- solar control of walkways assist in providing privacy to residential
- walkways assist exit strategy of cellular lab support space



5

Lifestyle Concept

The residential concept for M.I.S.T focuses on the creation of lively energetic neighbourhoods. This requires careful planning of the scale of the buildings but more importantly the spaces in between the buildings. places of interaction, safe areas, and areas of relaxation and contemplation that are essential ingredients in creating a cohesive educational environment.

The university campus is envisaged around a hierachy of streets and squares that form the backdrop to an environment of integration, communication and co-operation; a place where the ground plane is active throughout the day and night, providing a safe environment. Small intimate squares allow for chance meetings, conversation and encourage a neighbourhood cafe culture. These lead to larger streets required for wayfinding around the campus and the PRT network. The change of scale avoids disorientation, always giving people direction and a range of environments washed with both light and shade.

The residential element of M.I.S.T is integral to this, contributing not only to the visual articulation of these spaces but also to maintaining a cool and comfortable micro-climate in which to walk and mingle with the wide range of students and inhabitants of M.I.S.T and MASDAR City.
While high density low-rise living is a major component in any low impact development, the neighbourhoods embody the residential fabric and communal services that lend the complementary social conuterpoint to the essential research and development that underlines M.I.S.T. This urban component is vital in achieving a balanced, socially and commercially sustainable campus. This manifests itself architecturally as residential accommodation which blends the traditional compact and dense typologies and new technologies such as the incorporation of wind towers, solar shading and screening that satisfy modern demands for style, identity, adaptability and flexibility and it will provide a range of residential types that will relate to individuals, couples and young families.

Residential Concept - Post Graduate Apartments

Place-Making: Spatial Concepts For Contemporary Student Lifestyles

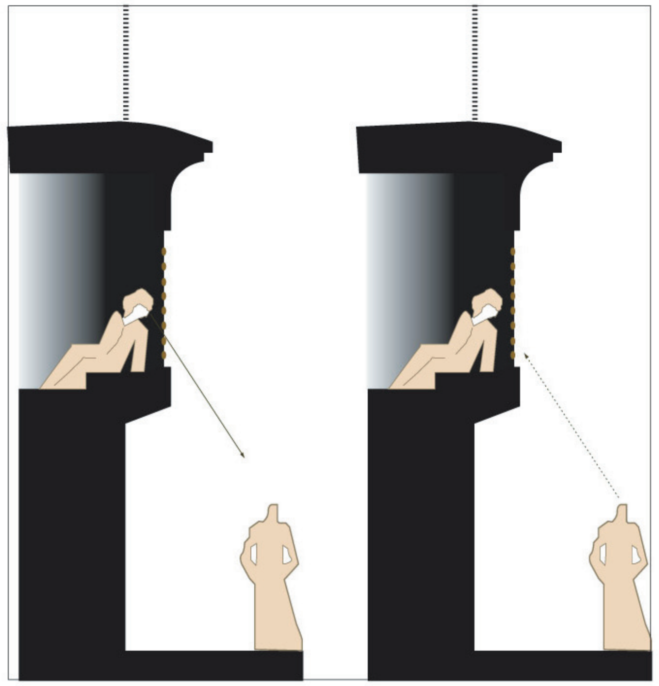
social interaction / ***flow*** from private to semi private space

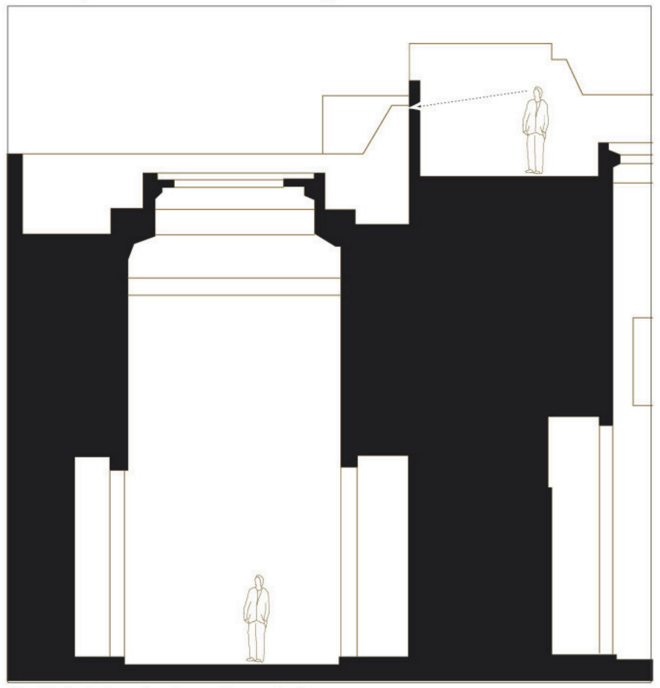
student family support / ***flexible***, need accommodating space

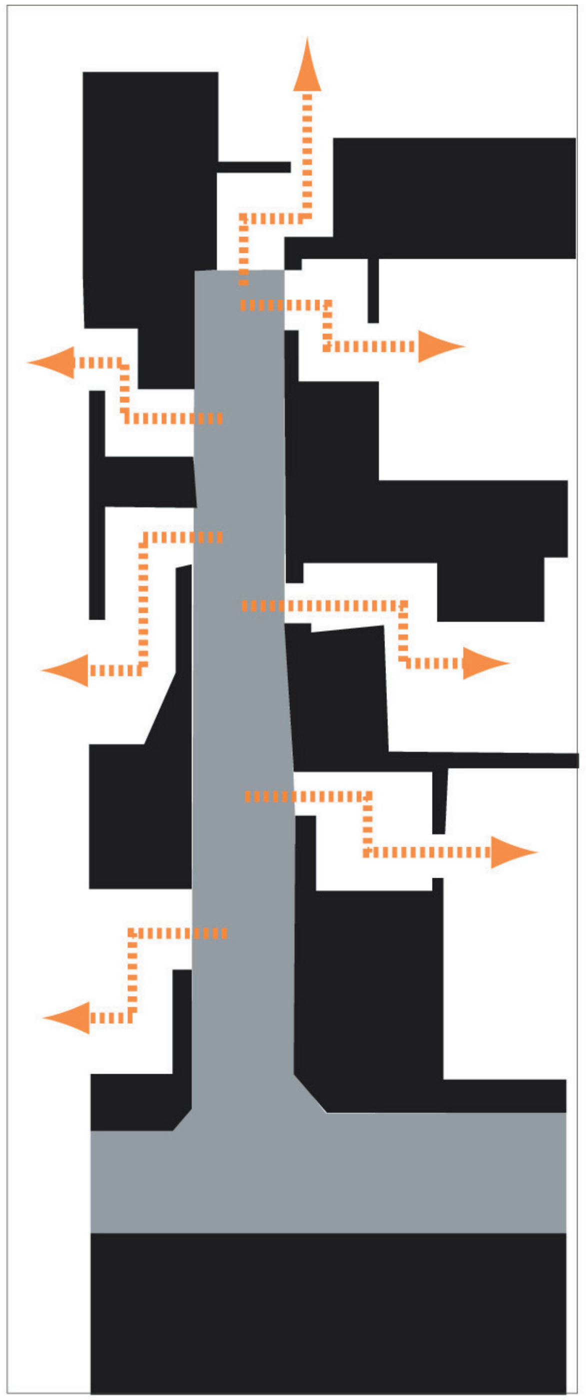
modern student lifestyle / multi-functional place of ***exchange***

Traditional Facades and Privacy in Dwellings


Mushrabiya


Mushrabiya restrict views into a dwelling from the outside


Restricted views in domestic contexts


Entrances to houses are staggered to provide privacy

Central Core

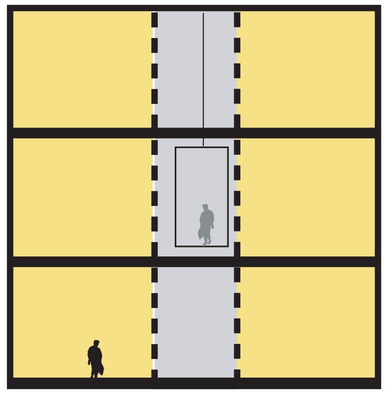
too many lifts
requirement for multiple cores results in need for lifts

natural light
requirement to artificially light some spaces at all times

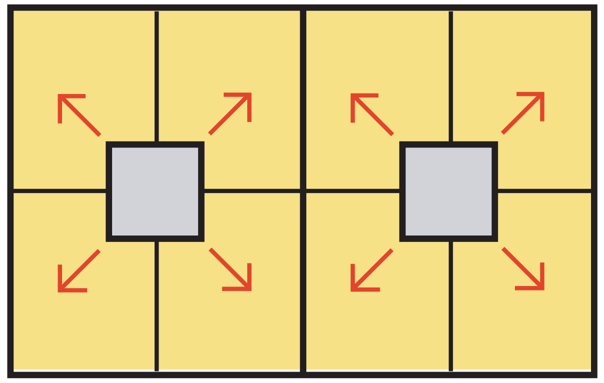
CO2
high energy consumption

HVAC
requirement to air condition some interior spaces

section



plan

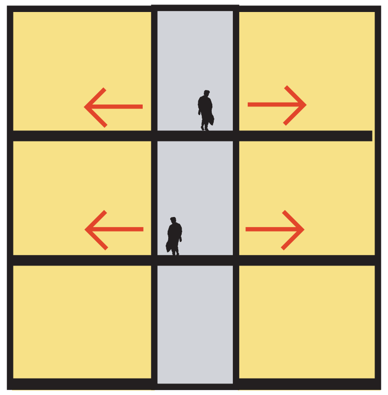


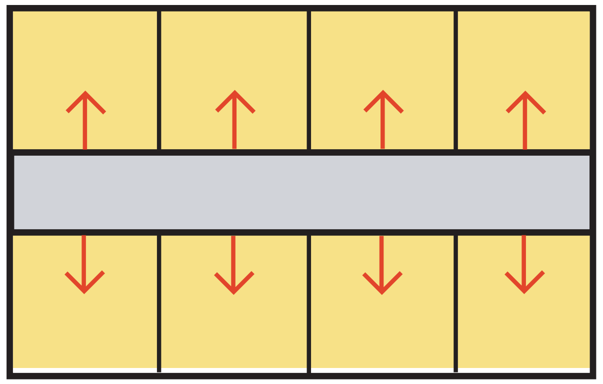
Central Corridor

natural light
requirement to artificially light some spaces at all times

CO2
high energy consumption

HVAC
requirement to air condition some interior spaces



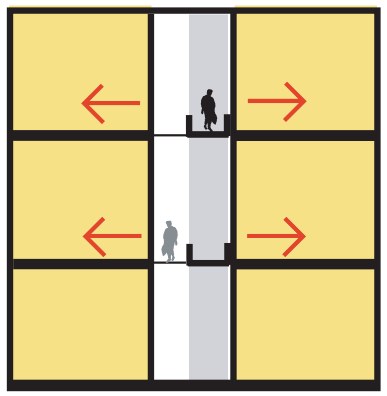


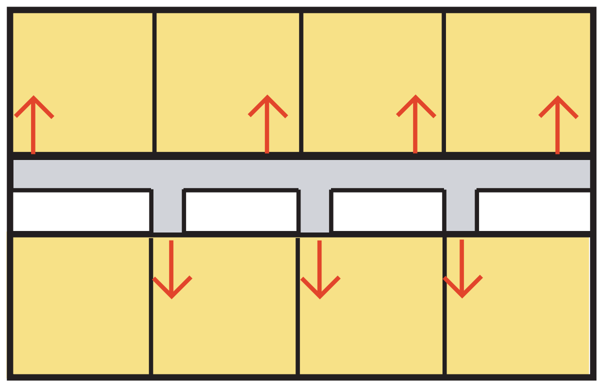
Central Atrium + Corridor

natural light
natural day light to all rooms and shared spaces throughout the day

CO2
reduced energy consumption

passive ventilation
all spaces naturally ventilated with the option to air condition only where necessary





APPROVED FOR MIST

Apartments Variations

Requirements

-Direct links to labs, reducing use of lifts

- Corresponding structure and height for laboratories and residential units allowing future expansion and flexibility of use.

- Optional segregation of male and female students respecting each individual's cultural background

-Windows and natural ventilation for all rooms while respecting privacy

-Variation of facade components to create identity for individual apartments.

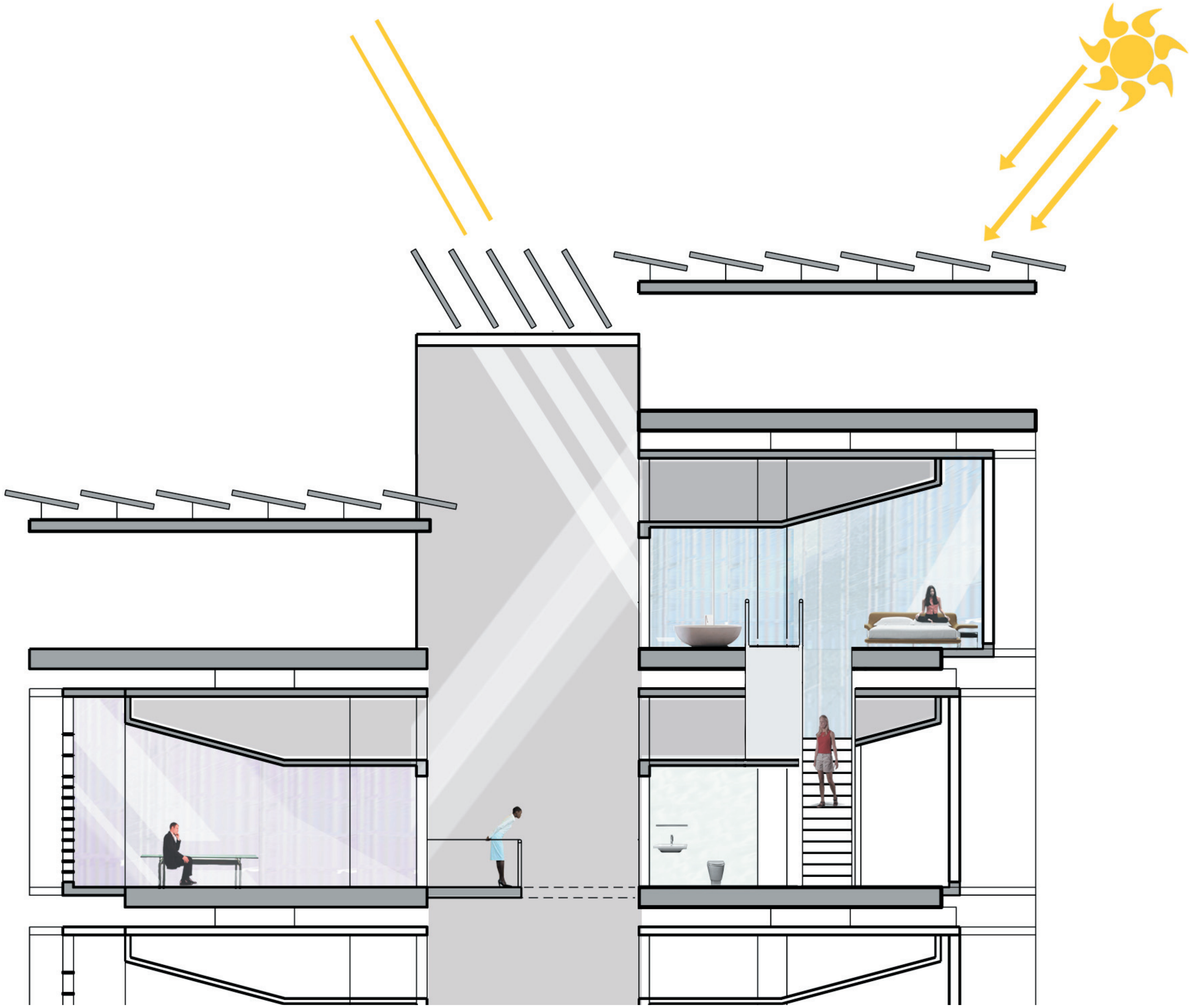
1 Bedroom Apartments	76
2 Bedroom Apartments	9
3 Bedroom Apartments	5

0m 1 2 5

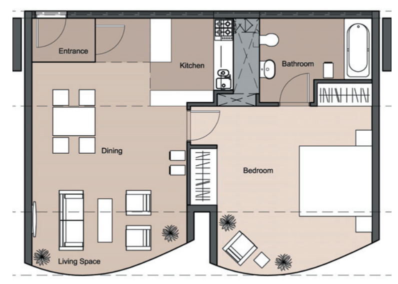
Residential

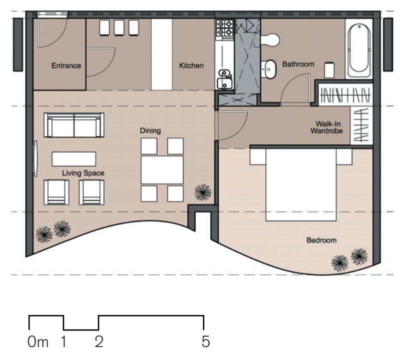
Typical Post Graduate Apartment Layout

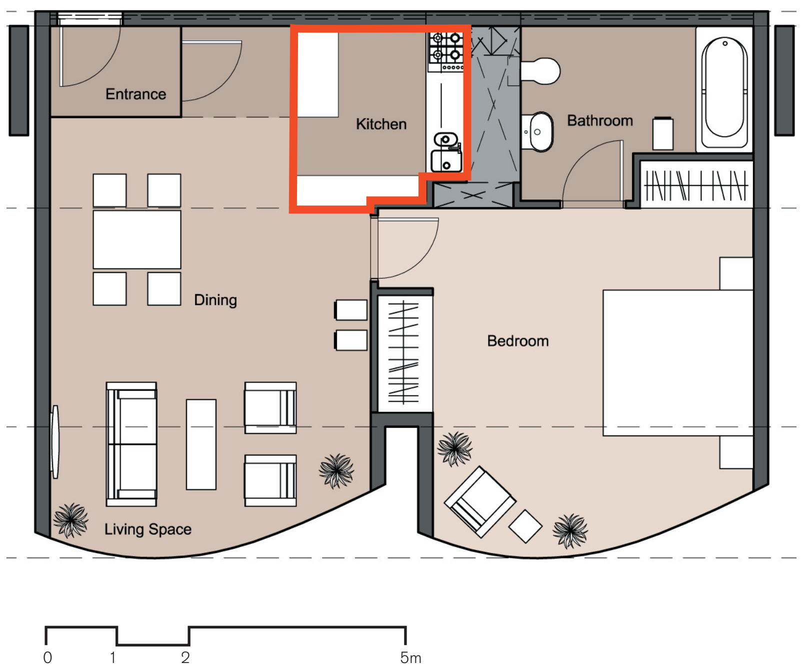
Typical Section

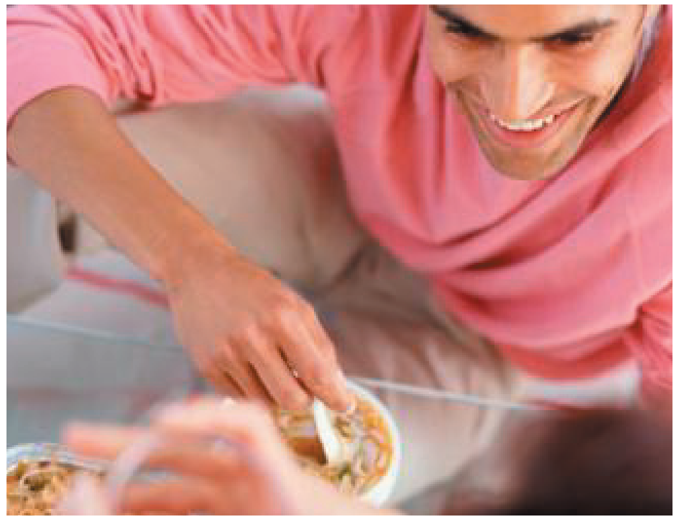


Apartments Variations



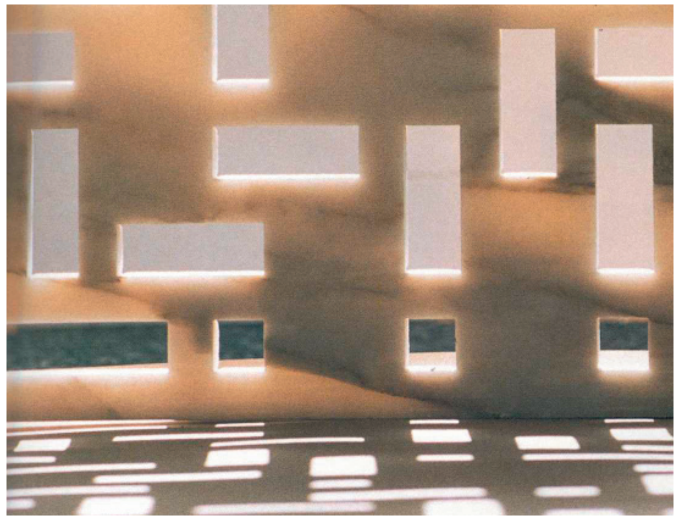



Entrance
Kitchen
Bathroom
Dining
Bedroom
Living Space
0
1
2
5m



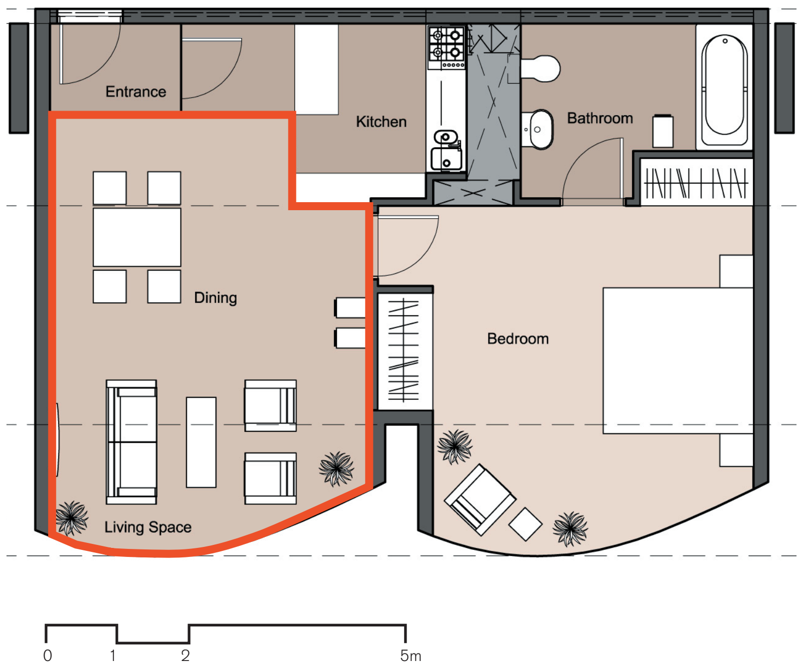
Residential

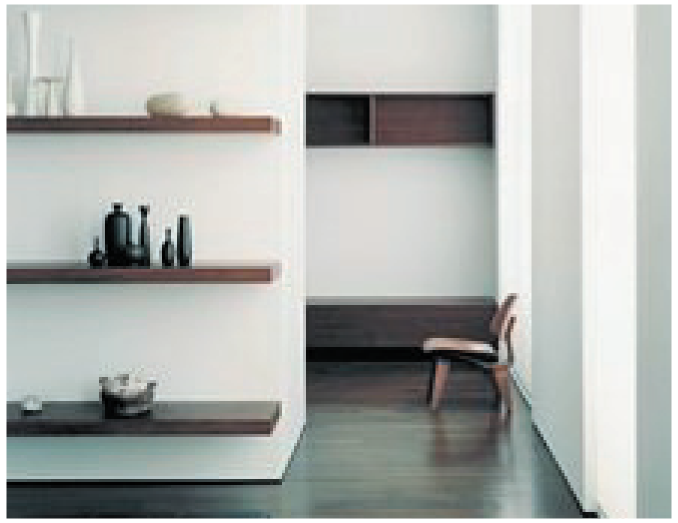
Residential Unit Images - Bedroom

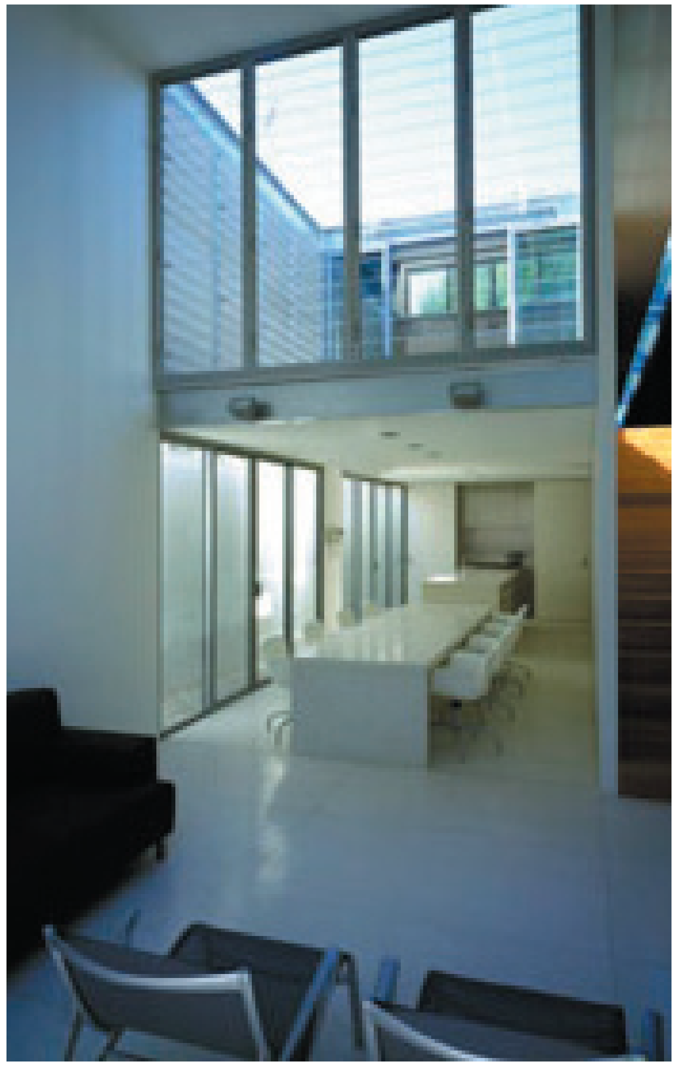


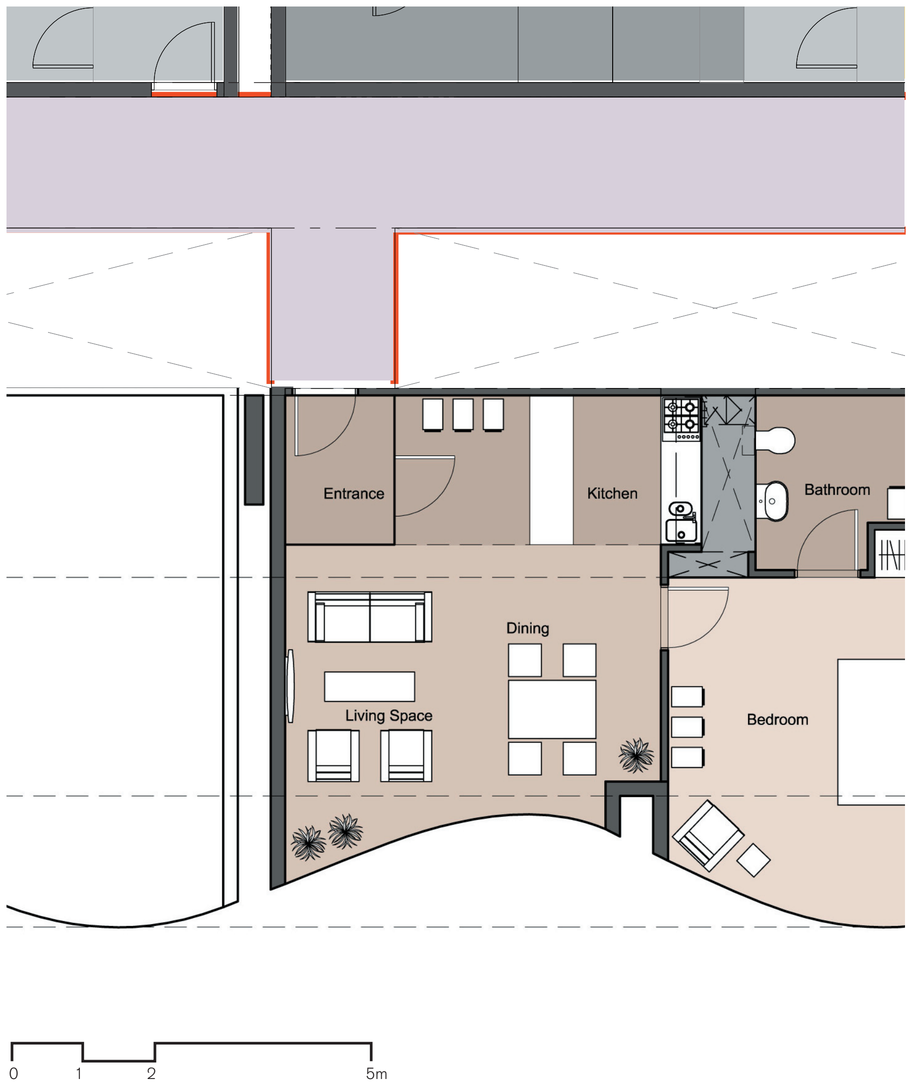
Residential

Residential Unit Images - Living Area








Entrance
Kitchen
Bathroom
Dining
Living Space
Bedroom
0
1
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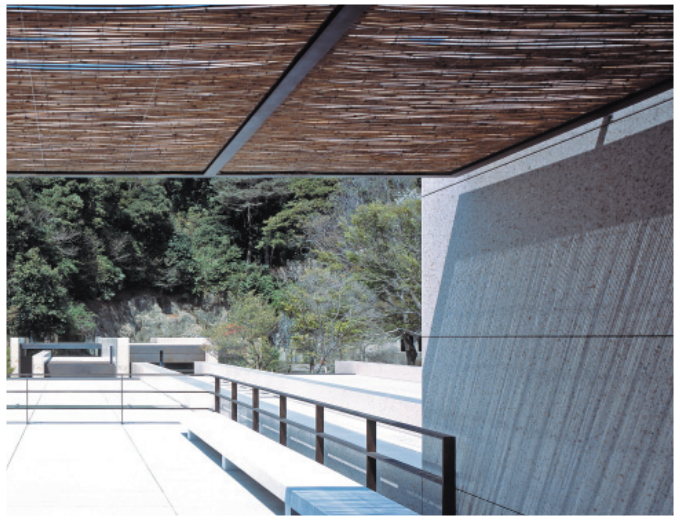
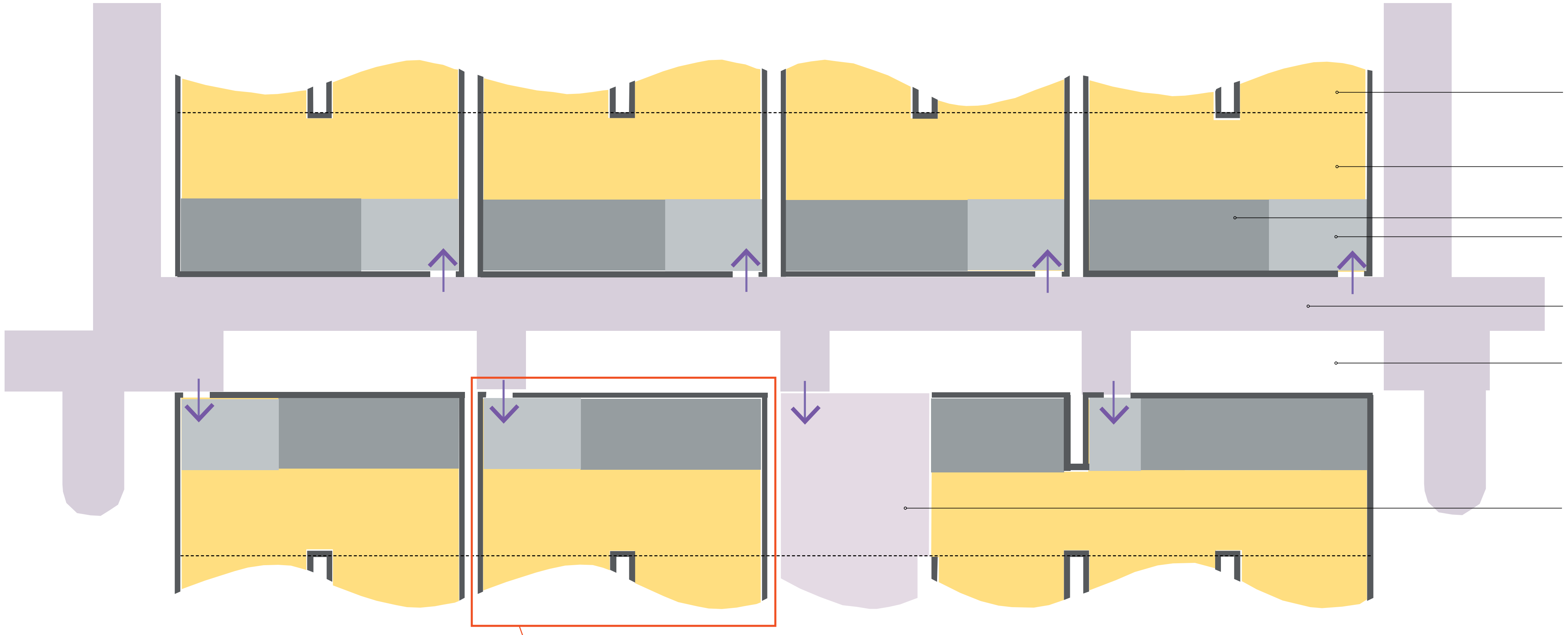
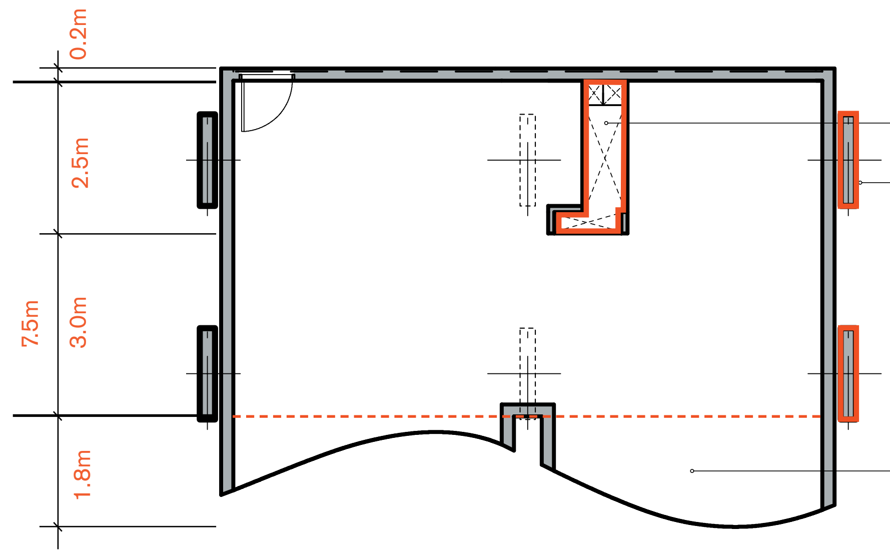
5m

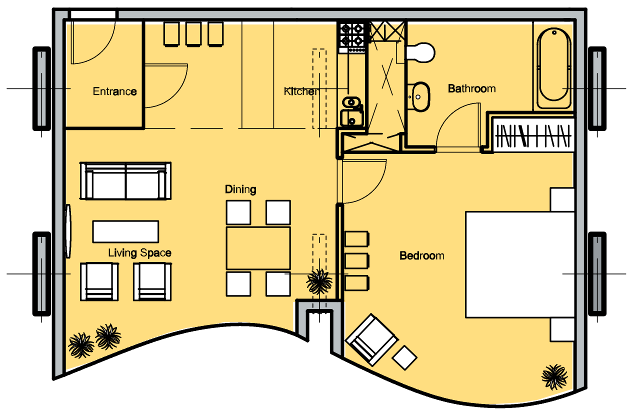


Spatial and Structural System

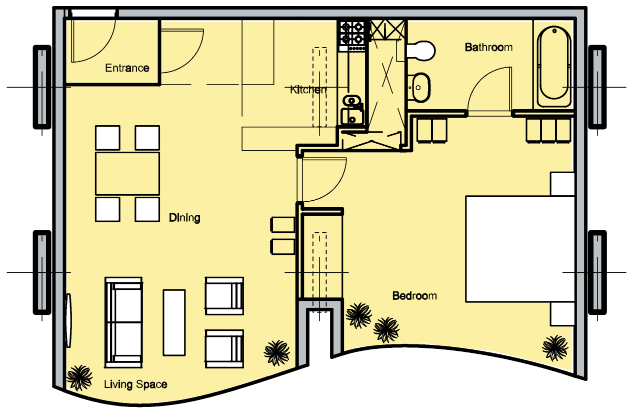




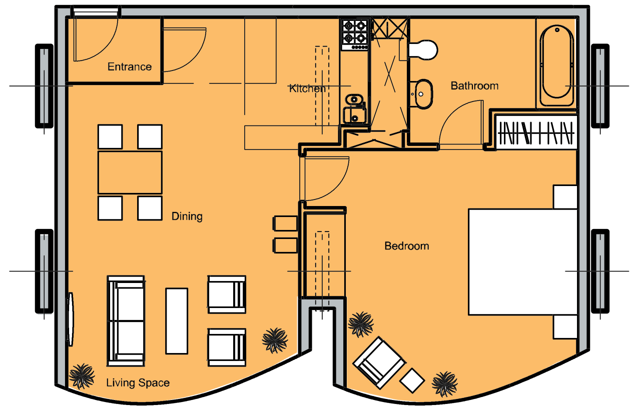
Apartment Types and Concept Images



Residential Unit / Singles type A
Area: 67.35m2

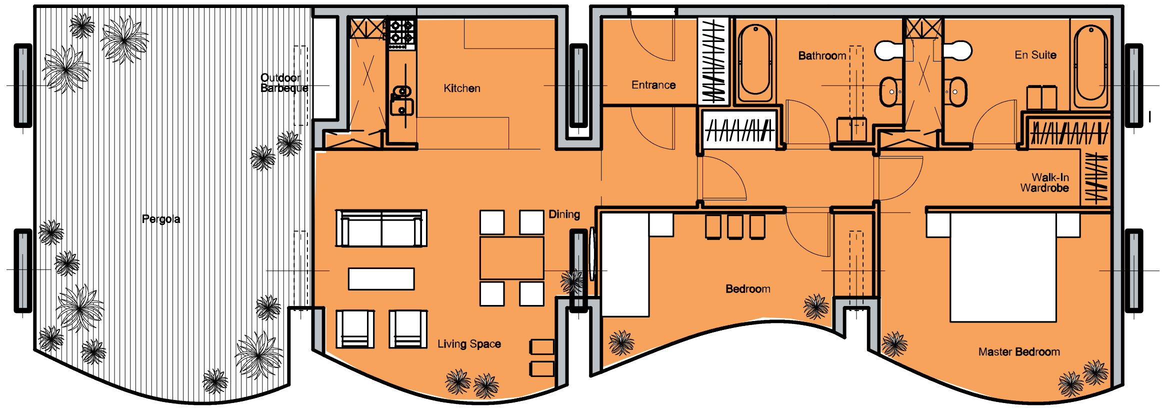


Residential Unit / Singles type B
Area: 68.95m2

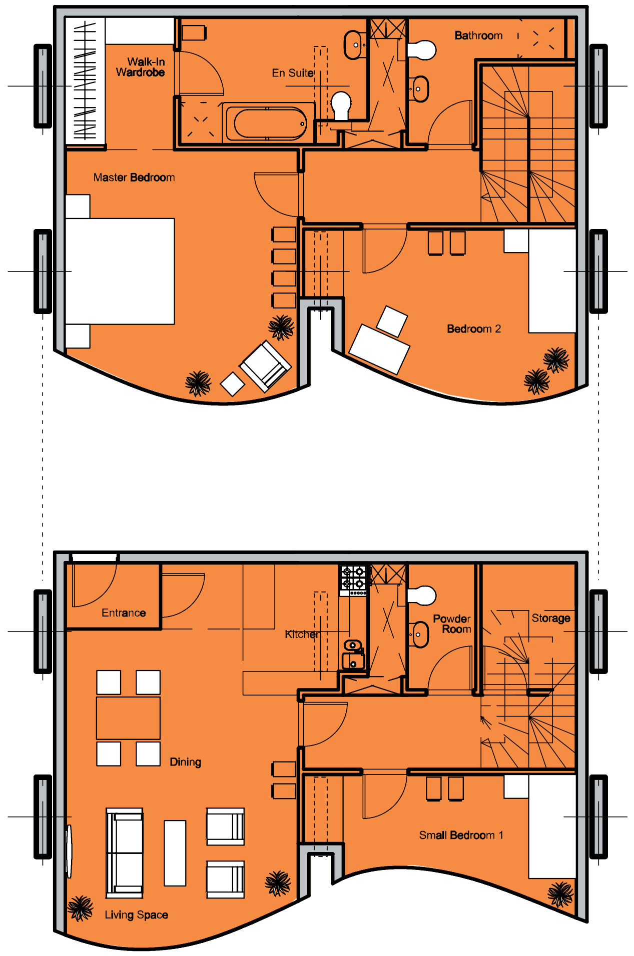


Residential Unit / Singles type C
Area: 71.88m2

Apartment Types and Concept Images



Residential Unit / Couple Family type D
2 bedrooms + terrace pergola. Area: 141.79m2

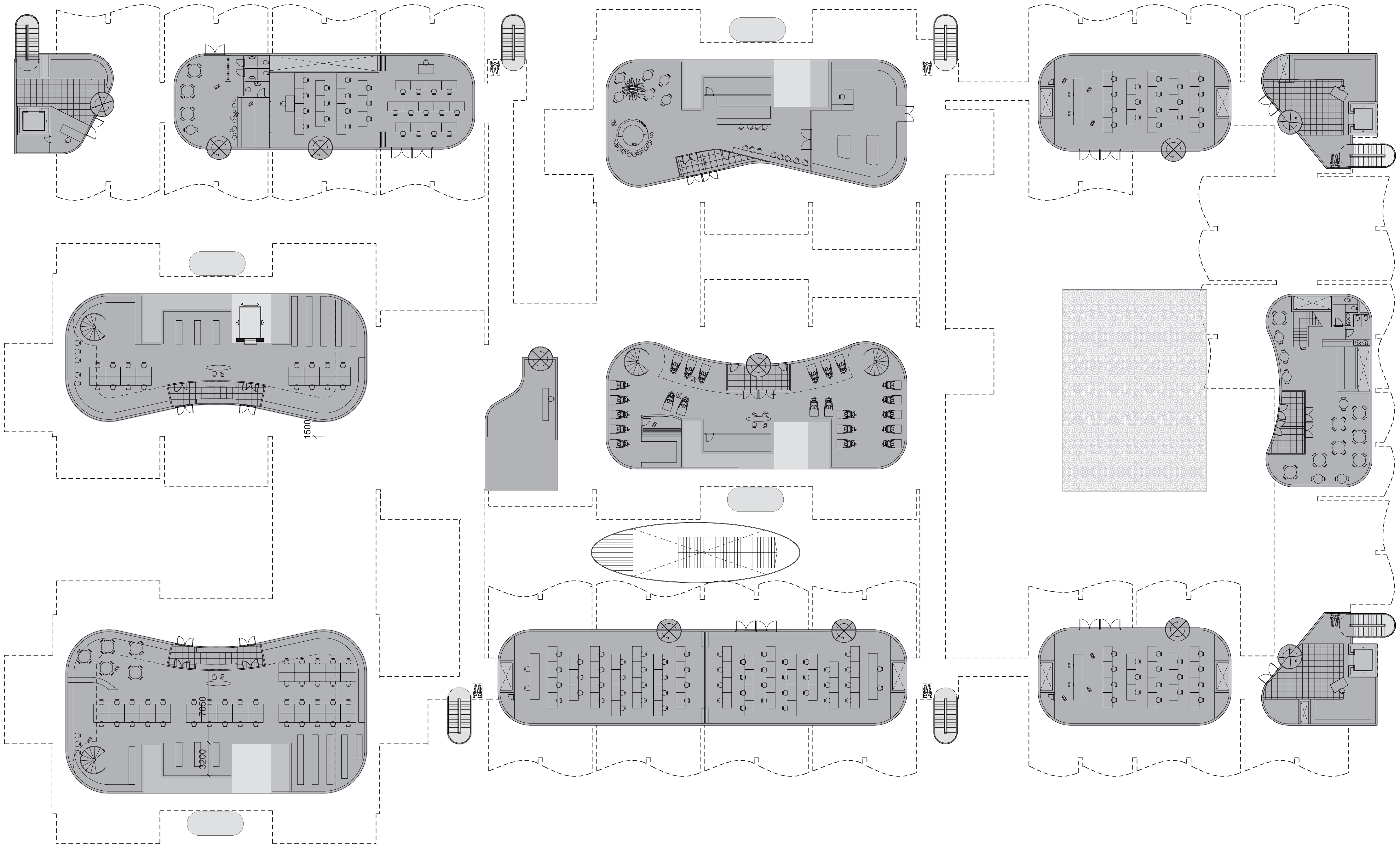


Residential Unit / Couple Family type E Duplex
3 bedrooms, split levels / Area: 139.23m2

Residential
Apartment Types Distribution

L 00 Ground

Total number of units: **0**



Unit Type A (Singles)
Unit Type B (Singles)
Unit Type C (Singles)
Unit Type D (Couples / Family)
Unit Type E (Couples / Family, Split Level)

0m 5 10 N

Residential
Apartment Types Distribution

L 01

Total number of units: **27**
type A: 8
type B: 9
type C: 6
type D: 4
type E: 0

Unit Type A (Singles)
Unit Type B (Singles)
Unit Type C (Singles)
Unit Type D (Couples / Family)
Unit Type E (Couples / Family, Split Level)

0m 5 10

N

Residential

Apartment Types Distribution

L 02

Total number of units: **27**
type A: 9
type B: 10
type C: 4
type D: 4
type E: 0

Unit Type A (Singles)
Unit Type B (Singles)
Unit Type C (Singles)
Unit Type D (Couples / Family)
Unit Type E (Couples / Family, Split Level)

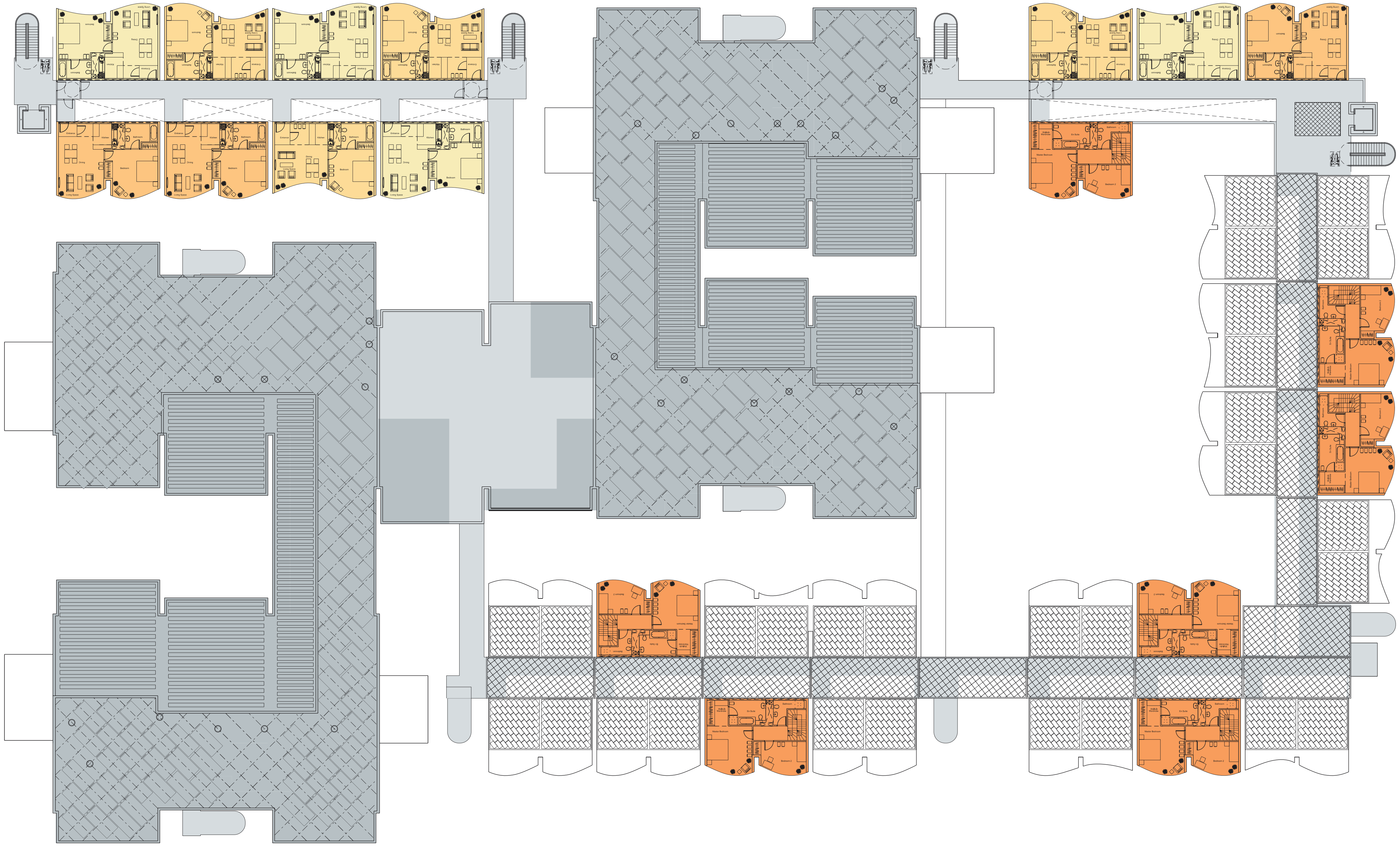
0m 5 10 N

L 03

Total number of units: **31**
type A: 8
type B: 6
type C: 8
type D: 1
type E: 8

L 04

Total number of units: **11**
type A: 4
type B: 4
type C: 3
type D: 0
type E: counted in level 03



Unit Type A (Singles)
Unit Type B (Singles)
Unit Type C (Singles)
Unit Type D (Couples / Family)
Unit Type E (Couples / Family, Split Level)

0m 5 10 N

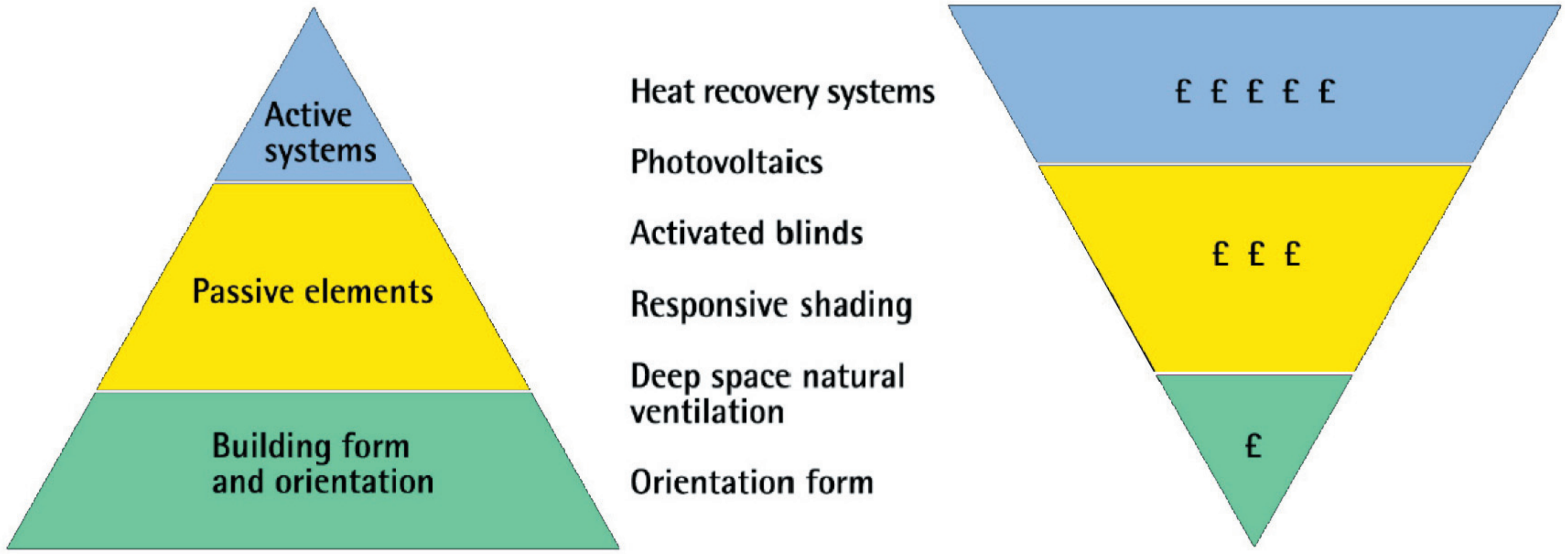
6

Construction Systems
Introduction

One of the main sources of CO_2, a primary “greenhouse gas” is our use of fossil fuels. Buildings and the construction process are responsible for approximately 50% of all global carbon dioxide emissions. The overall efficiency of buildings and their siting relative to sustainable forms of transport (e.g. public transport, cycling and walking) can contribute greatly to the overall energy totals. We should seek to minimise energy consumption in our buildings through the choice of materials, construction techniques, building design and organisation.

In the next phase, the significance of how we, as a design team, will be designing, procuring, manufacturing and constructing the M.I.S.T. campus will be crucial in helping to reduce the amount of CO_2 produced during its construction.

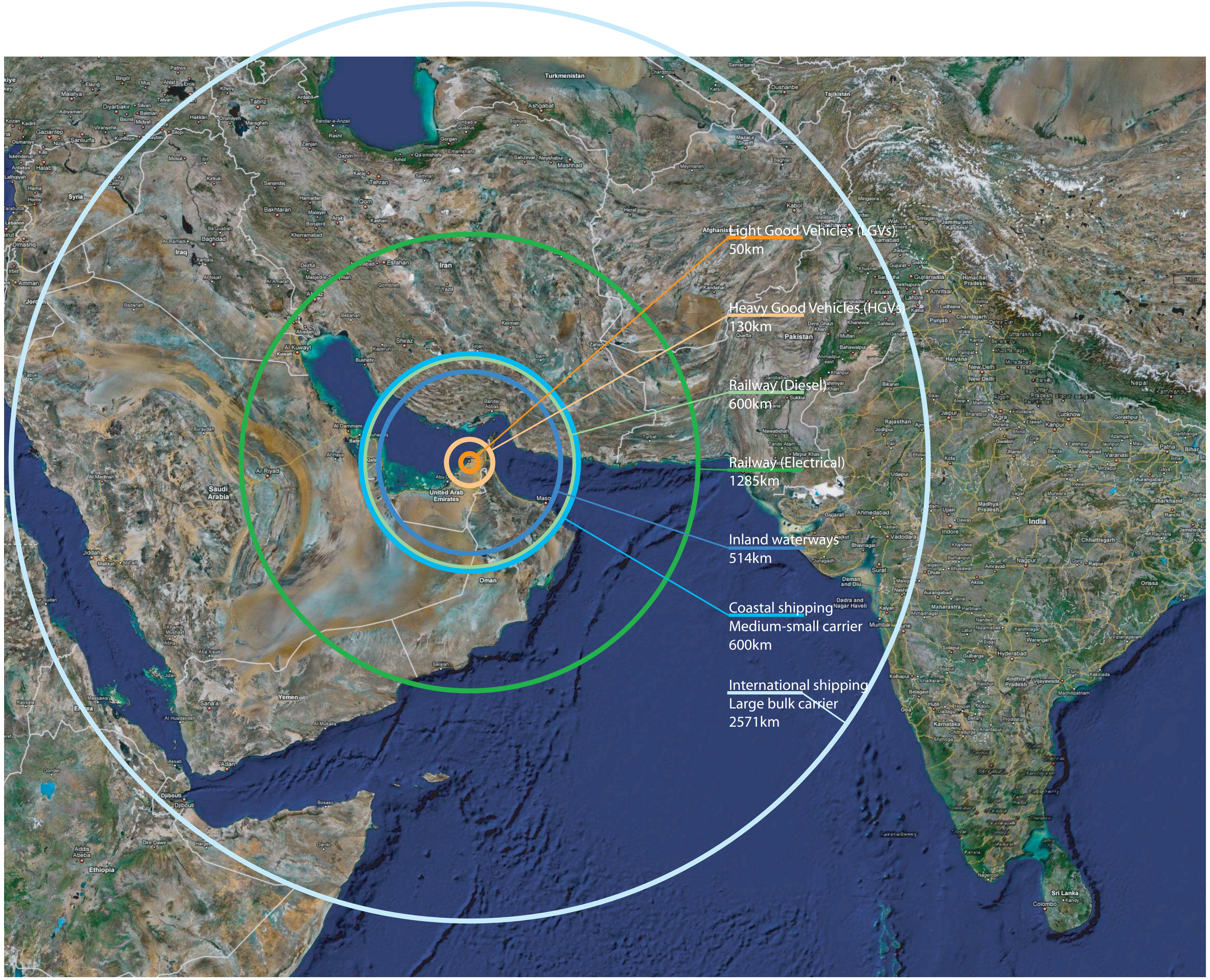
The aim should always be to design the buildings and infrastructure which form M.I.S.T., and the greater conurbation of Masdar city as a whole, as self-sufficient and energy efficient as possible. Provisional guidelines for energy consumption have already been developed within the Masdar masterplan that will be further tested through the various work stages. Local energy sources have been identified and the selections of renewable alternatives are currently being prioritised. Where renewable alternatives are not available, the aim should be to minimise energy consumption, maximise energy efficiency and high performance systems.



Construction Systems
Equivalent CO2 Distances

Part of this process includes the consideration of embodied energy and the reduction of the carbon footprint of the scheme almost at its source. It is important that assessments are made about the efficiency of where building materials are sourced and procured and its environmental impact not just within the Middle East but also where the elements are being made. It concerns the efficiency of how the various elements of the buildings are transported, the packaging required and the quality of its installation or assembly on site since each affects the overall efficiency and sustainability of the design.

The diagram on the right highlights such concerns. Using a constant unit of carbon, it illustrates the various distances that can be achieved in using various forms of transport to deliver/source the materials and components which will form M.I.S.T. In reality the final figures will be a combination of the various modes of transport illustrated but it does raise additional thoughts such as the carbon efficiency of prefabricating concrete units and importing them to Abu Dhabi compared to establishing a batching plant on site for the duration of construction. In the next scheme design phase specialist advice from consultants will be required to advise the M.I.S.T. project team; so that collectively informed decisions on the best options can be made.



Construction Systems

Facade Studies

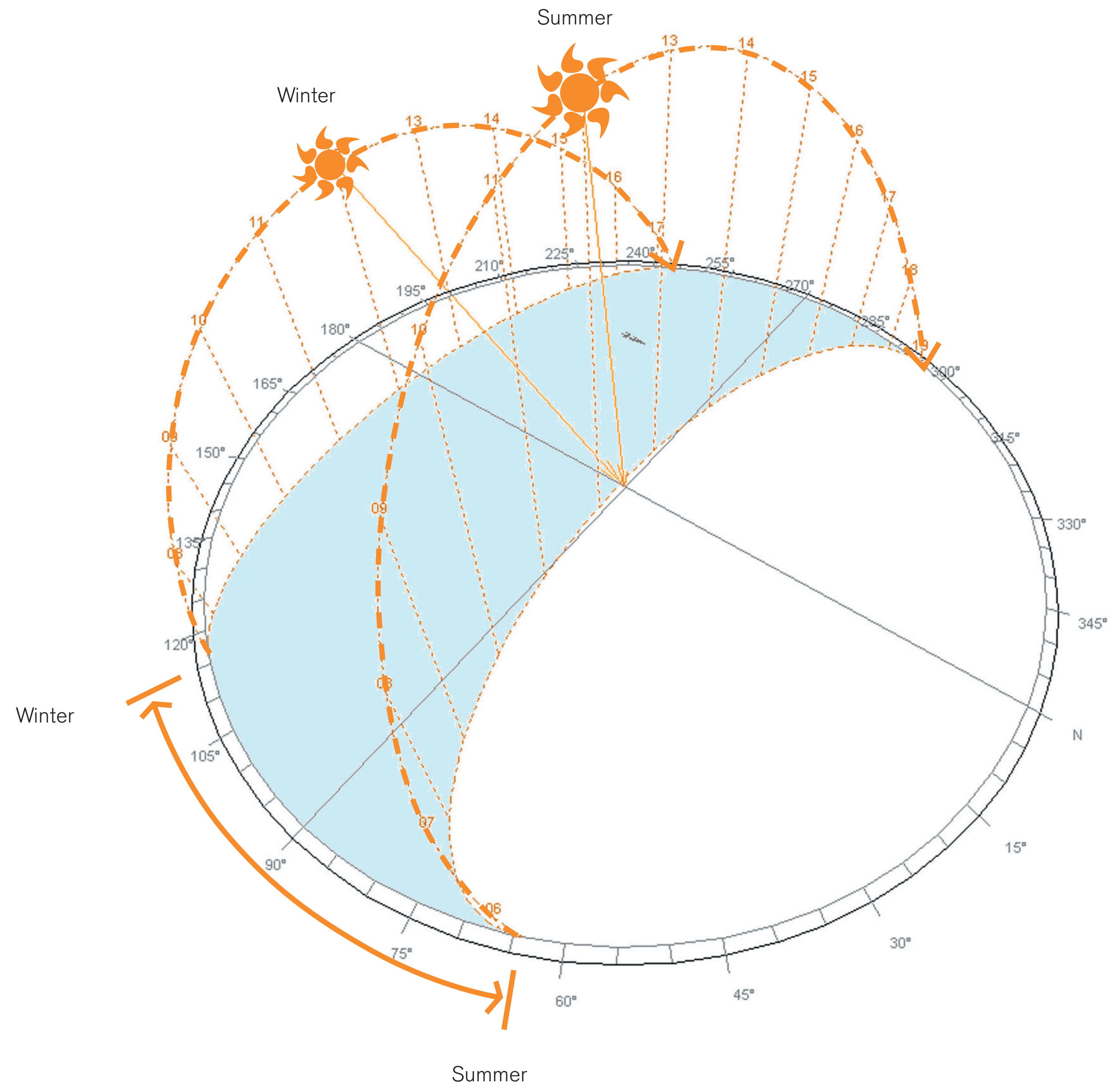
If we are to draw an analogy, the façade of a building relates in a simplistic way to the face of a person, forming the link between the inner and outer realm where the various moods are expressed.

Whilst EMOTION drives human faces' expression, LIGHT would be the equivalent factor on buildings.

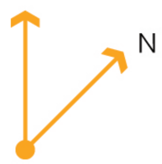
Understanding how the sun affects our façade is therefore our first task.
In addition, the analysis of the local climate i.e. temperature, humidity, wind, etc., in conjunction with the Abu Dhabi cultural heritage, programme and costs constraints will form the basis of the façade design development.
Our ultimate aim is to design a unique façade that responds to these constraints and implement the sustainable parameters set on the Masdar masterplan.

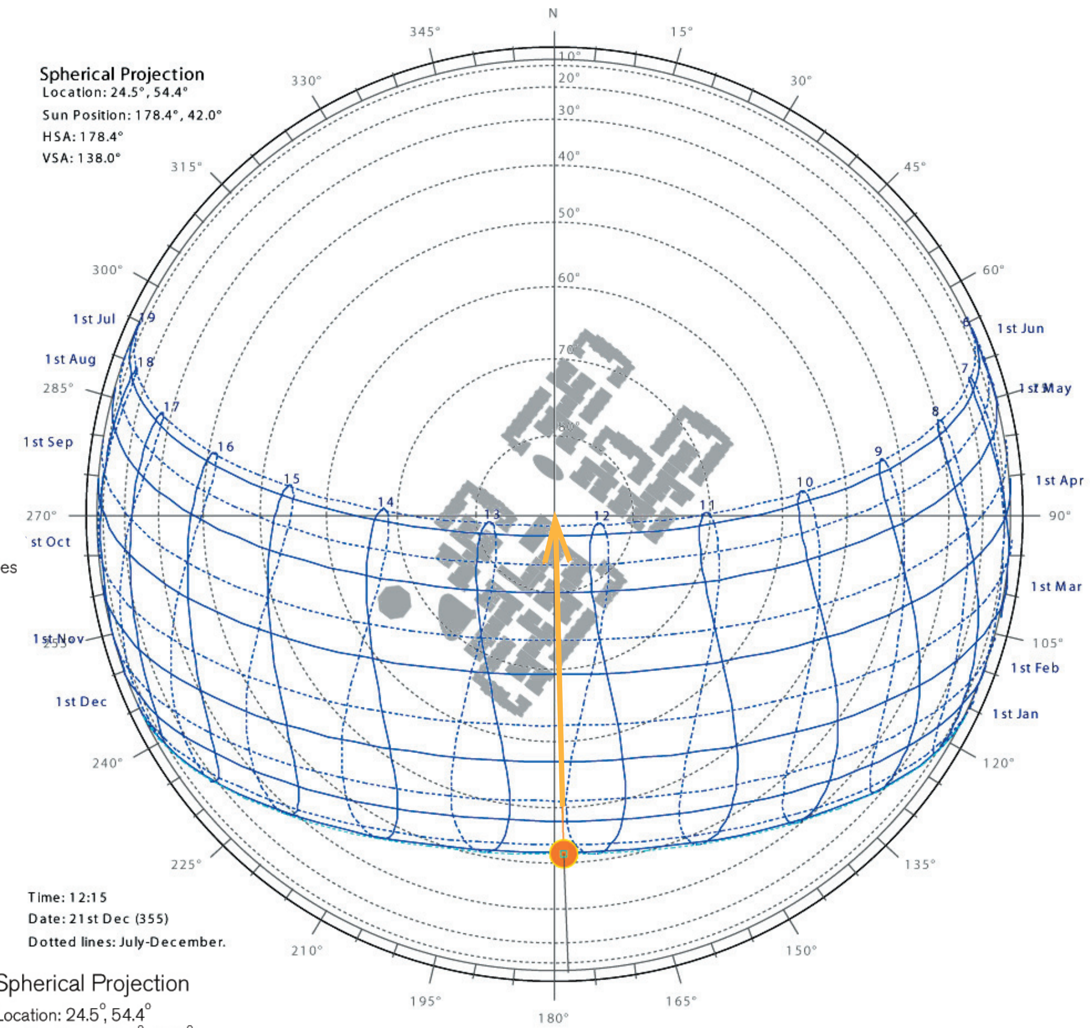
The following sketches and diagrams are initial studies only and illustrate WORK IN PROGRESS. Further development will take place on the subsequent design stage.

Only views of the northern sky and the lower half of the southern sky are guaranteed to have no direct solar exposure



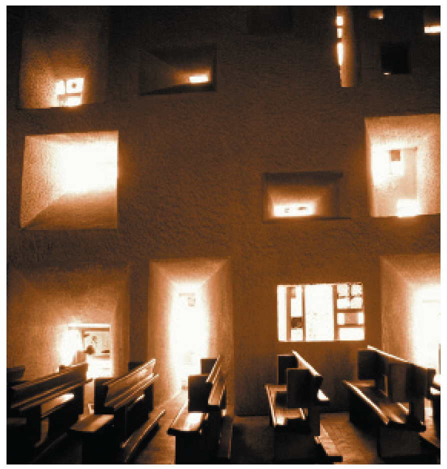
with a horizontal rotation of 45 degrees
wave angle achieved = 54 degrees



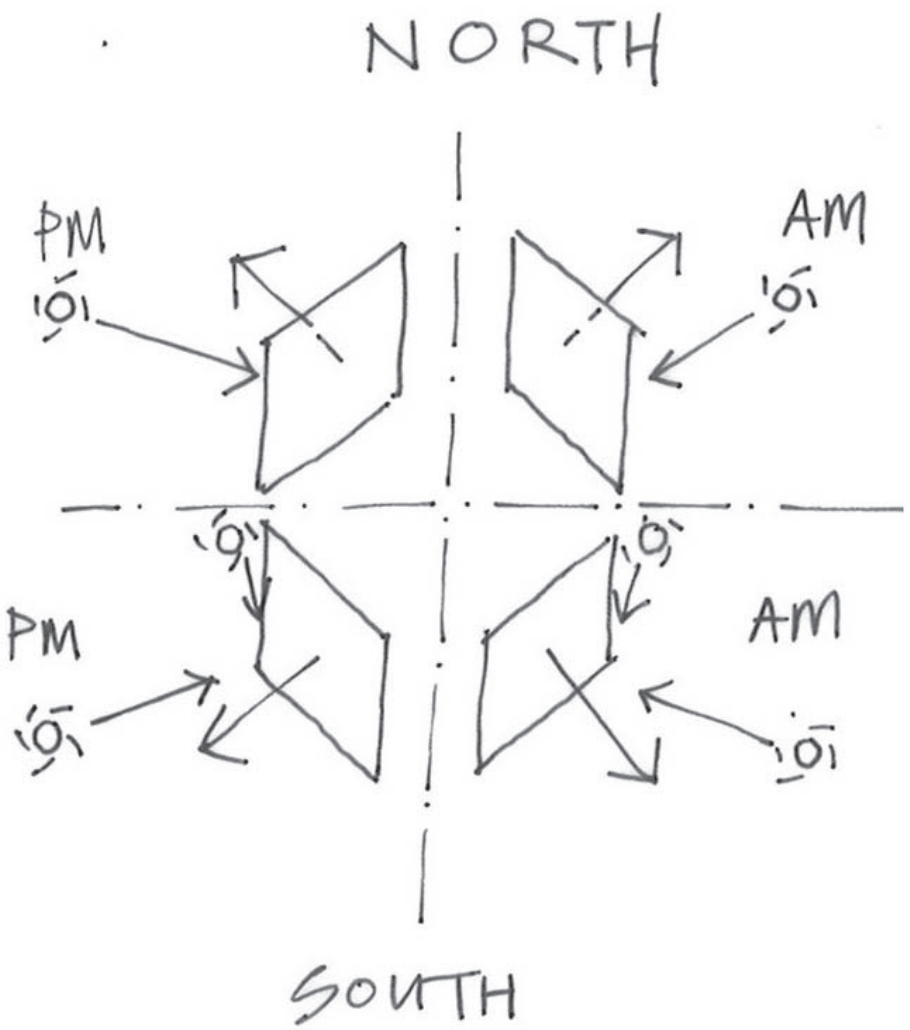


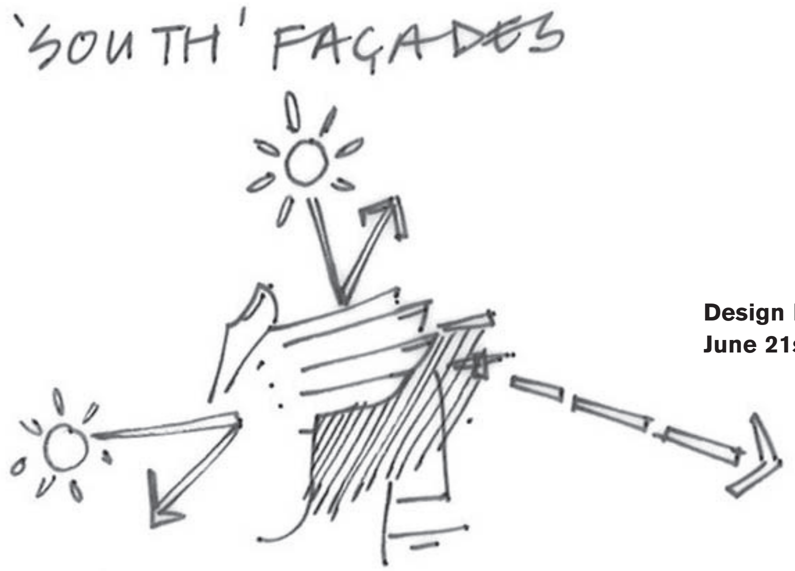
Spherical Projection
Location: 24.5°, 54.4°
Sun Position: 178.4°, 42.0°
HSA: 178.4° VSA: 138.0°

We can identify two principle façade typologies – a north facing and a south facing, with AM and PM variants

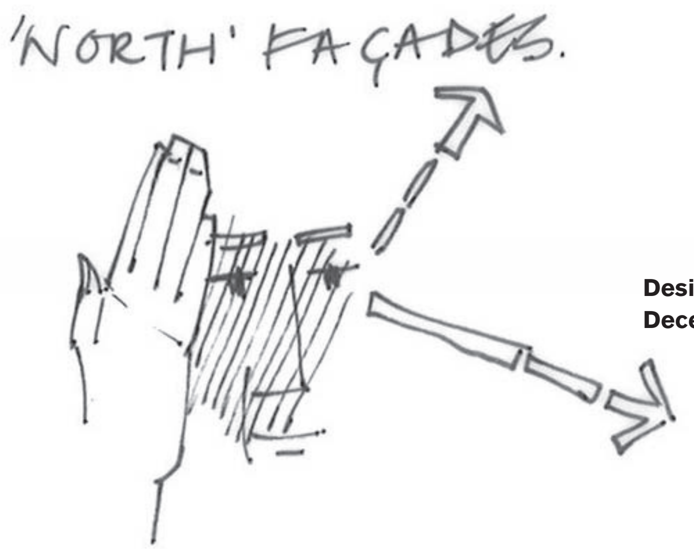


Masterpieces in its use of natural daylight





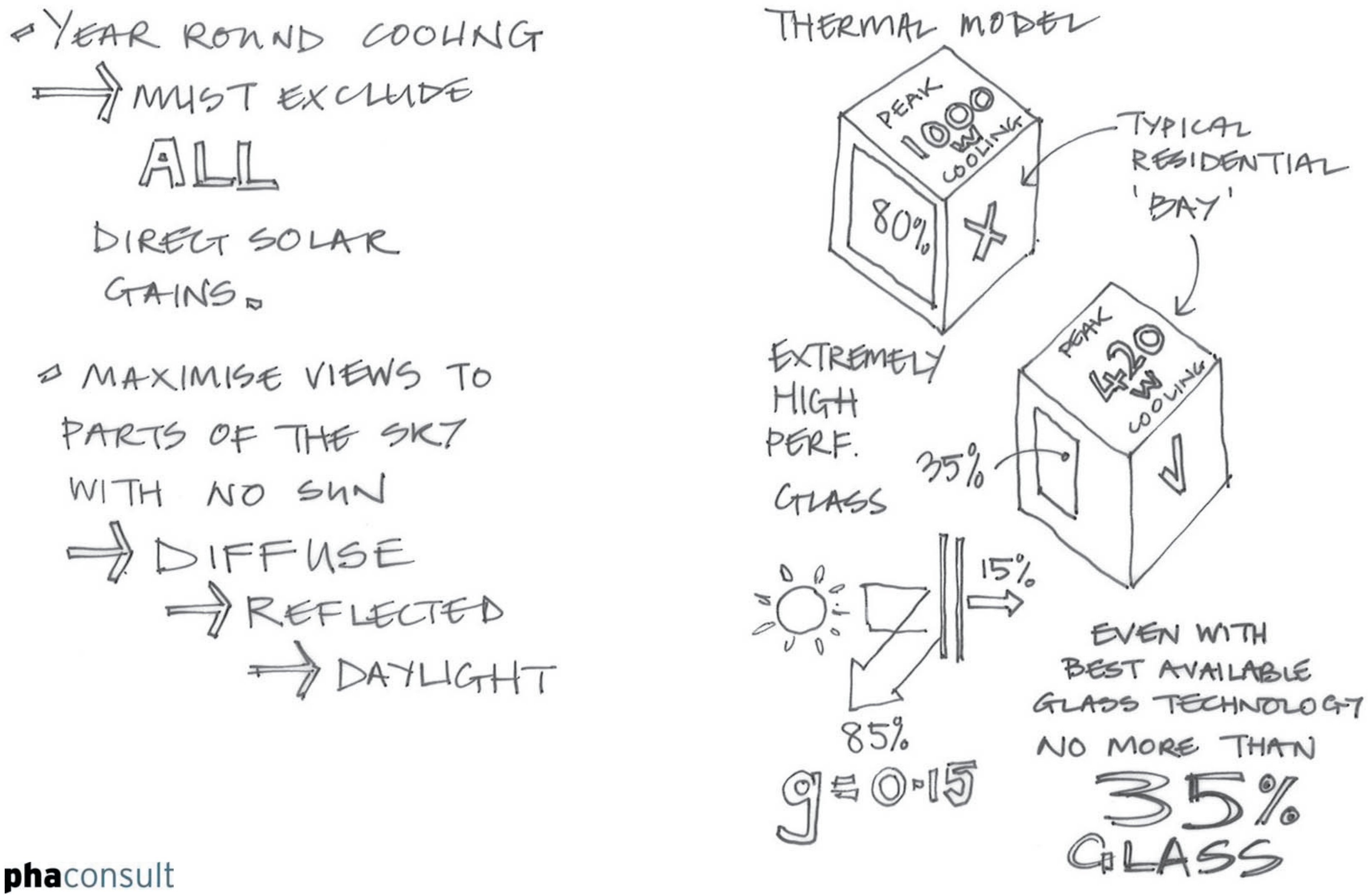
Design Day:
June 21st



Design Day:
December 21st

phaconsult

Thermal analysis sets a budget that cannot be exceeded if we are to maintain comfort without excessive cooling requirements and CO2 emissions



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Construction Systems

Facade Studies - Achieving g=0.15

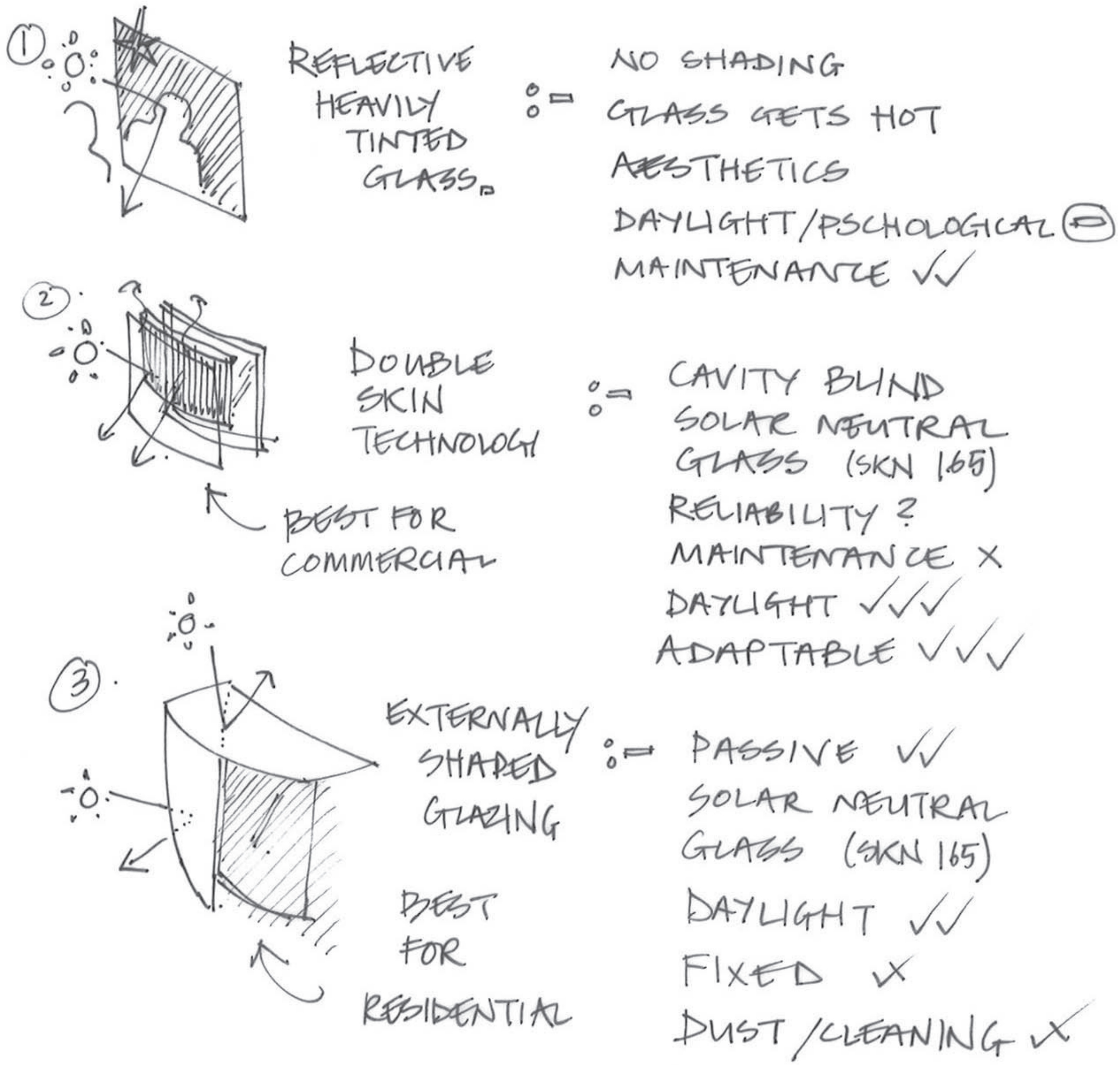
To achieve an equivalent 'g' value of 0.15, allowing no more than 15% solar energy through a façade we have three options:

1. Externally Reflective Glazing
2. Double Skin Systems
3. Externally Shaded

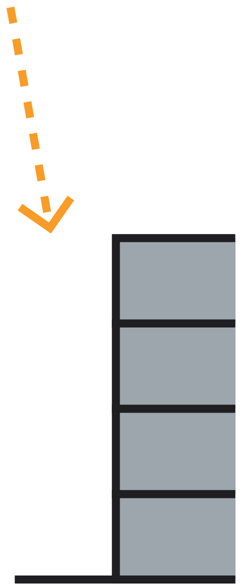
For residential applications the use of double skins is not generally successful – our design intent is a passive response that does not require the occupant to remember to operate a device.

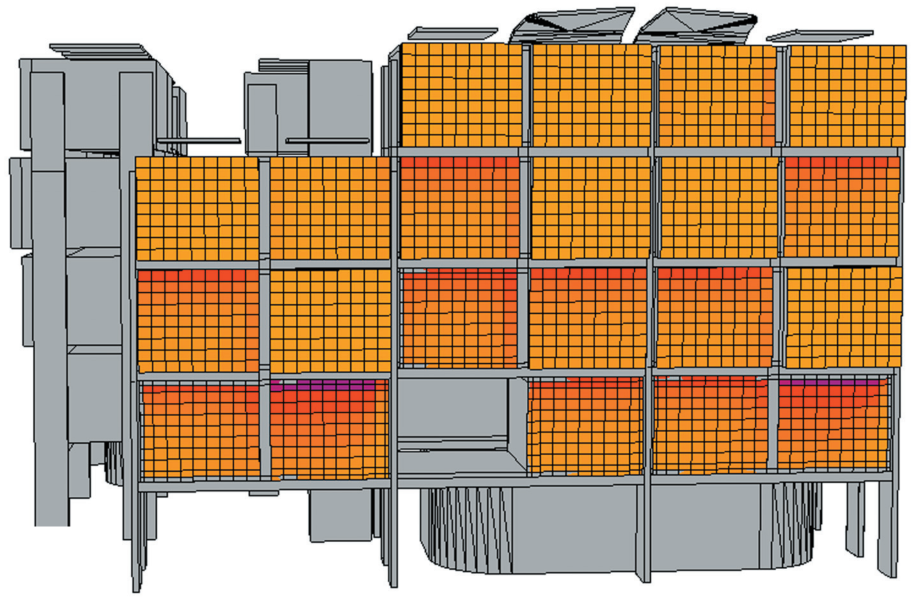
Laboratory Facade

Residential Facade



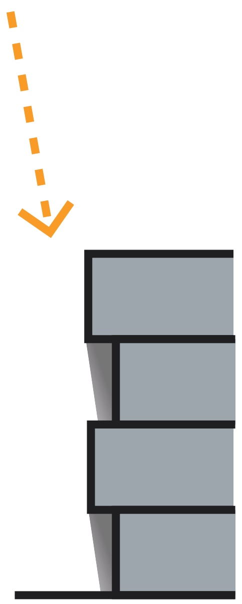
Basic Arrangement

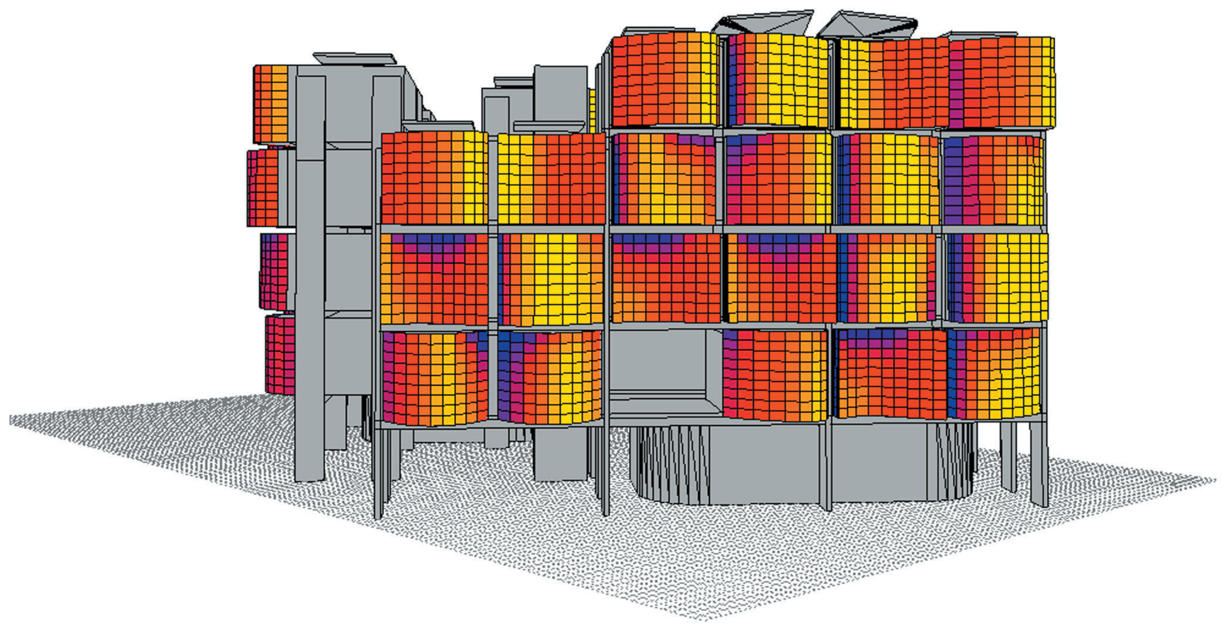




OBJECT ATTRIBUTES
Avg. Daily Radiation
Value Range: 300.0 - 3000.0 wh/sqm

Proposed Arrangement





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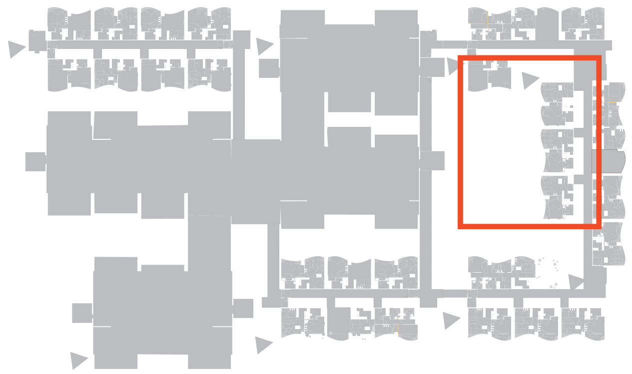
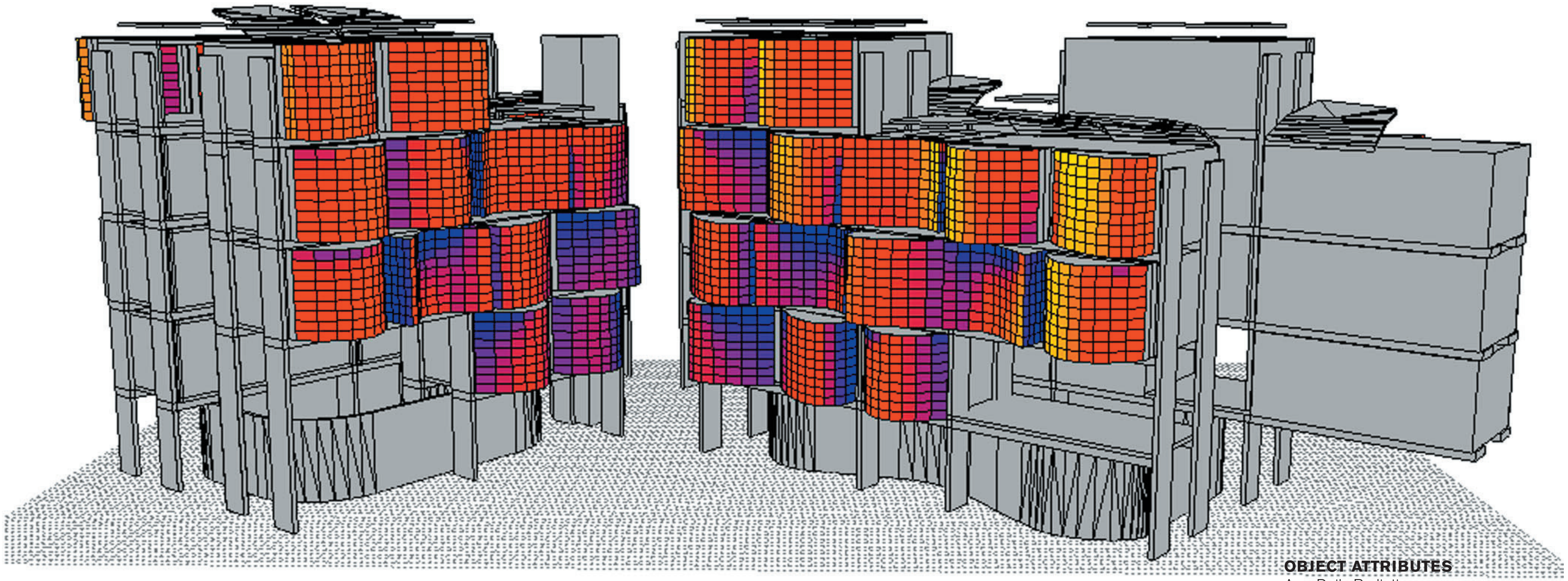


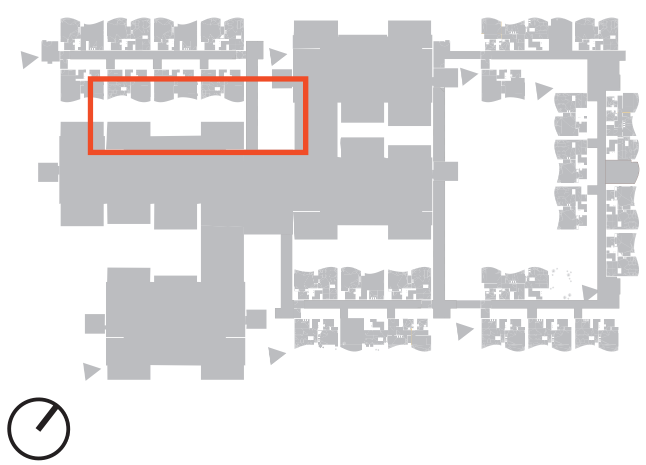


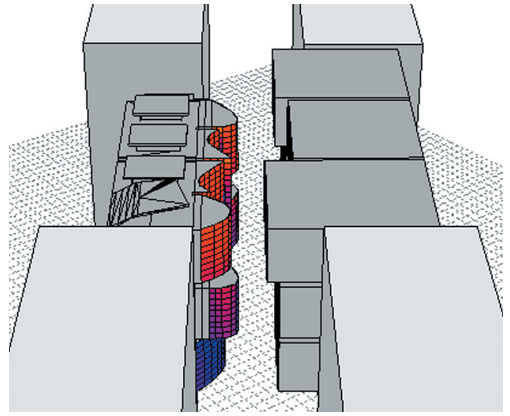
OBJECT ATTRIBUTES
Avg. Daily Radiation
Value Range: 300.0 - 3000.0 wh/sqm

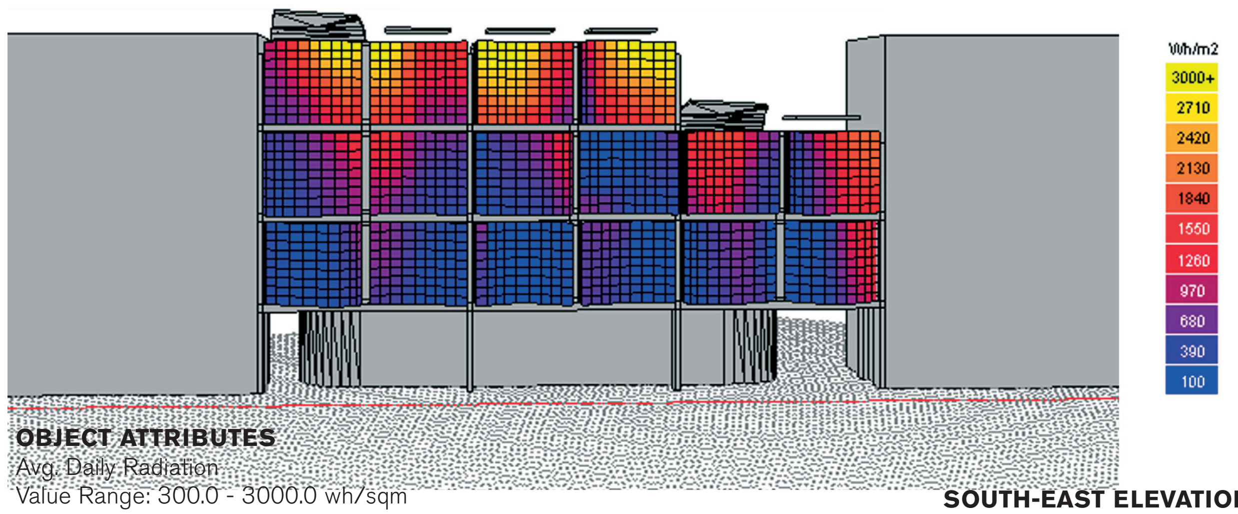
Facade Studies -Street Facade and Overshadowing

Solar studies show the possibility of increasing the area of glazing towards the lower shaded areas of the buildings.

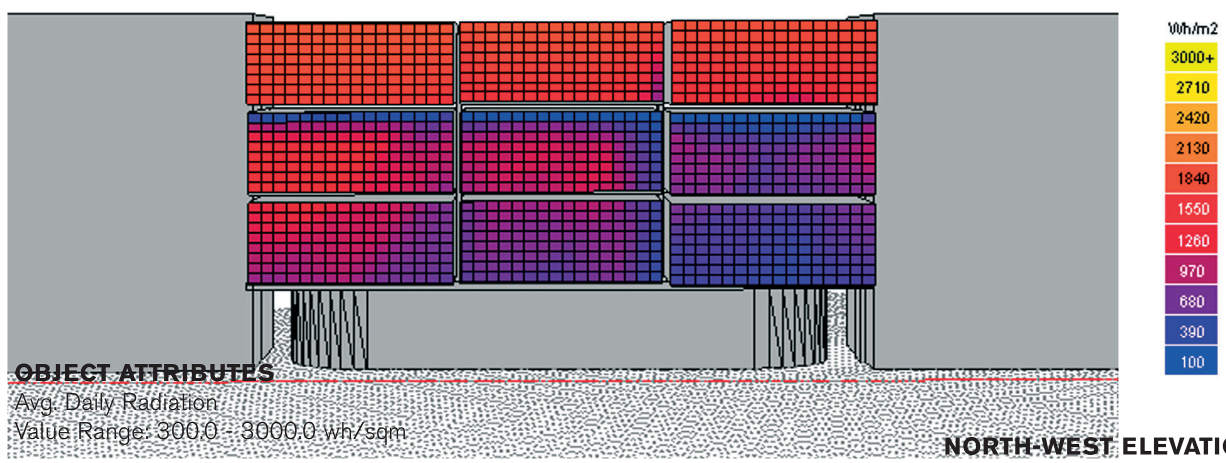
This could be applicable to the **laboratory building** where the visual connection are important.



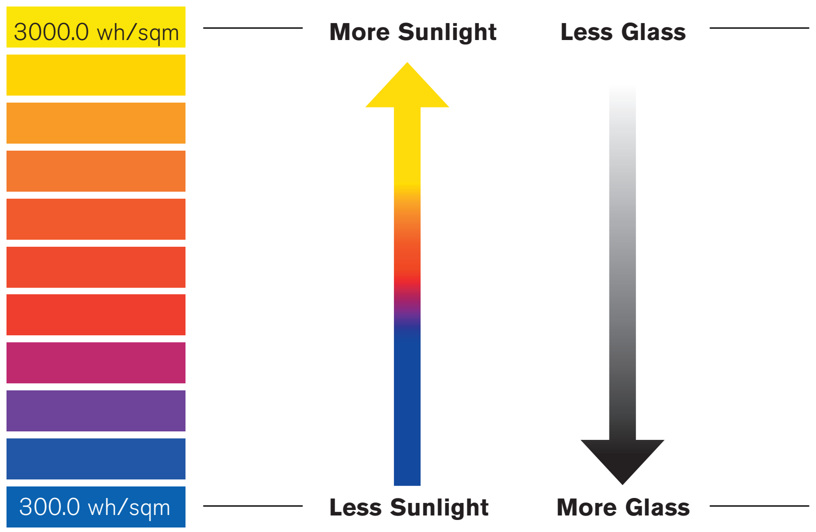


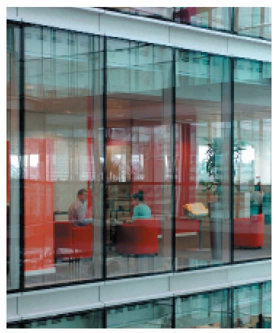


SOUTH-EAST ELEVATION



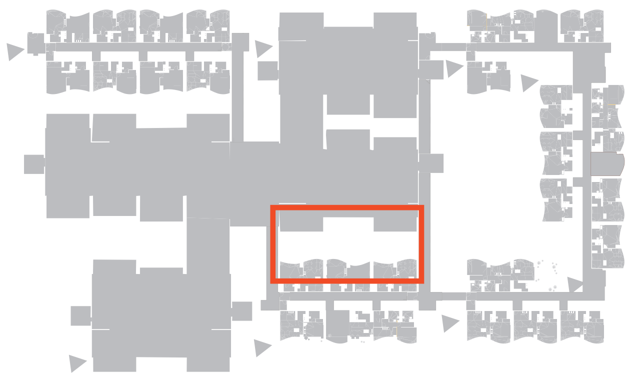
NORTH-WEST ELEVATION

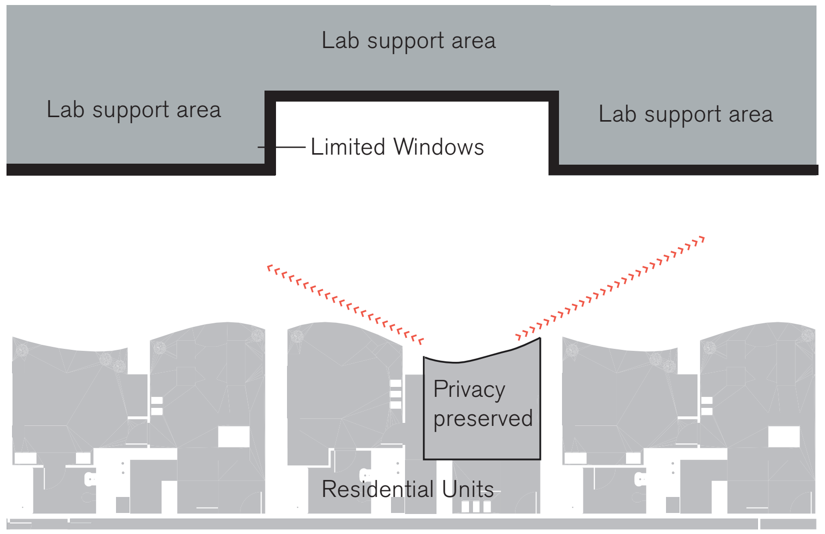


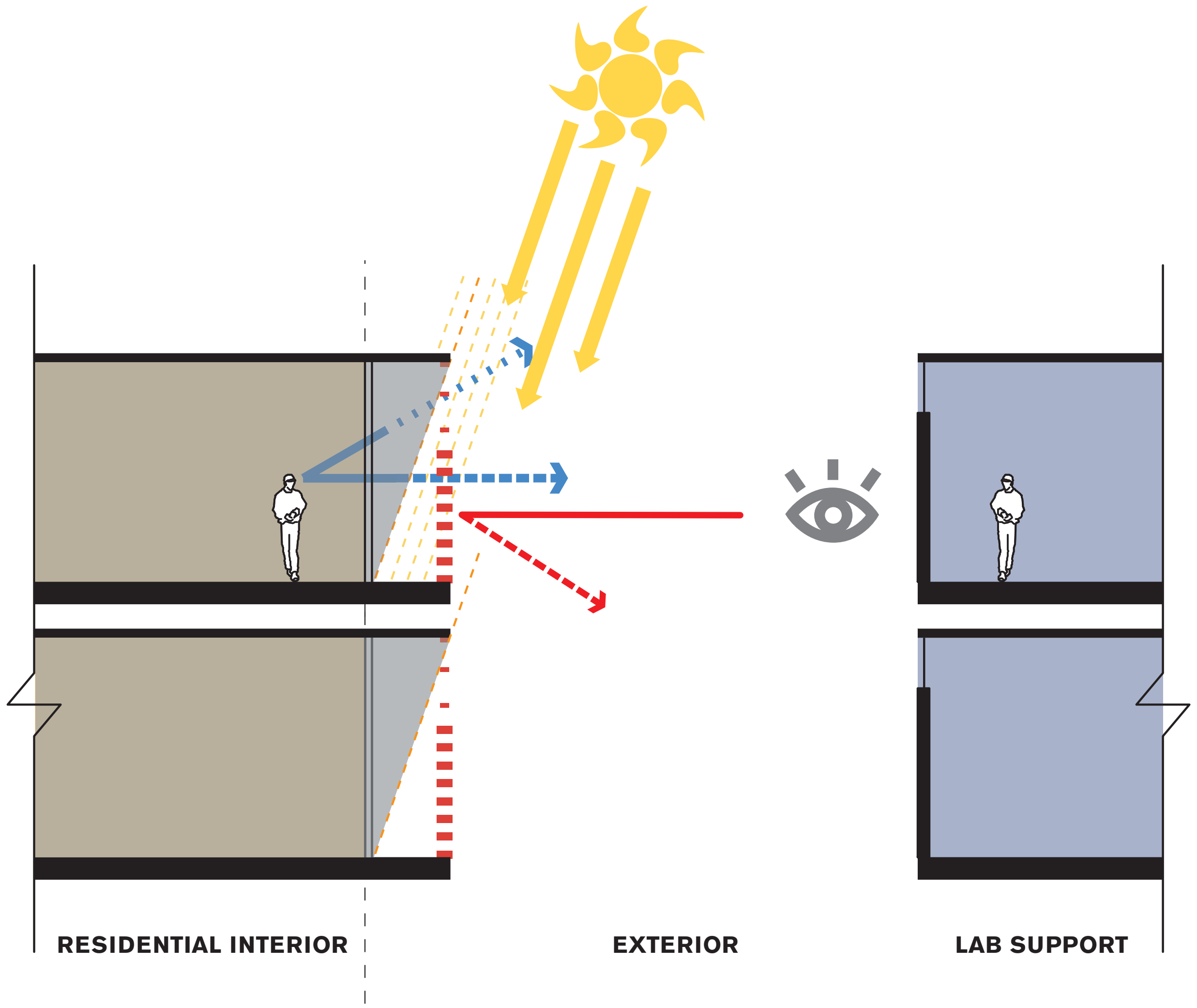


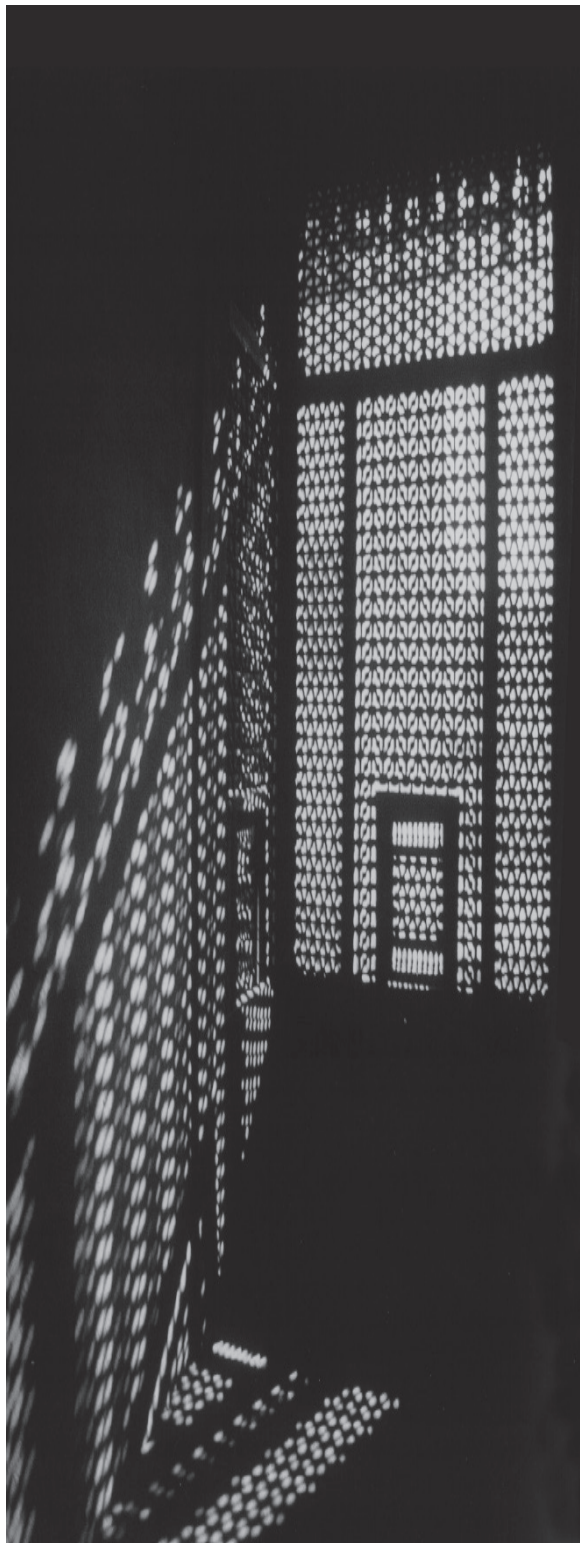
Construction Systems

Facade Studies -Privacy









traditional mashrabiya screen

Though engaged in providing M.I.S.T. with an environment which promotes interaction, collaboration and flexibility, Foster and Partners and their dedicated design team are also conscious that any decisions made throughout the design process must be informed and influenced by an underlying sustainable agenda. Unlike most projects, the impact on the planet is paramount with consideration of the local environmental concerns and local resources influencing the methodology of production, delivery, the materiality and construction of M.I.S.T., more specifically Phase 1a.

The nature of cutting edge research facilities as proposed for M.I.S.T. results in highly serviced and tipically energy intensive laboratories so any sustainable measures which are to be employed must be achieved within other areas of the M.I.S.T. brief (such as the residential component) as a whole; whilst also trying to minimise the carbon footprint of the laboratories as much as possible.

To achieve this, the design team aim to maximise the passive measures to be employed within the servicing and construction of the various building typologies, learning from the more traditional architecture of the past and blending it with the new technologies of today and tomorrow.

Factors such as orientation, solar shading and natural ventilation will form the basis of the cooling and maintenance of a comfortable environment around the campus with mechanical servicing limited to where it is needed only. Thermal labyrinths, windtowers, heat recovery plants (HRC) and desiccant cooling are some of the ideas being explored to minimise the energy consumption and the demand for cooling while always being conscious of providing a stimulating and exciting environment in which to live and work.

Such appraisals will be done in conjunction with not just the Client but also alongside the Abu Dhabi Municipality and the WWF through BioRegional to establish a new standard for sustainability in the region, one that is both relevant and responsive to the environmental concerns and demands of the area.

A windcatcher (Bâdgir) is a traditional Persian architectural device used for many centuries to create natural ventilation in buildings. It is not known who first invented the windcatcher, but it still can be seen in many countries today. Windcatchers come in various designs, such as the uni-directional, bi-directional, and multi-directional.

The windcatcher functions on several principles:

First, a windcatcher is capped and has several directional ports at the top. By closing all but the one facing away from the incoming wind, air is drawn upwards using the Coanda effect, similar to how opening the one facing the wind would push air down the shaft. This generates significant cooling ventilation within the structure below, but is not enough to bring the temperature below ambient alone - it would simply draw hot air in through any cracks or windows in the structure below.

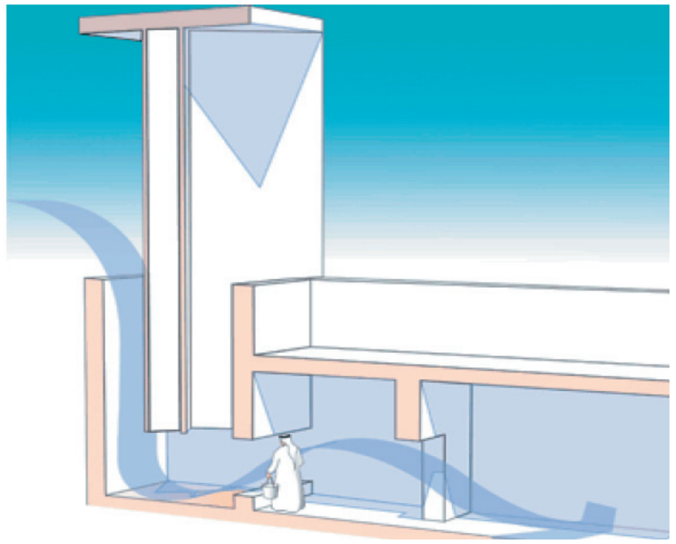
In a windless environment or waterless house, a windcatcher functions as a stack effect aggregator of hot air. It creates a pressure gradient which allows less dense hot air to travel upwards and escape out the top. The temperature in such an environment can't drop below the nightly low temperature. These last two functions have gained some ground in Western architecture, and there are several commercial products using the name windcatcher.

When coupled with thick adobe that exhibits high heat transmission resistance qualities, the windcatcher is able to chill lower level spaces in mosques and houses in the middle of the day to frigid temperatures.

A small windcatcher (badgir) is called a "shish-khan" in traditional Persian architecture. Shish-khans can still be seen on top of ab anbars in Qazvin, and other northern cities in Iran.

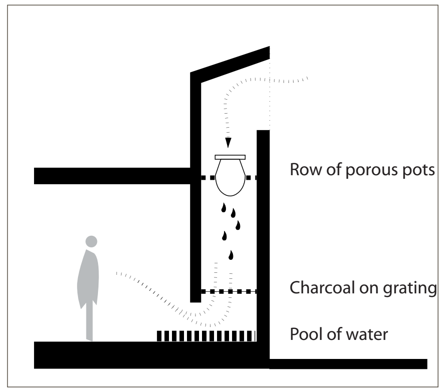
A Wind Tower is a structure seen on ancient buildings of the Middle East, particularly Iran and Bahrain. This acted like a natural air conditioner creating a soothing effect in the harsh conditions of the desert.

The emergence of a traditional Bahraini and Persian Gulf style of architecture arose as people migrated to Bahrain with the growth of the pearl trade. With newfound wealth, the merchants built houses of note in the 18th and 19th centuries. The people of Ahvaz in Iran, for example, came and brought with them new architectural designs, including the distinctive wind tower which can be seen so prominently in the Awadiya area and elsewhere in Bahrain. This distinguishing feature was adapted locally with its own distinctive decorative motifs. The wind tower, an early and very effective form of air conditioning, has in fact been around for about 500 years and was developed from the early Wind Scoops first built about 2,000 years ago in Iran.

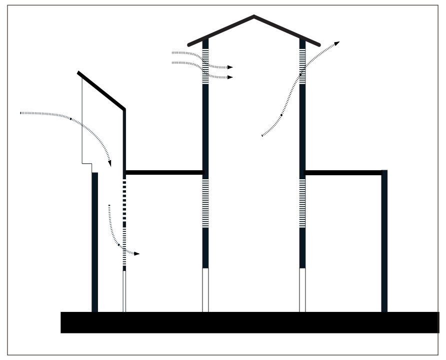


Perspective diagram of a typical wond tower

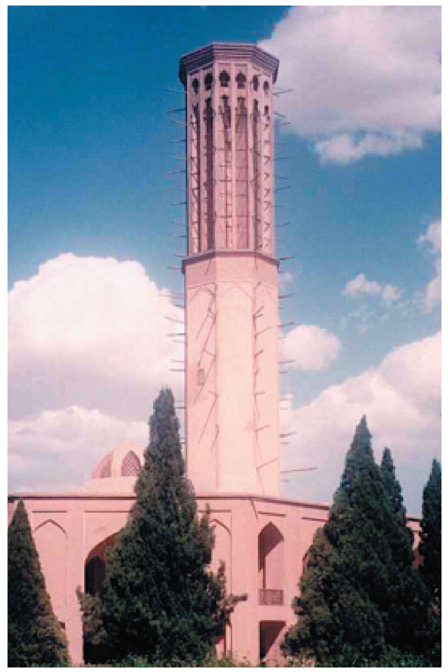
A series wind tower in Yazd, Iran



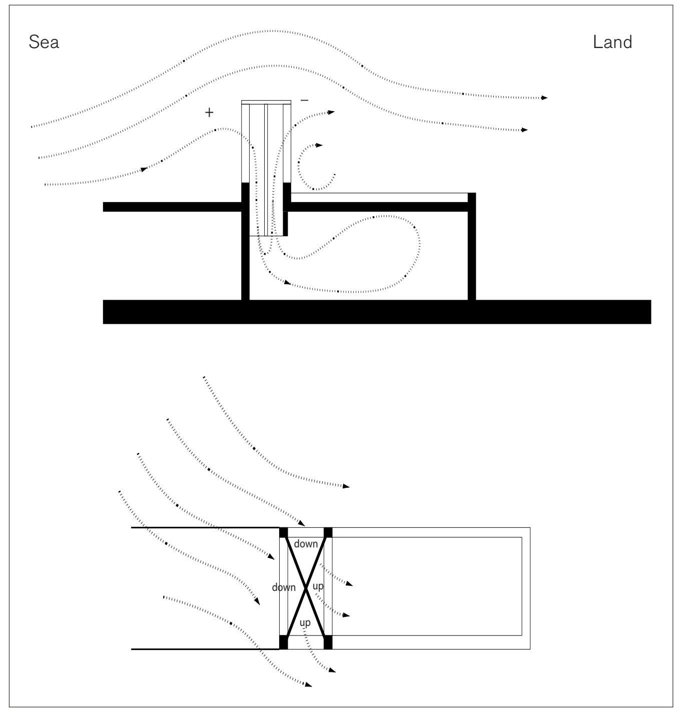
Qanat concept diagram



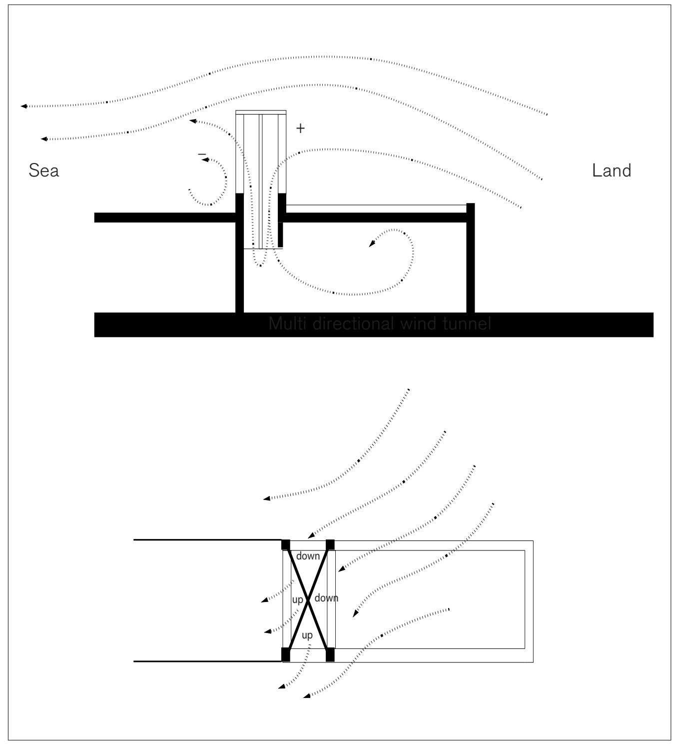
Section through a typical windtower



A wind tower in Yazd, Iran



Ventilation patterns in a seaside wind tower house

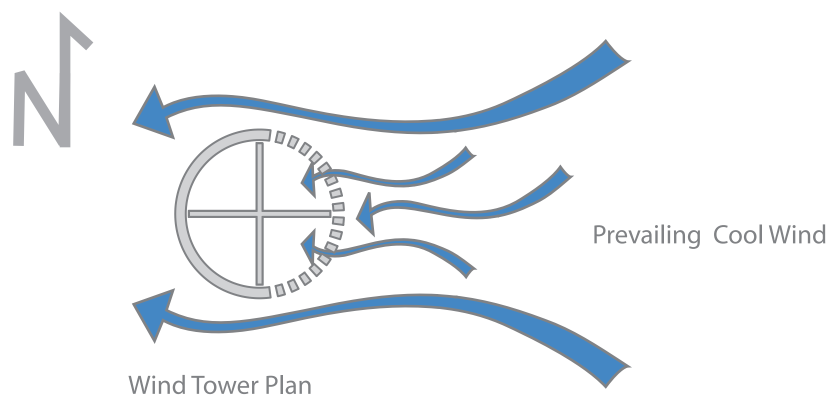


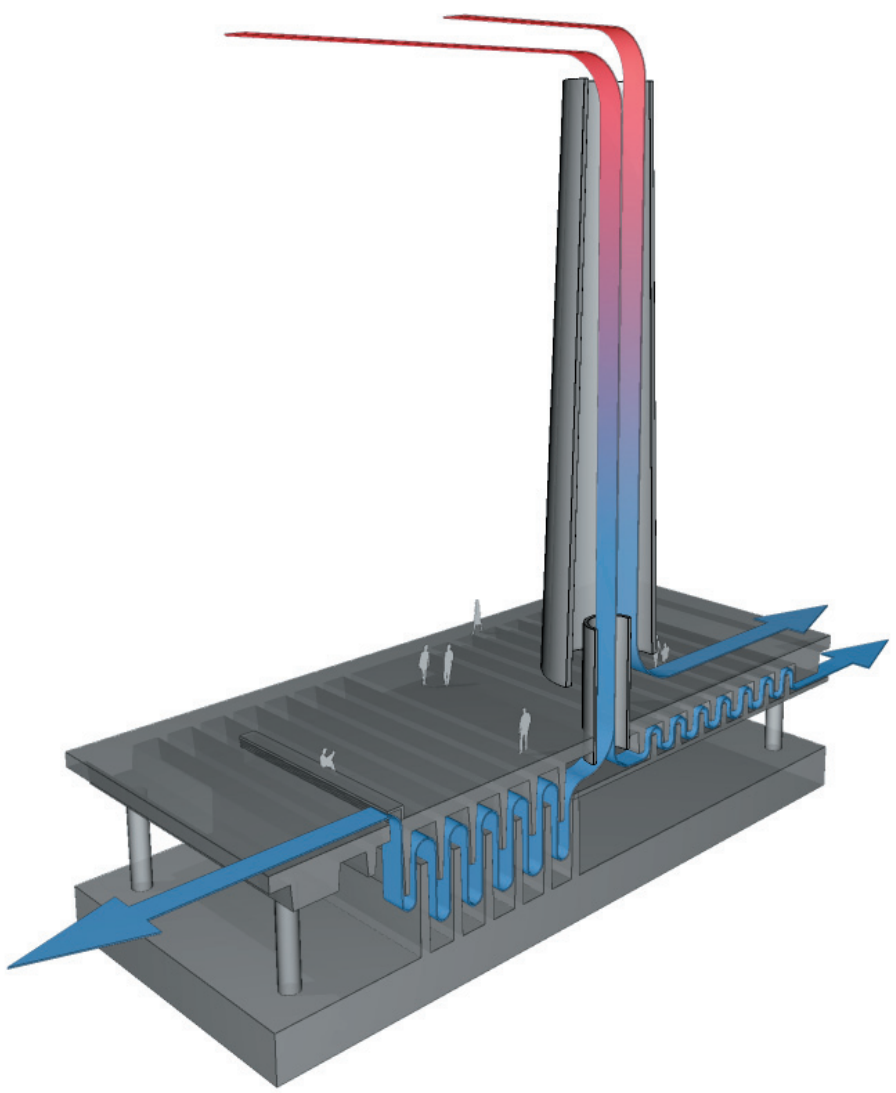
Ventilation patterns in a seaside wind tower house

Typical Wind Tower

Day
▪ Wind towers catch air at a high level, cool the air and distribute to the ground plane.
This is assisted when necessary by fans.

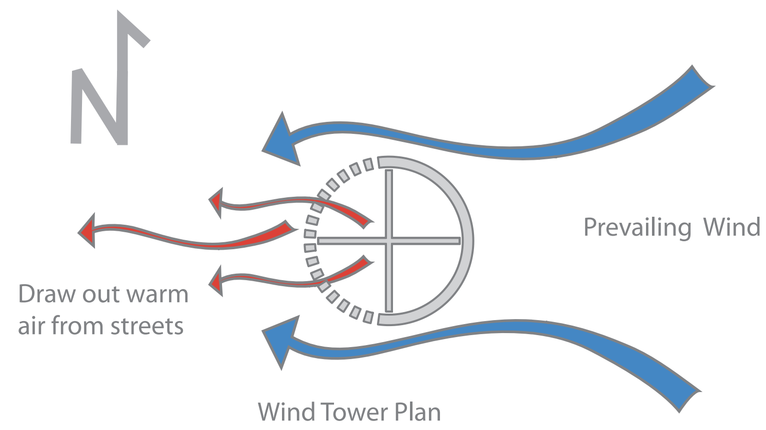
▪ Air is also distributed via the wind towers to the thermal labyrinth within the structural waffle of the plenum.

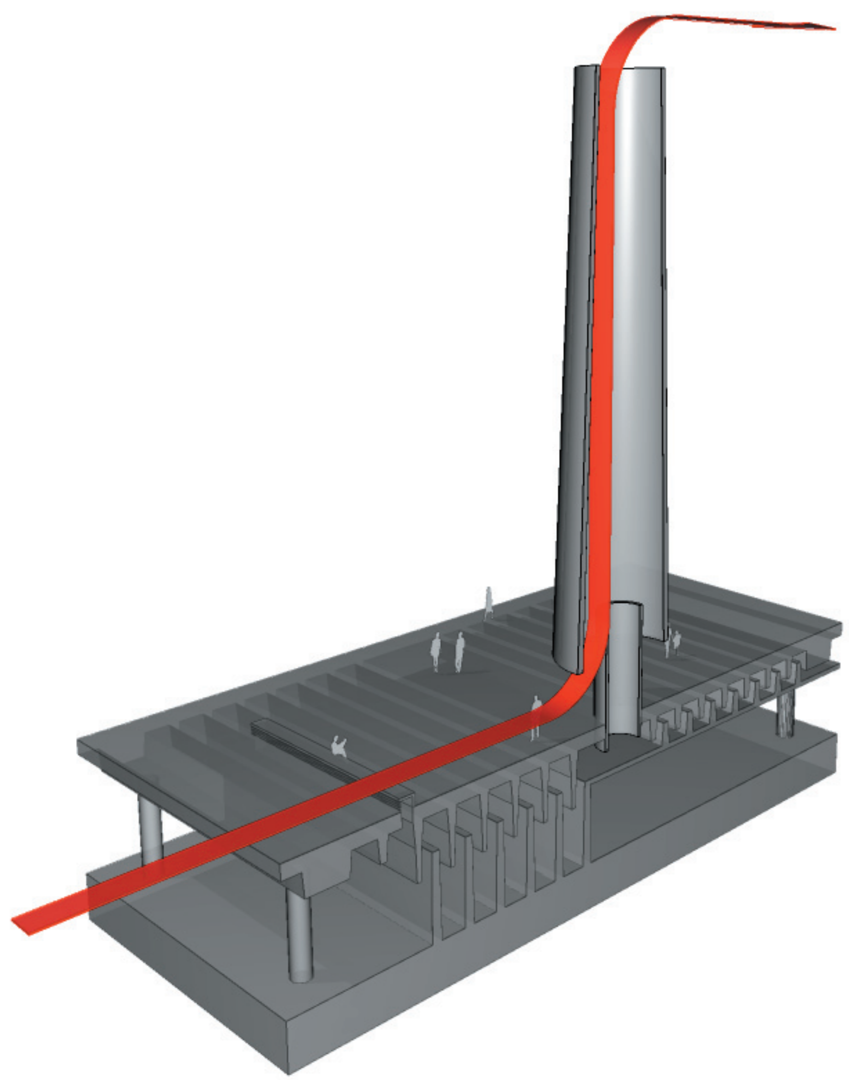




Typical Wind Tower

Night
▪ Warm air is drawn up the towers by the prevailing winds from the ground plane and are extracted back into the atmosphere.

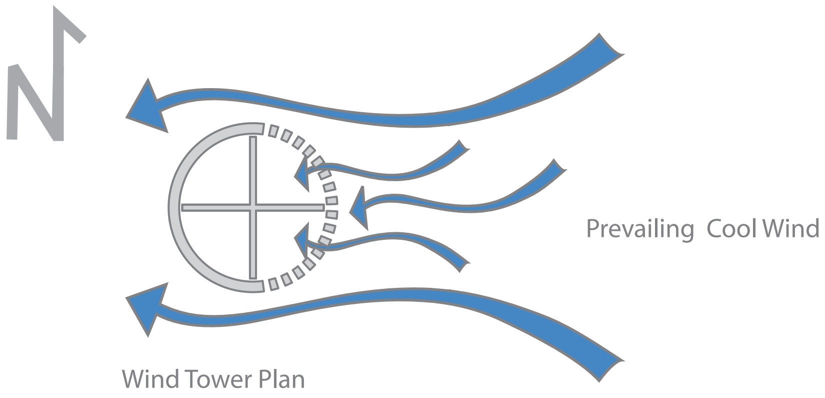


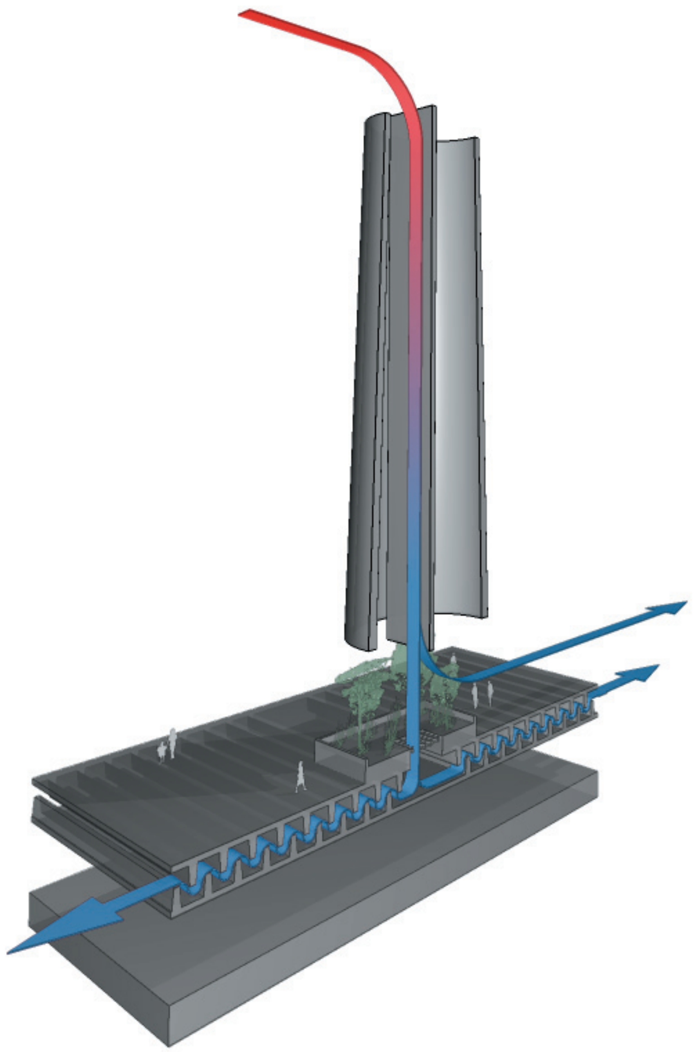


Passive Wind Tower

Day

- Passive wind towers catch air at high level, cool the air and distribute to the ground plane.
- At the base of the wind towers, grills located as part of planters or water features distribute air into the waffle system below.





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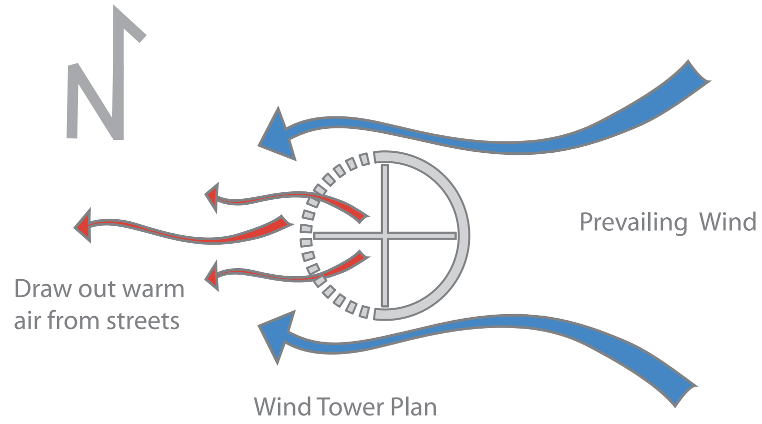
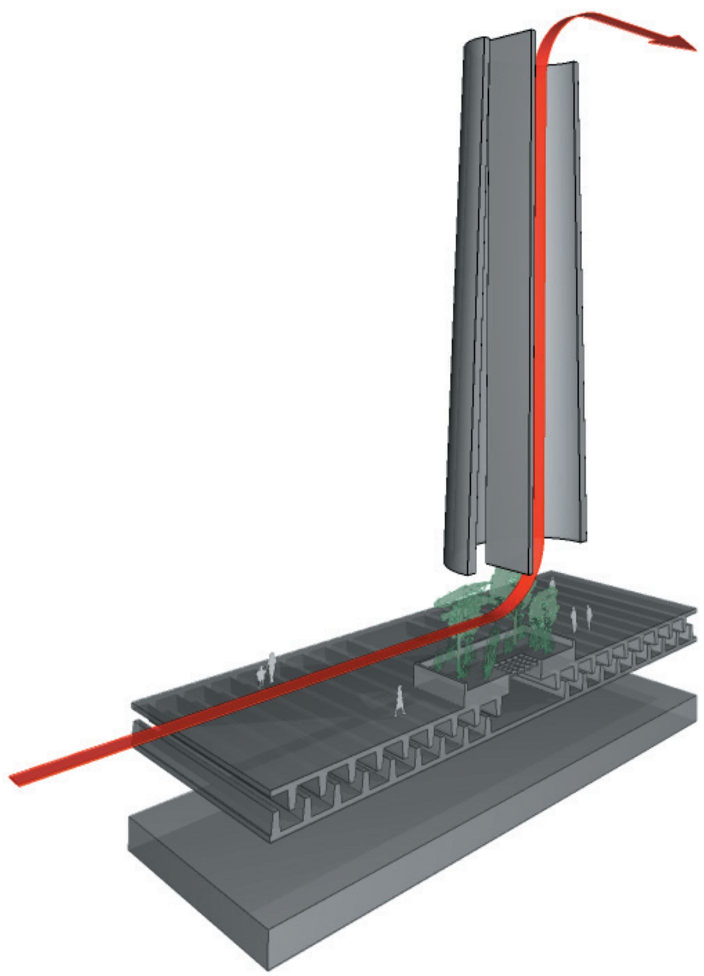
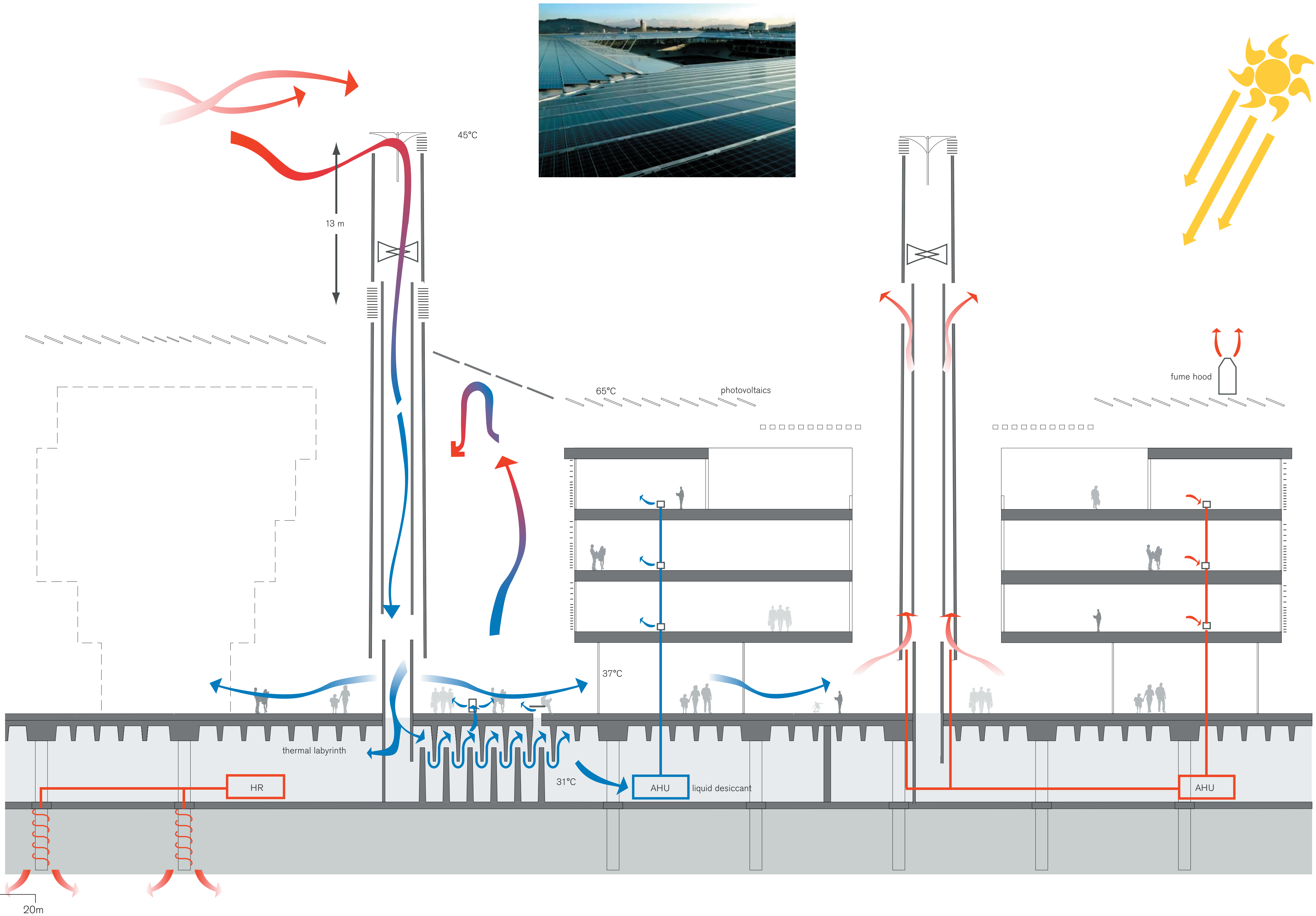




Typical Laboratory and Residential Wind Tower

Winter Day

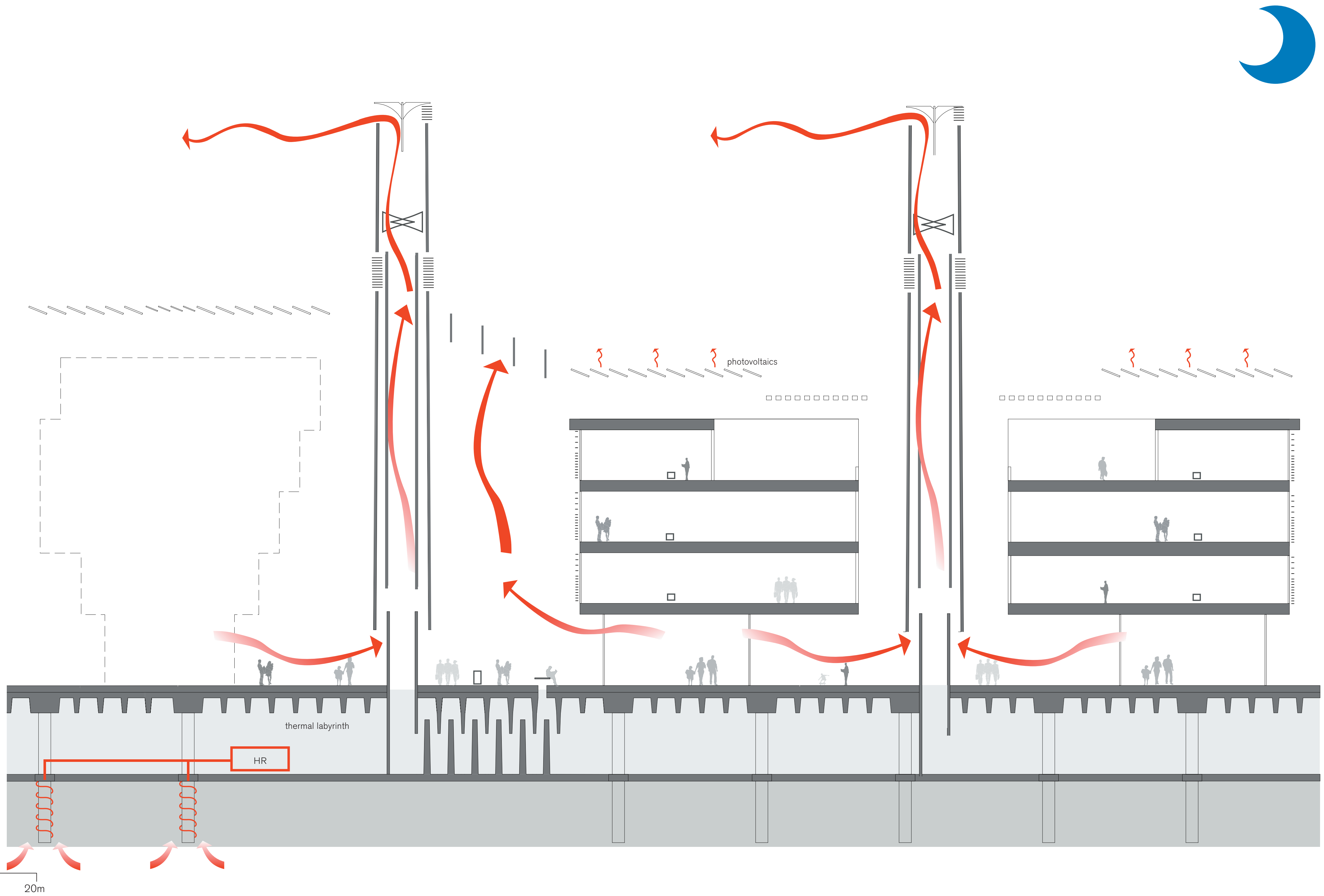
- Wind towers catch air at a high level, cool the air and distribute to the ground plane. This is assisted when necessary by fans.
- Wind towers allow warm air to be released 13m below the top of the wind tower.
- Air is also distributed via the wind towers to the thermal labyrinth within the structural waffle of the plenum.
- Cool air is released from the thermal labyrinth through diffusers in street furniture.
- An air handling unit (AHU) is located within the thermal labyrinth to distribute cool air through risers to the laboratories.
- A liquid desiccant system is located within the AHU to extract moisture out of the air.
- Ground coupled heat rejection (HR) energy piles takes approx. 14% of the heat load away from the building and releases it into the ground.
- Fume hoods extract air from the laboratory away from the building.



Typical Laboratory and Residential Wind Tower

Winter Night

- Warm air is taken from the ground plane and extracted back into the atmosphere by the wind towers. This is assisted when necessary by fans.
- Warm air is extracted at low level via the diffusers in the street furniture to the labyrinth to be cooled.
- Warm air is taken from the laboratories and extracted back via risers to the windtowers.
- PVs release heat.
- Panels open at night to release warm air.
- Warm air is taken from the ground by the HR to recharge the system for the following day.



Typical Laboratory and Residential Wind Tower

Summer Day

- Wind towers catch air at a high level, cool the air and distribute to the ground plane. This is assisted when necessary by fans.
- Wind towers allow warm air to be released 13m below the top of the wind tower.
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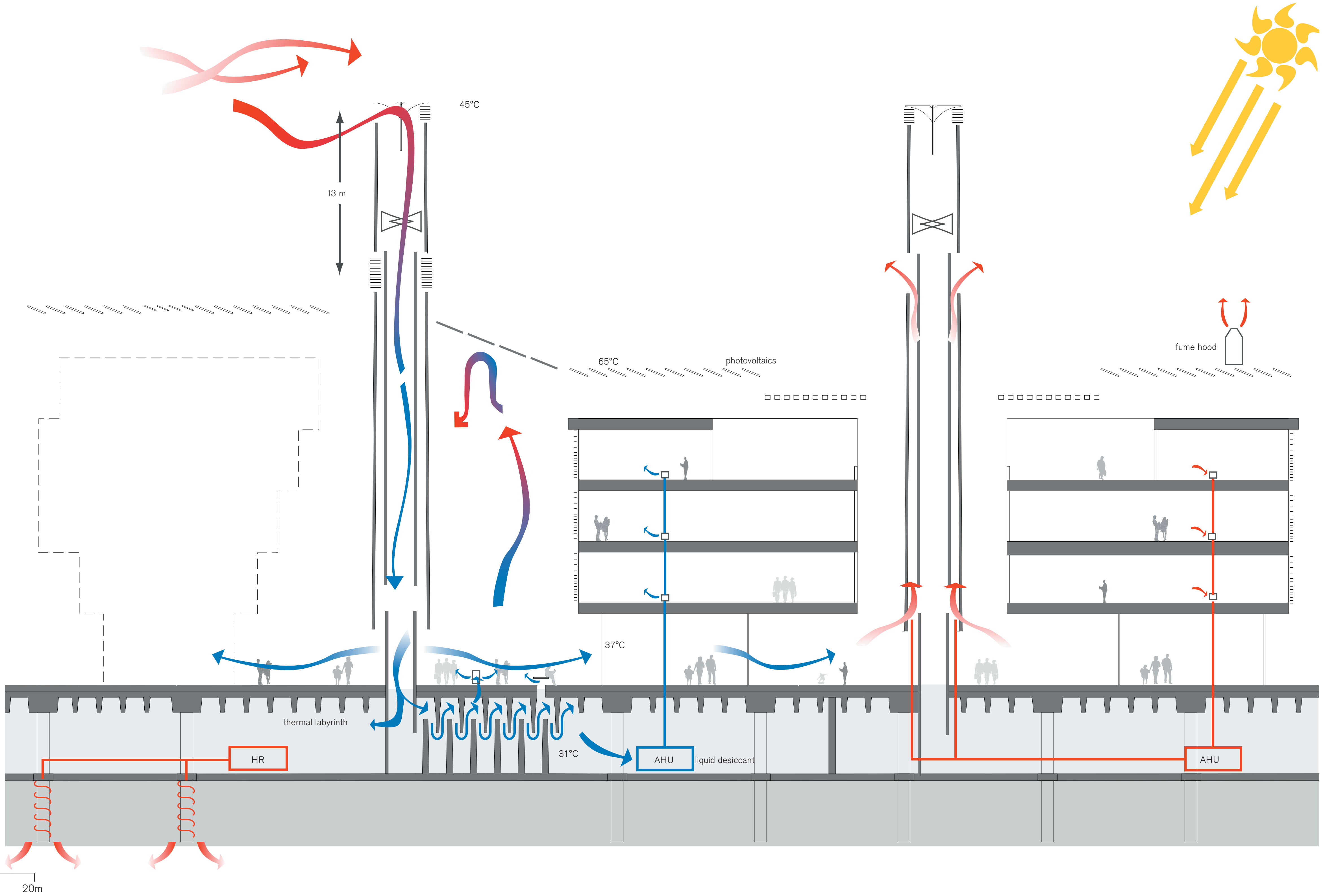

Typical Laboratory and Residential Wind Tower

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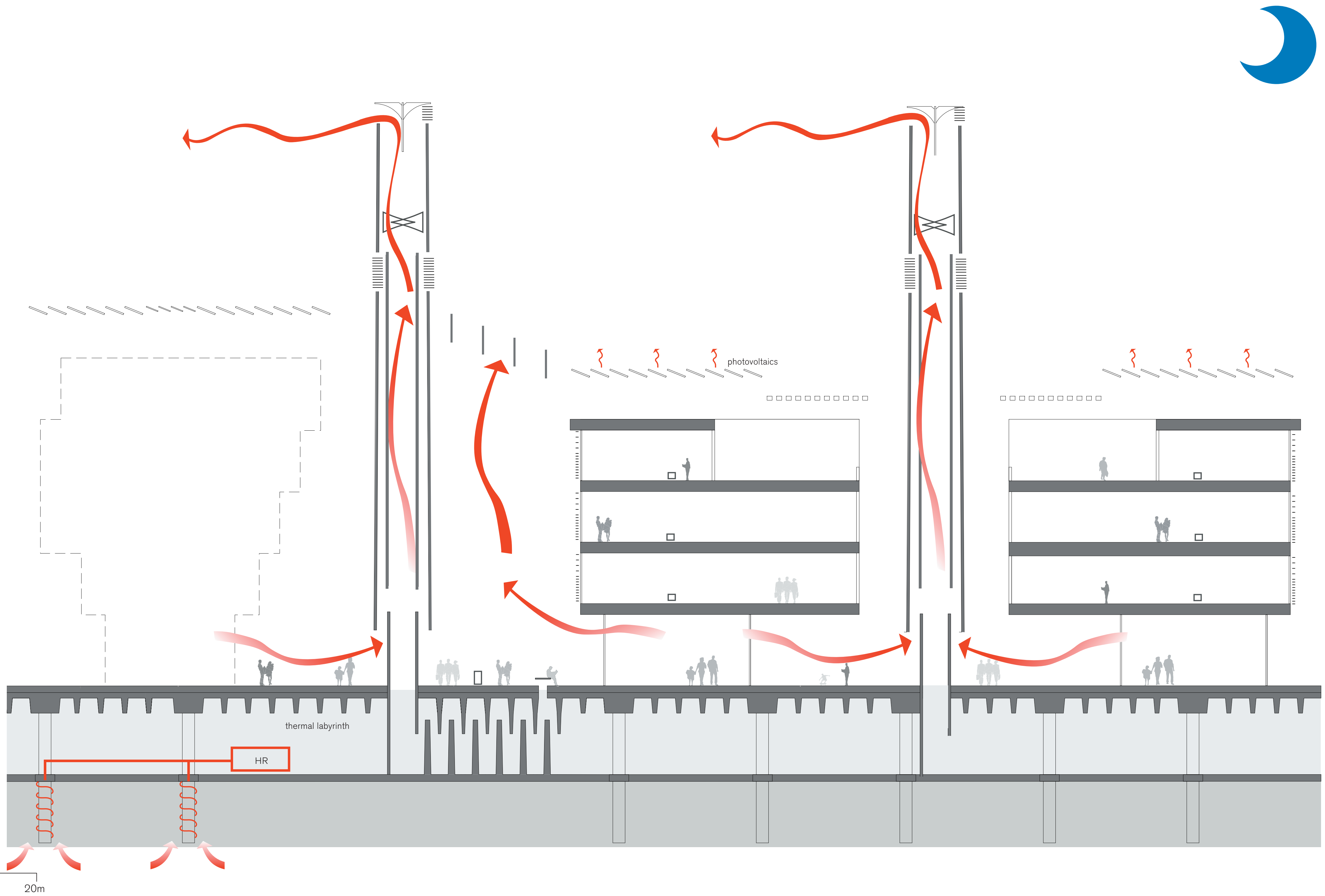
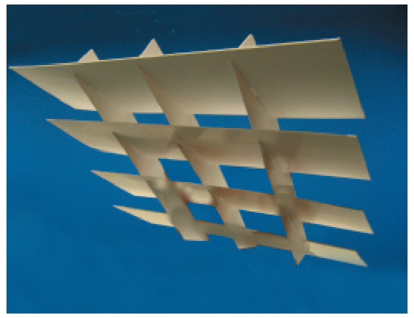




Typical Passive Streetscape Wind Tower

Winter Day

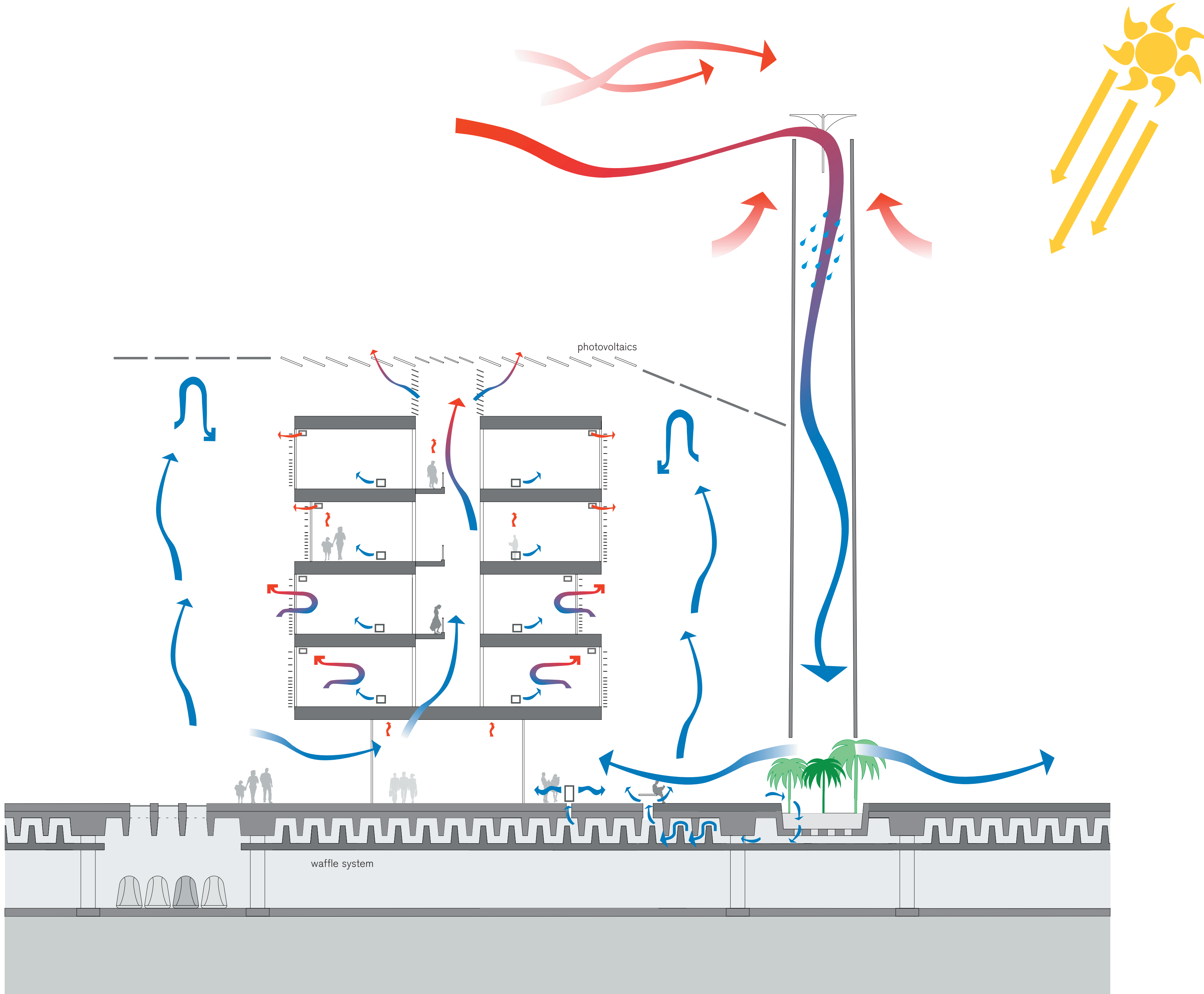
• Passive wind towers catch air at high level, cool the air and distribute to the ground plane.

• At the base of the wind towers, grills located as part of planter or water features, distribute air into the waffle system below.

• Residential atriums are naturally ventilated by the induced air movements of the PVs on the roof.

• Screens/panels above streets help maintain a cool microclimate by trapping the cool air.

• Residential apartments can be cooled either by being naturally ventilated.



0 5 10 20m

Typical Passive Streetscape Wind Tower

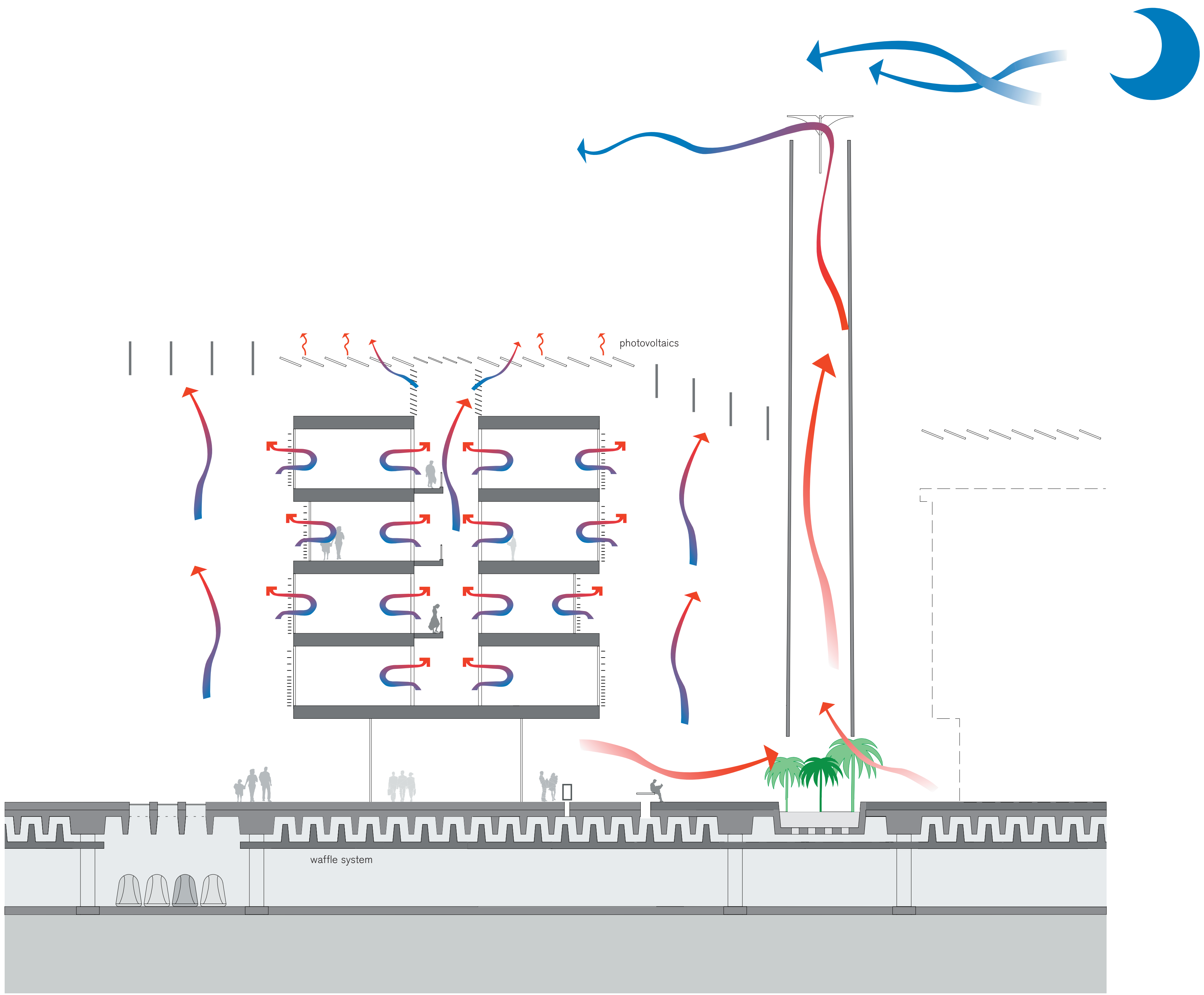
Winter Night

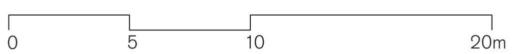
▪ Warm air is drawn up the towers by the prevailing winds from the ground plane and extracted back into the atmosphere.

▪ Residential atriums are naturally ventilated by the induced air movements of the PVs on the roof.

▪ To assist in the release of heat gained during the day screens/ panels are retracted,

▪ Convection assisted by the release of heat in photovoltaic panels.





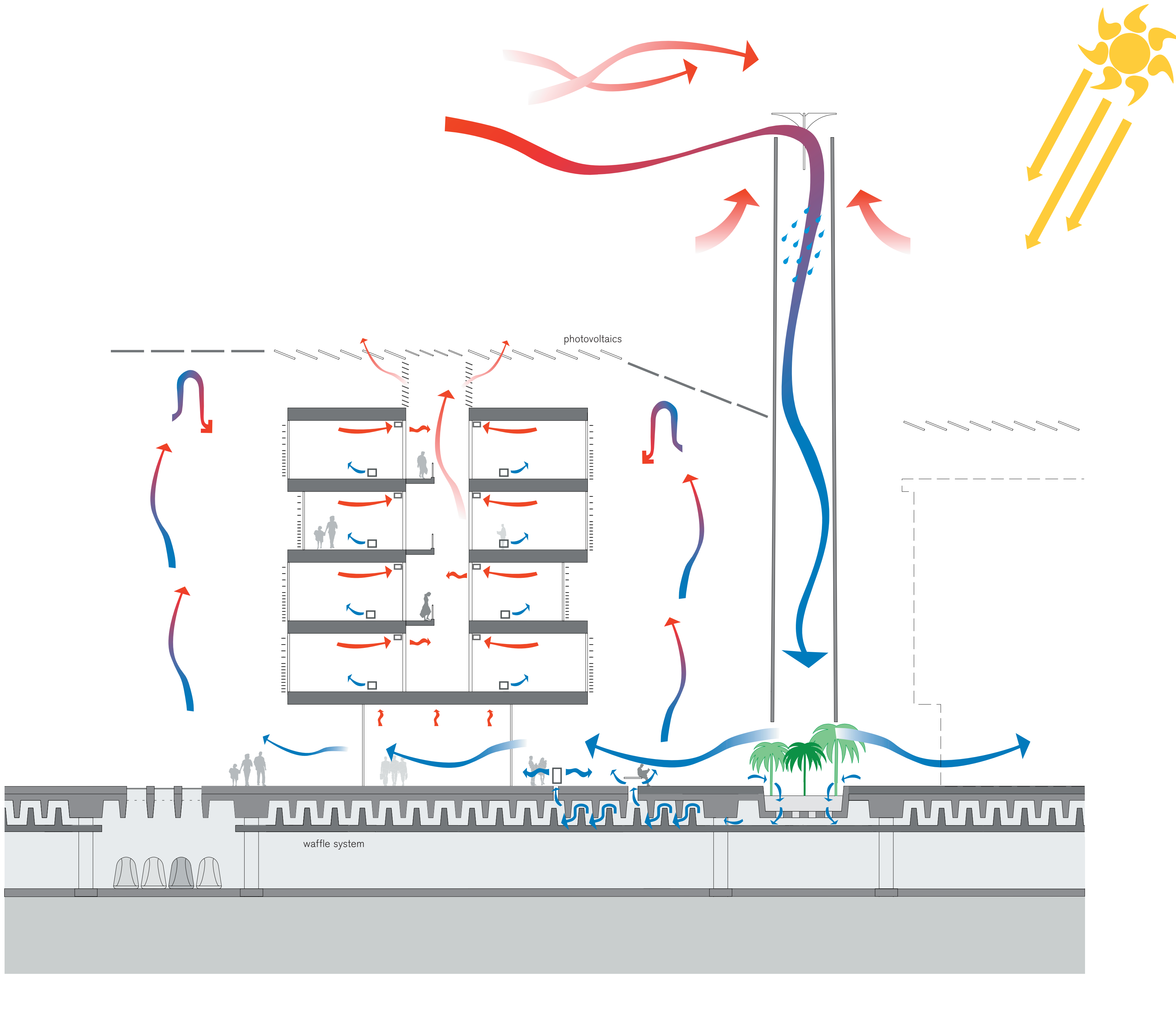
Typical Passive Streetscape Wind Tower

Summer Day
- Passive wind towers catch air at high level, cool the air and distribute to the ground plane.

• At the base of the wind towers, grills located as part of planter or water features, distribute air into the waffle system below.

• Residential atriums are naturally ventilated by the induced air movements of the PVs on the roof.

• Screens/panels above streetshelp maintain a cool microclimate by trapping the cool air.



Typical Passive Streetscape Wind Tower

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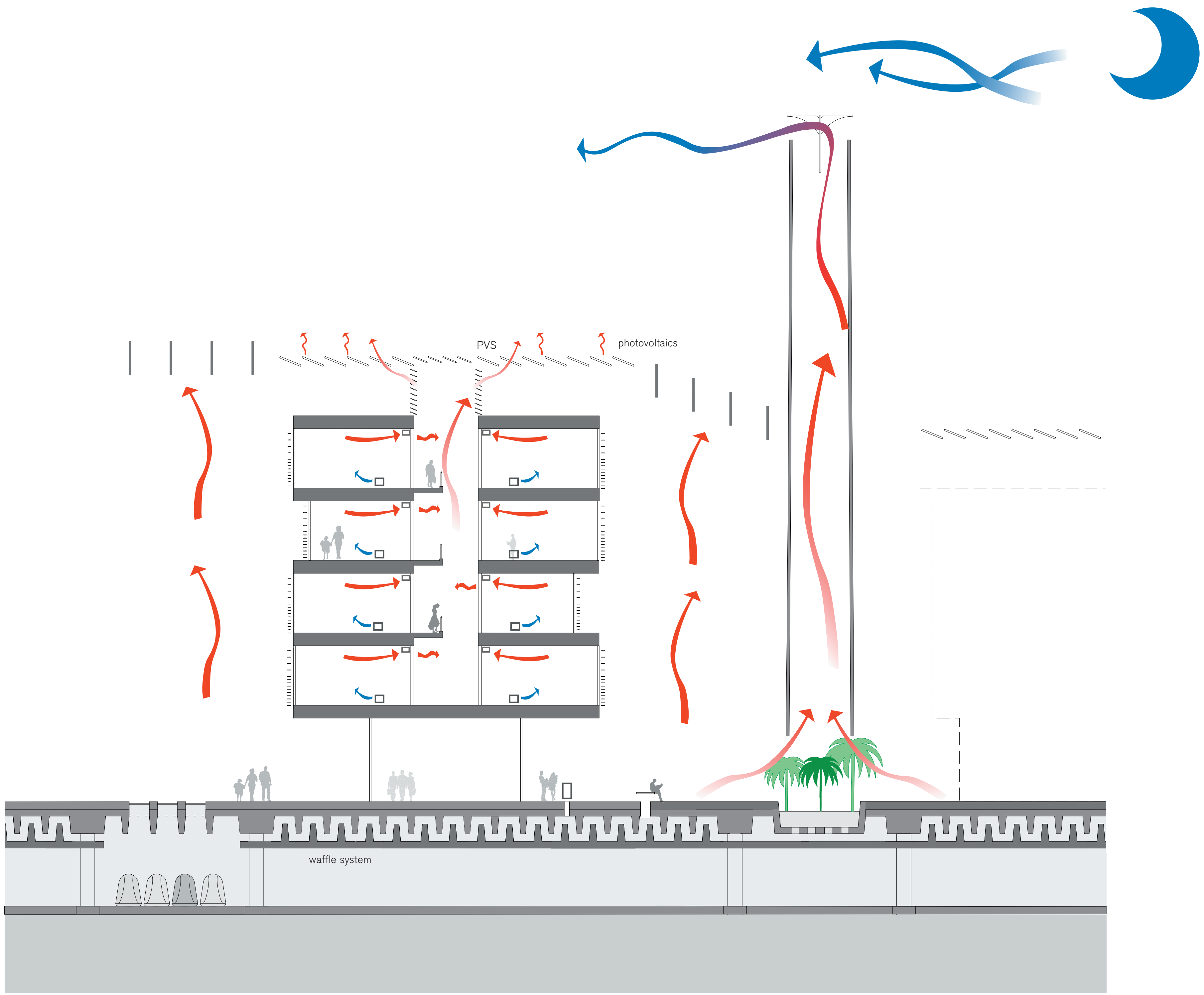
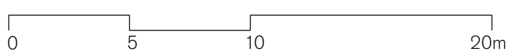


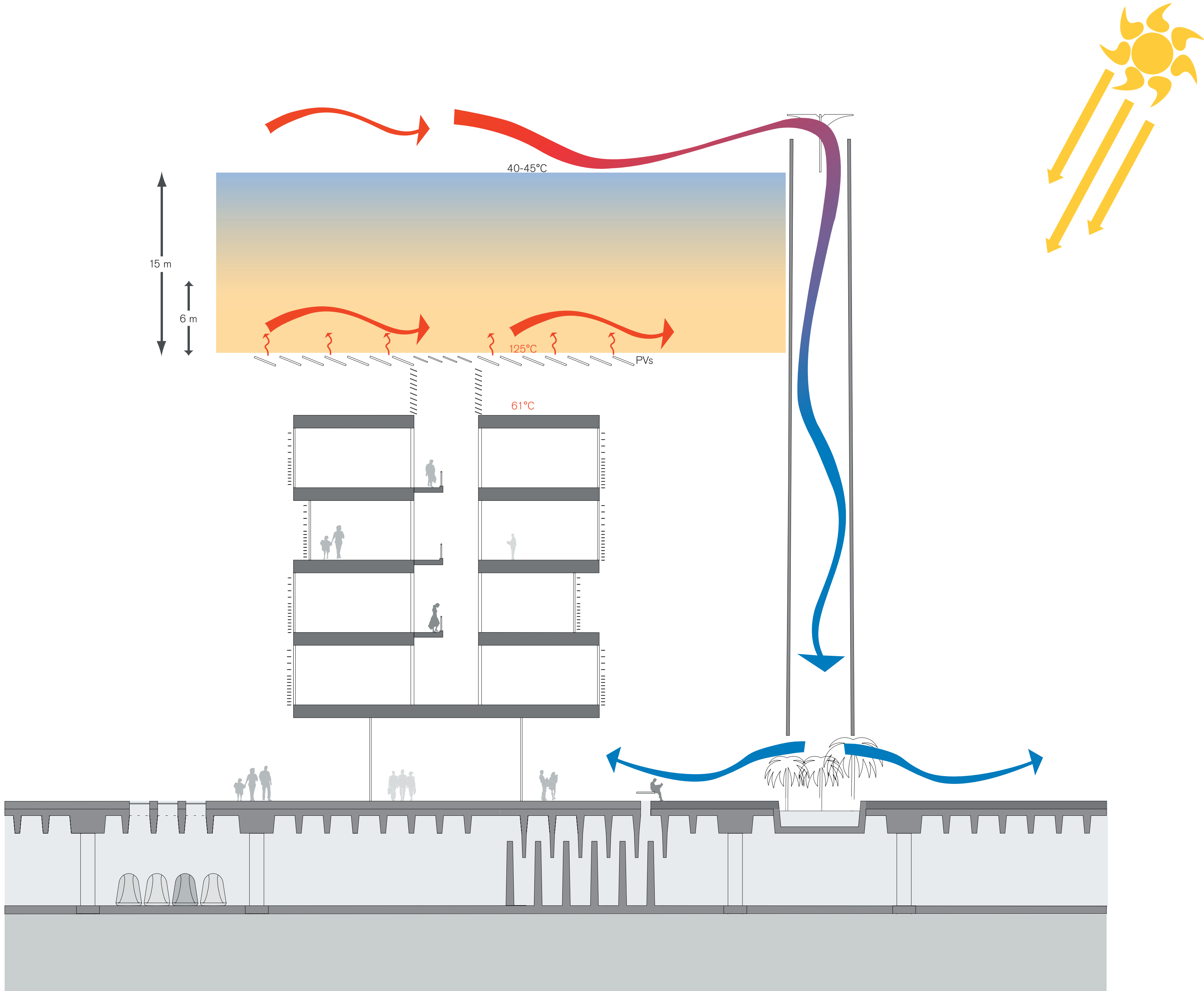


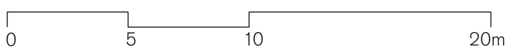
Construction Systems
M.I.S.T. Windtowers

Solar Heat Haze

- A combination of the urban heat island effect and use of PVs to collect solar energy results in a 6m heat haze layer collecting above the city. The temperature at this level is an average of 61°C.

- To ensure we can utilise the cool prevailing winds, the windtowers extend between 12m to 15m above the height of the photovoltaics.





Construction Systems

Daylight and Lighting

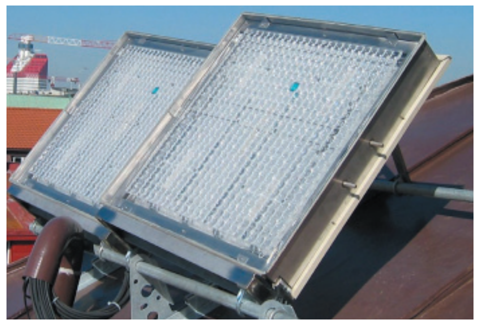
Daylight and Lighting

- The residential atriums are illuminated by natural daylight using directional louvres which mitigate sunlight and solar gain. Reflective surfaces ensure light reaches the base of the atrium.

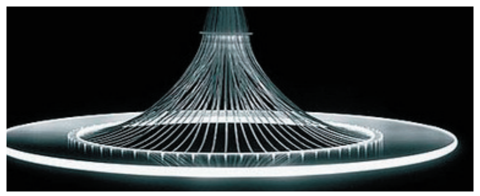
- The facades are designed to allow light to reach deep into the floorplate by incorporating lightshelves at high level while maintaining privacy through screening at low level.

- Glass blocks within the streetscape allows for the PRT and undercroft to receive natural daylight during the day and help illuminate the streets at night when the PRT is artificially lit.

- Solar collectors help provide natural light into rooms via a netwok of fibre optic cables and fittings.

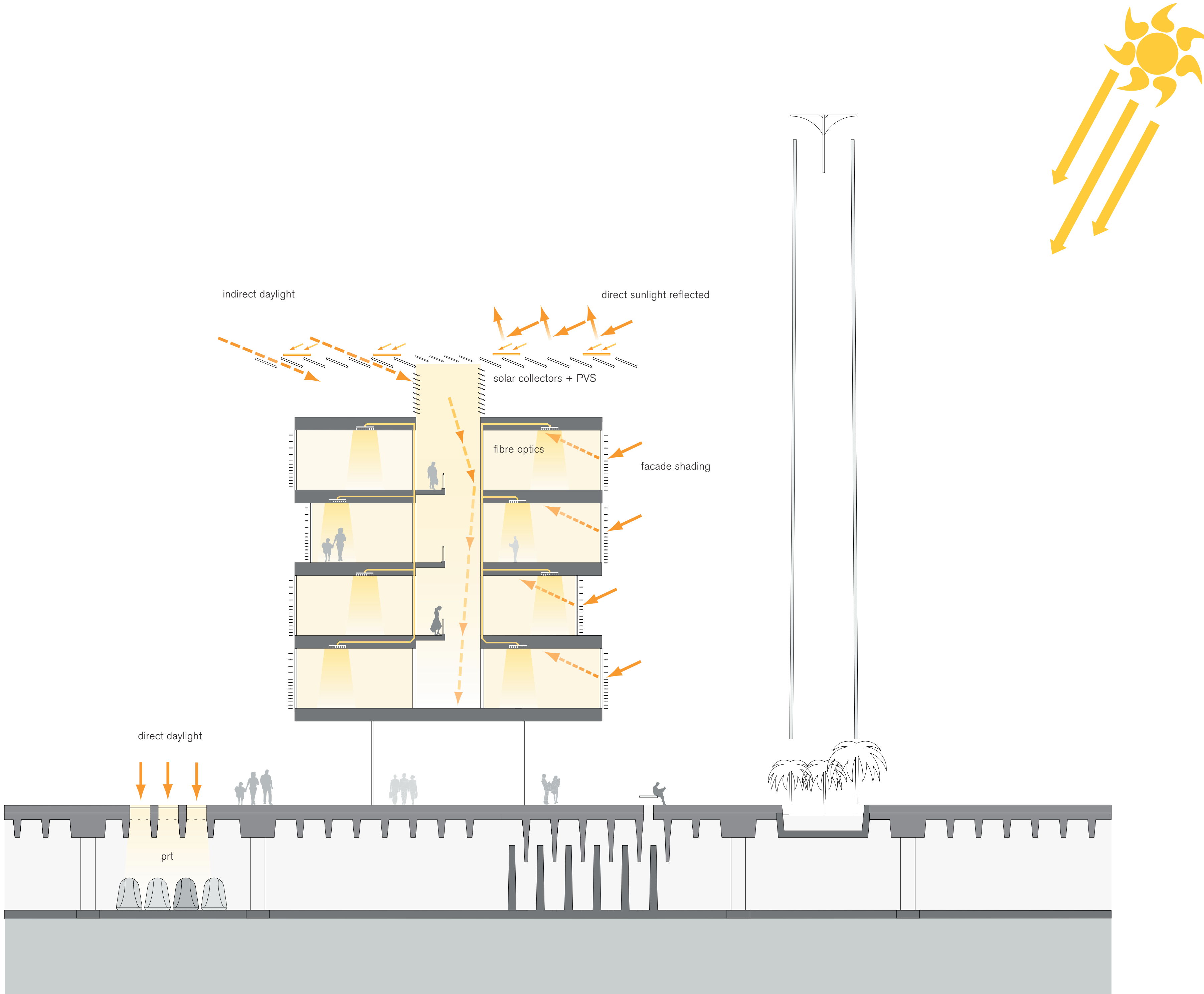


Solar collector



Fibre optic lighting fitting

0 5 10 20m



Construction Systems
Structural Strategy

Mindful of the August 2009 intake of the first researchers to M.I.S.T., the structural design and strategy of Phase 1a of M.I.S.T. involves the need for expediency and the overlaying and integration of what occurs above and below street level - three separate grids:-

The structural grid for the basement or undercroft.

2. The structural grid for the laboratories that allows for the maximum clear span research space.

3. The structural grid for the residential which allows for easy conversion and expansion into future laboratory space.

The tessellation of these three grids aim to address the need to be able to start on site at the earliest opportunity whilst providing the flexibility above street and podium level to design a fully functional and versatile campus which responds to the needs and dynamic demands of M.I.S.T.

The current proposal aims to utilise a waffle slab construction for the podium which will provide the flexibility demanded to form a dynamic and responsive campus. This structural strategy also helps to inform the environmental strategy of the overall campus, providing the opportunity for large areas of thermal mass to assist in the natural cooling and conditioning of ambient air for use in laboratories, housing and streetscapes within M.I.S.T., minimising energy consumption.

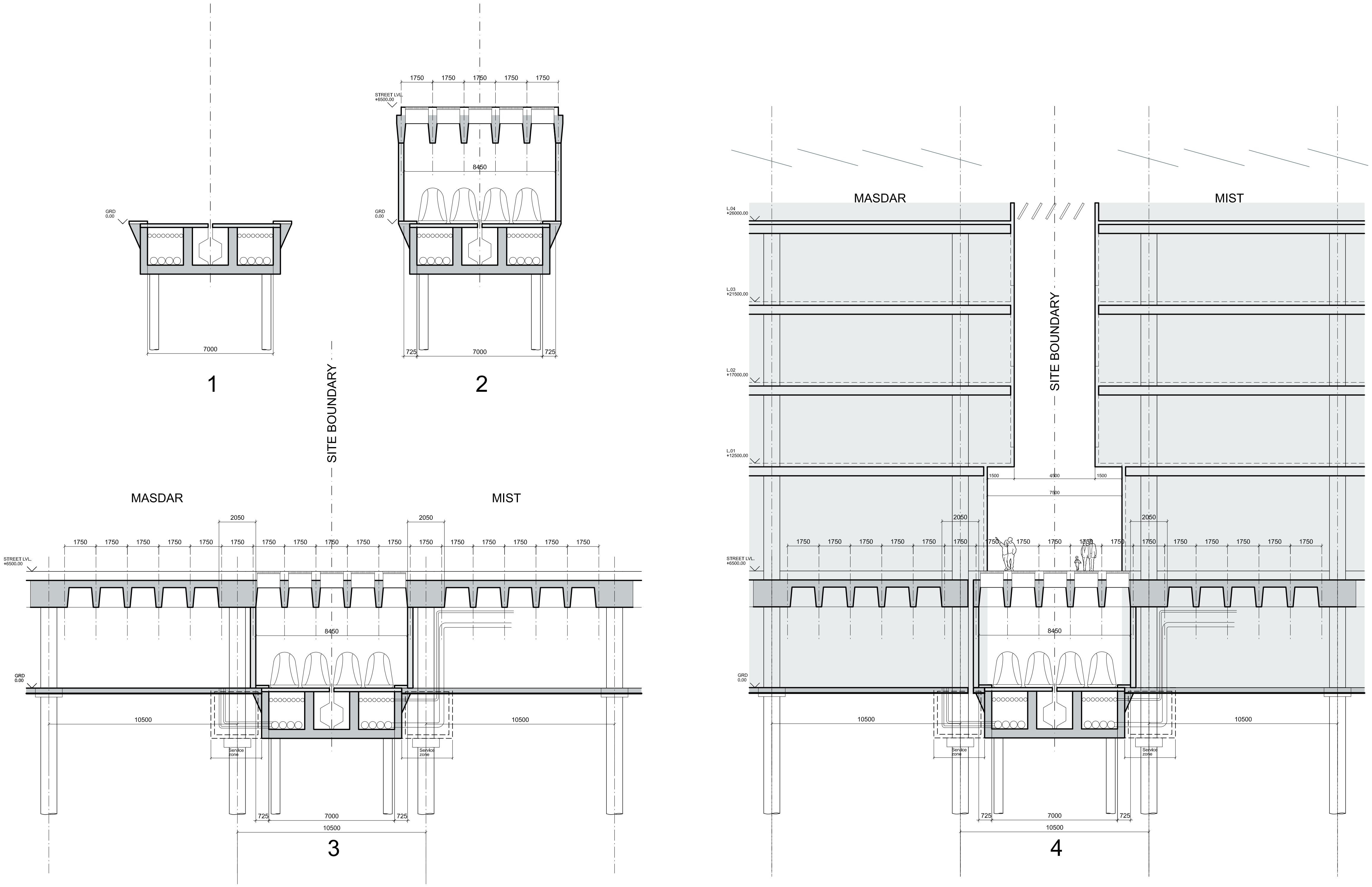
The first part of this process will look at the structural strategy for the scheme, the form of its construction and the methodology of its procurement. The choices of how we may construct Phase 1a of M.I.S.T. have been narrowed down to the following four options:-

- **Insitu/ Cast Concrete system**
- **Precast Concrete system**
- **Prefabricated/ Pod system**
- **Framed systems**

In assessing the strengths and weaknesses of each methodology, various forms of each system will be developed/ investigated and reviewed based on the following criteria:

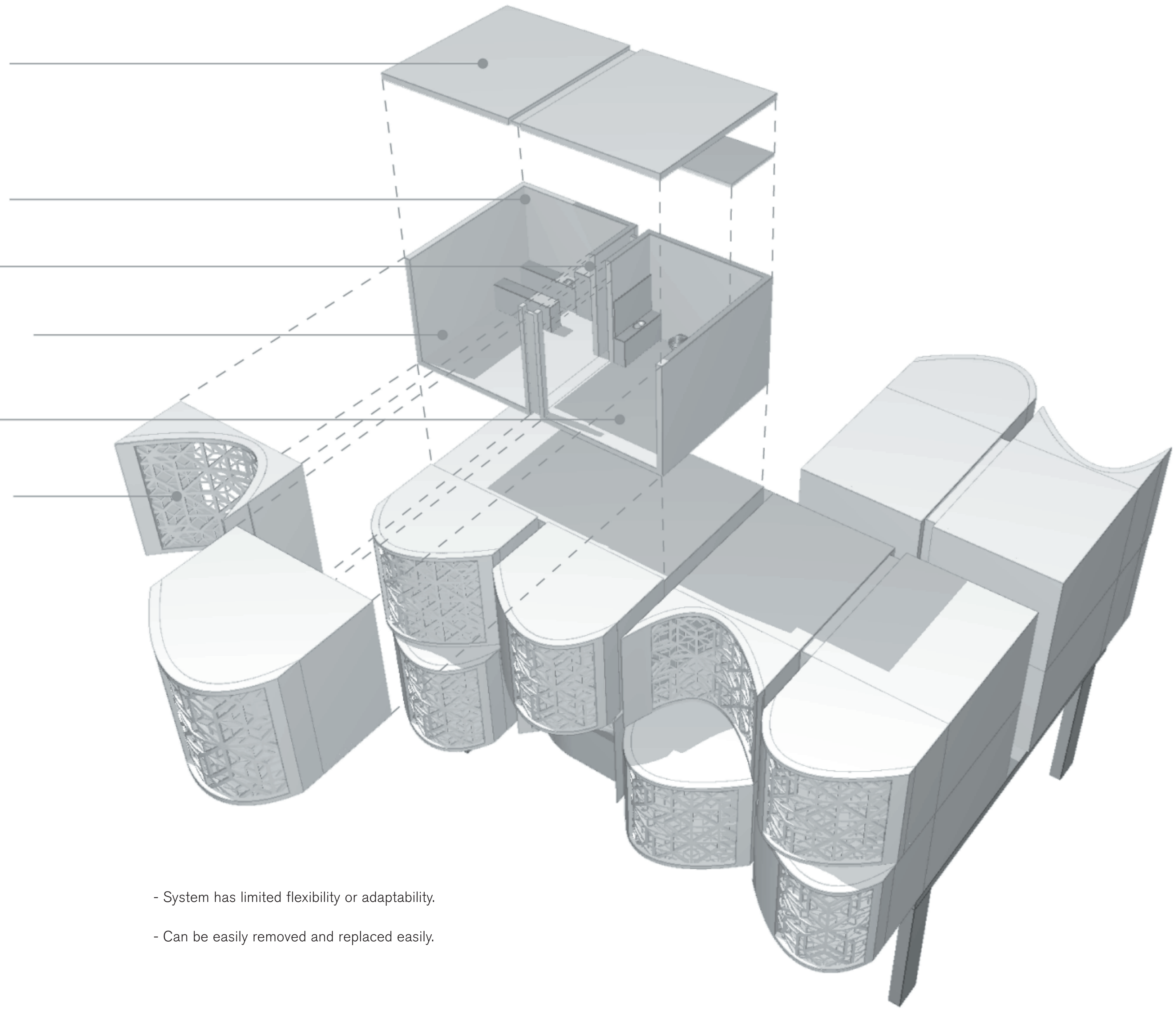
- **Design** – construction depths, stability, resistance to meet seismic requirements, achieve loading and vibration criteria.
- **Adaptability/flexibility**
- **Buildability** – material usage, local knowledge.
- **Programme** – lead in times and site times
- **Cost** – construction and whole life
- **Energy Issues/Sustainability** – embodied energy, whole life energy usage including maintenance.
- **Foundation Implications** – weight of superstructure, column spacing
- **Servicing strategy** – services integration, builders work holes
- **Durability** – resistance to specific site conditions.

Sectional Studies Sectional Construction of proposed Waffle Slab in a Typical Masdar Street



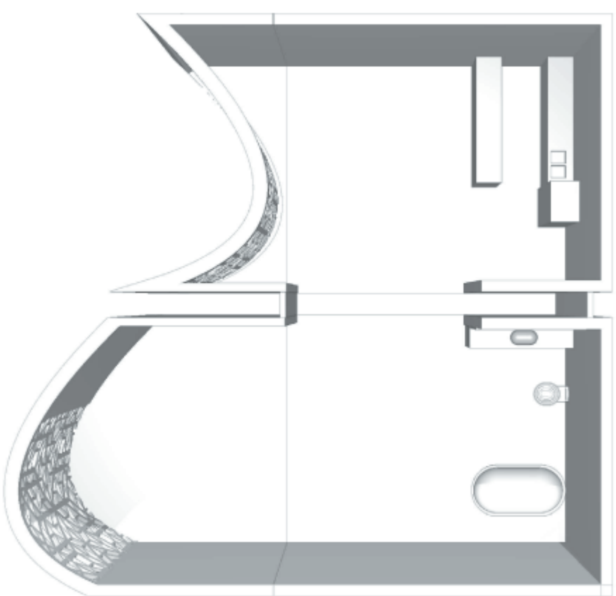
Construction Systems

Residential Construction - Pod System



- System has limited flexibility or adaptability.

- Can be easily removed and replaced easily.



Schematic 'Pod' Plan

Construction Systems

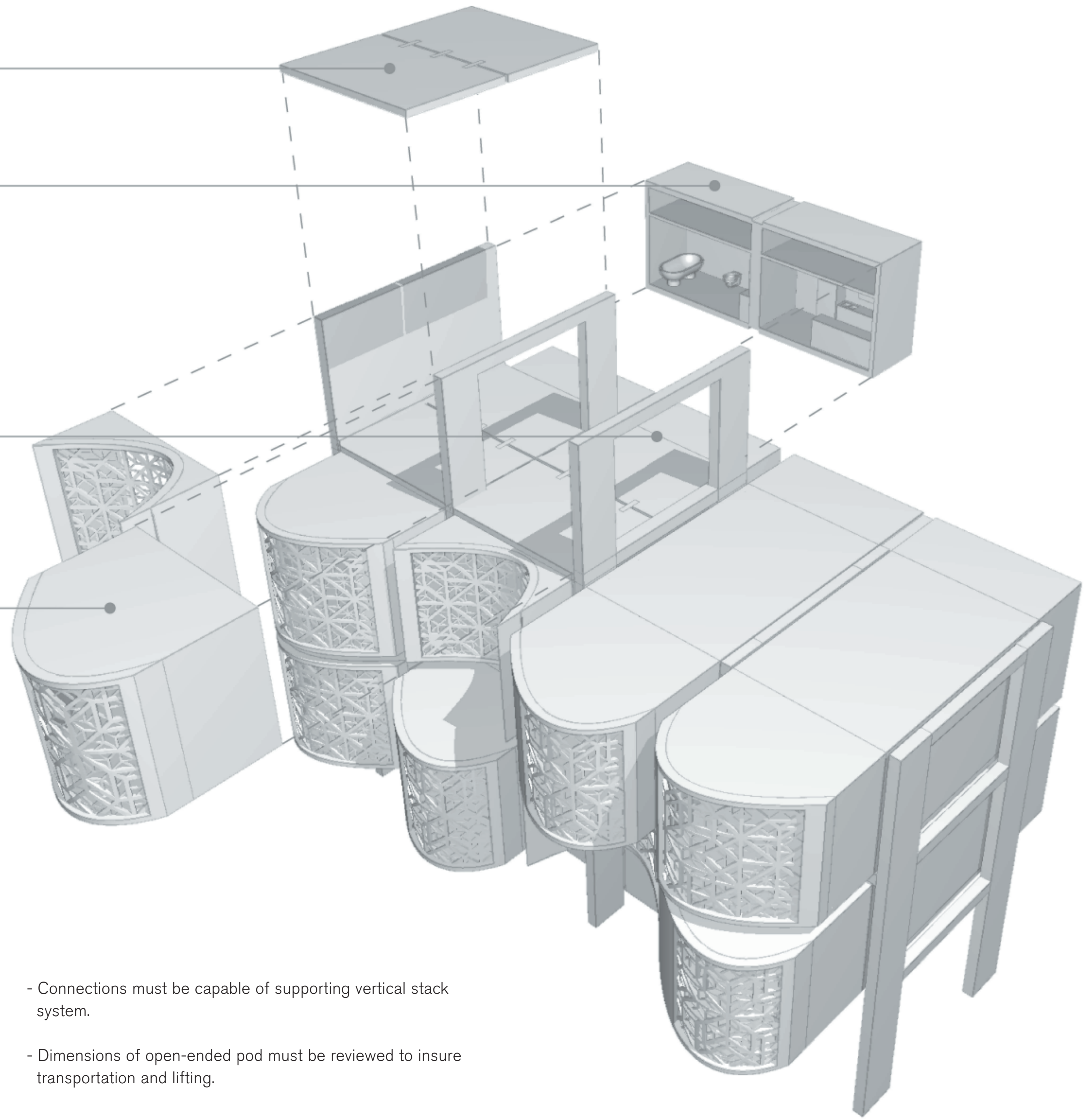
Residential Construction - Pod System

Rigid connections between units capable of transmitting, shear, lateral and seismic forces.

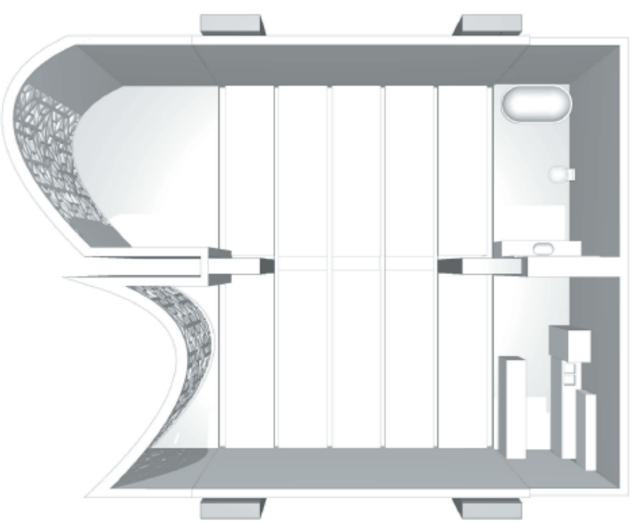
Bookends fixed to pod system. [lightweight] Contains toilet and kitchen fixtures.

Restricted future proofing. Opening capability to side of units. Lintel required in 'filled' and 'open' panel conditions.

Light to medium weight structure with glazing and screen.



- Connections must be capable of supporting vertical stack system.
- Dimensions of open-ended pod must be reviewed to insure transportation and lifting.



Schematic Plan

Construction Systems

6.4.4

Advantages and Disadvantages - Conventional Insitu / Cast System

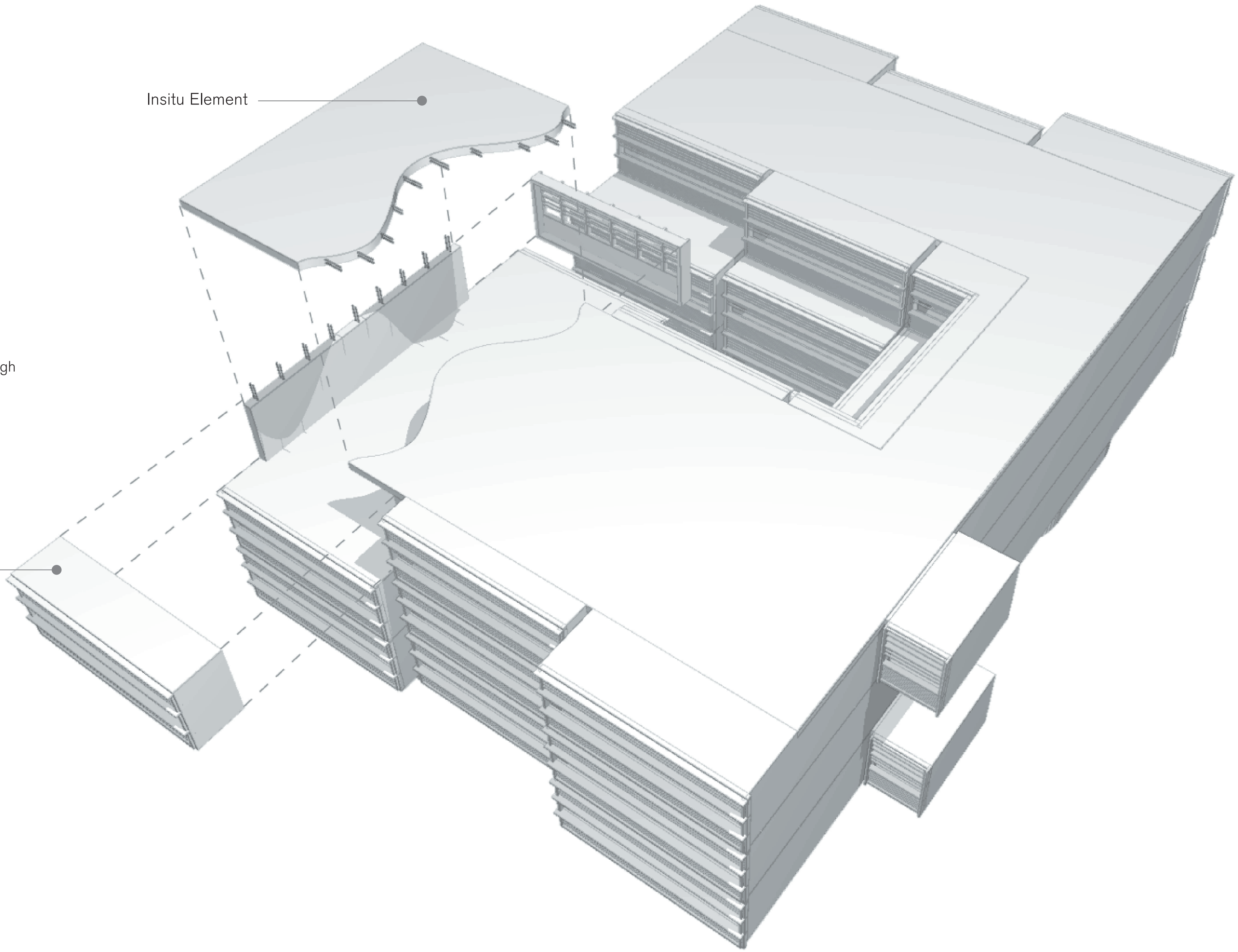
Frame formed on site with raw materials, most commonly insitu concrete.

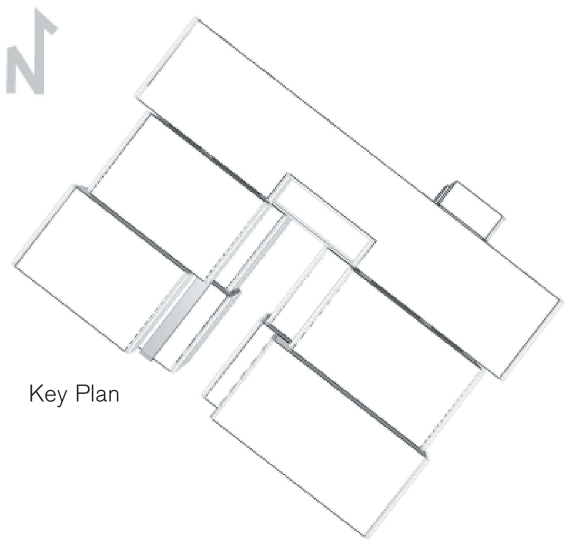
Advantages

- Good durability, reducing requirements for maintenance throughout life.
- Commonly used methodology in the UAE.

Disadvantages

- Raw materials usage on site.
- Heavy weight structure, requiring large volume of material (high embodied energy), and large foundations.





Key Plan

Construction Systems

Advantages and Disadvantages - Conventional Framed System

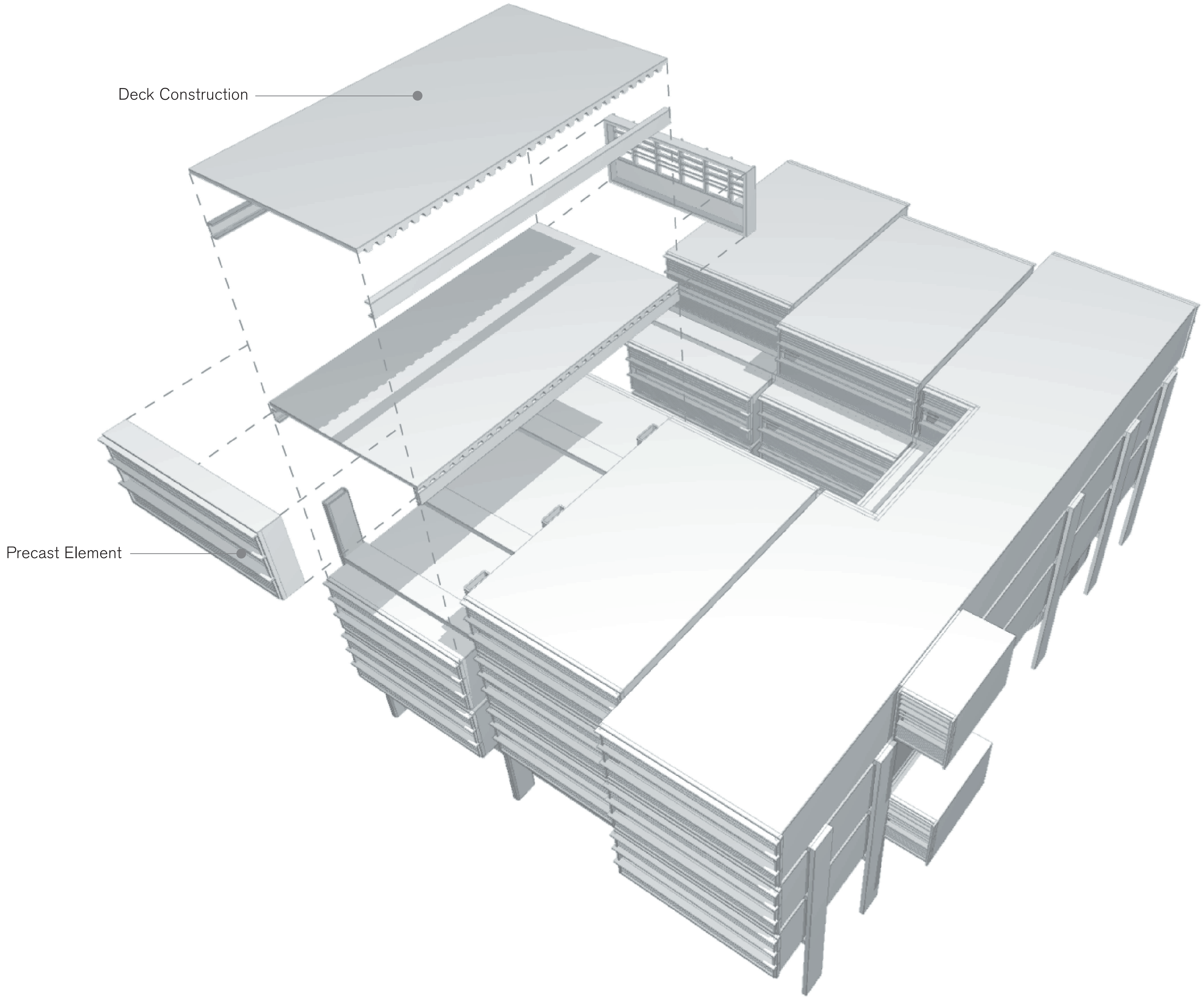
Primary frame constructed on site with floor added seperately (eg. traditional steel frame building).

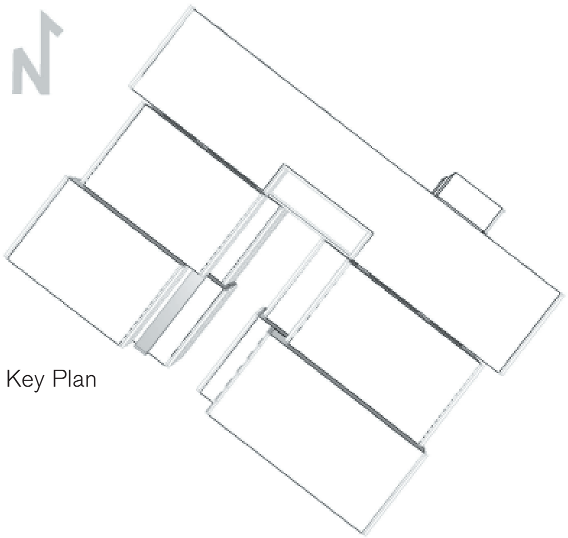
Advantages

- Commonly used methodology in UAE.
- Offers the buider greater flexibility on site.
- Reduced construction time on site.
- Able to provide long span column-free spaces.
- Light weight structures. Reduced foundation size.

Disadvantages

- Poor durability (steel), will require significant maintenance throughout life.
- Light weight structures are more sensitive to vibrations. (an important factor on laboratory buildings)
- Sourcing of steel to be investigated (transportation/carbon footprint)

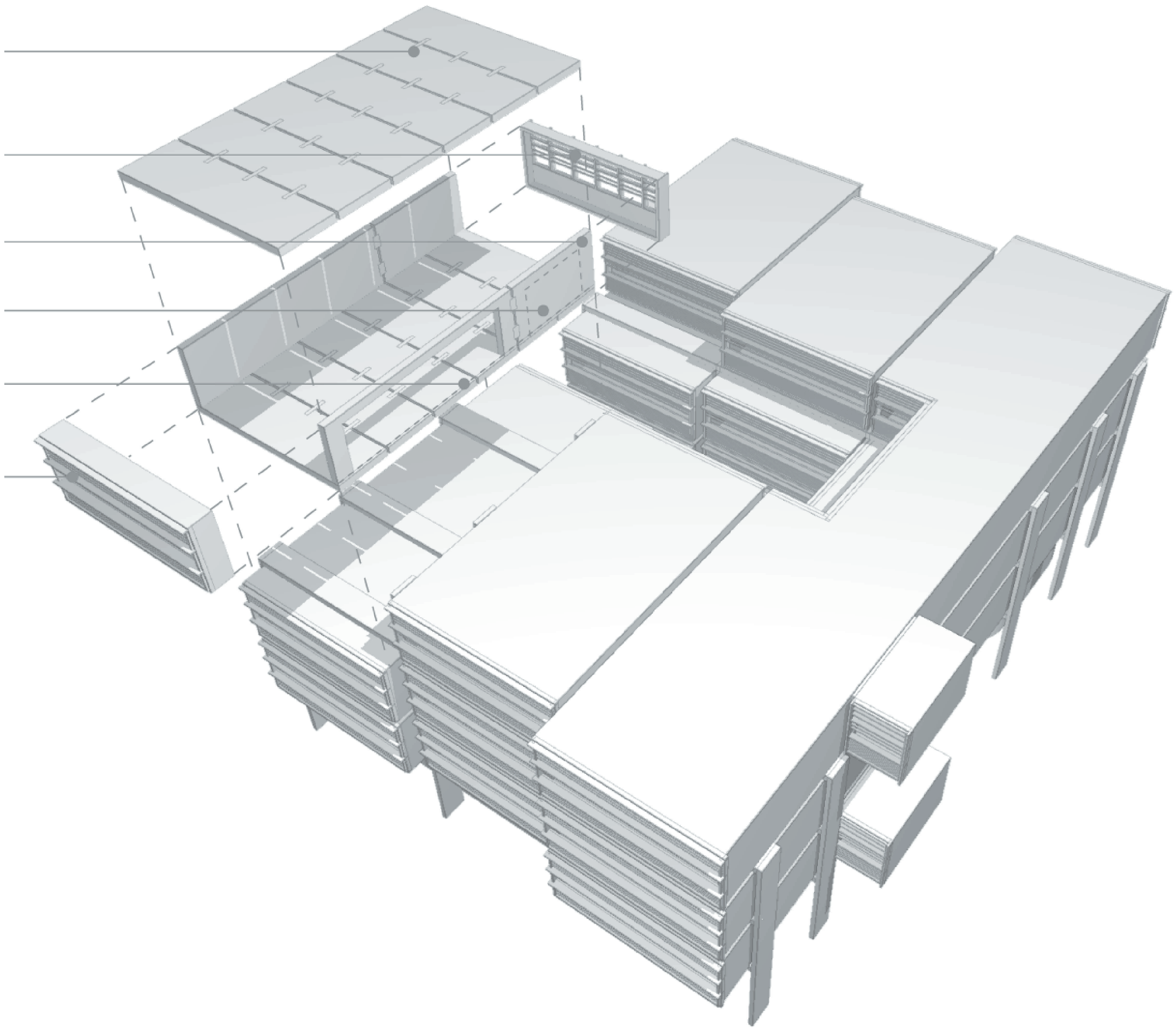


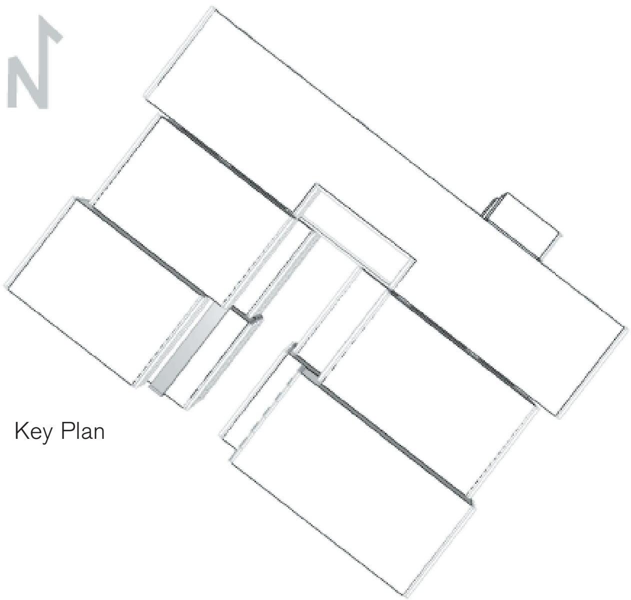


Key Plan

Construction Systems

Laboratory Construction - Precast Alternative





Key Plan

Construction Systems

Advantages and Disadvantages - Precast System

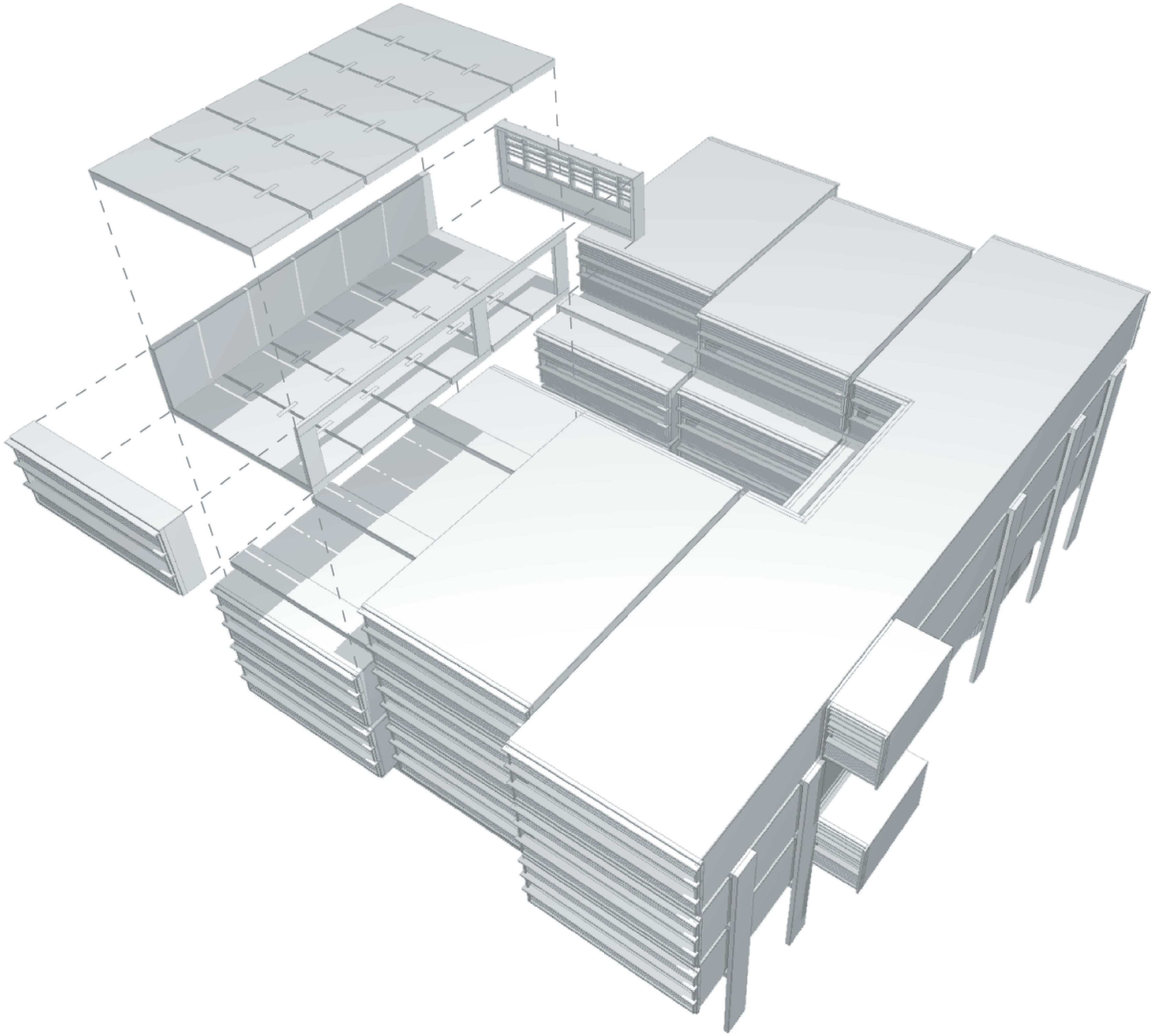
Concrete frame, but with elements manufactured off-site.

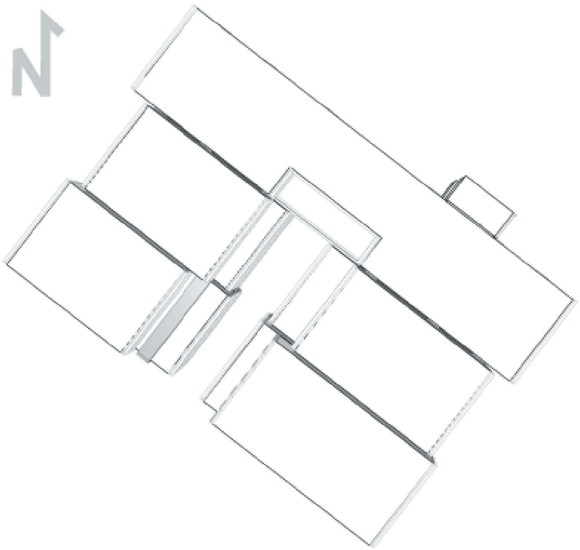
Advantages

- Good durability, reducing requirements for maintenance throughout life.
- A more controlled environment will improve efficiency of production, and the quality/workmanship of the elements.
- Reduced construction time on site.

Disadvantages

- Reduced adaptability/flexibility.
- Heavy weight structure. Energy also required for lifting and transport to site.
- Traditionally poor and dealing with seismic action.
- Shear walls to resist lateral loading would be necessary.





Key Plan

Construction Systems

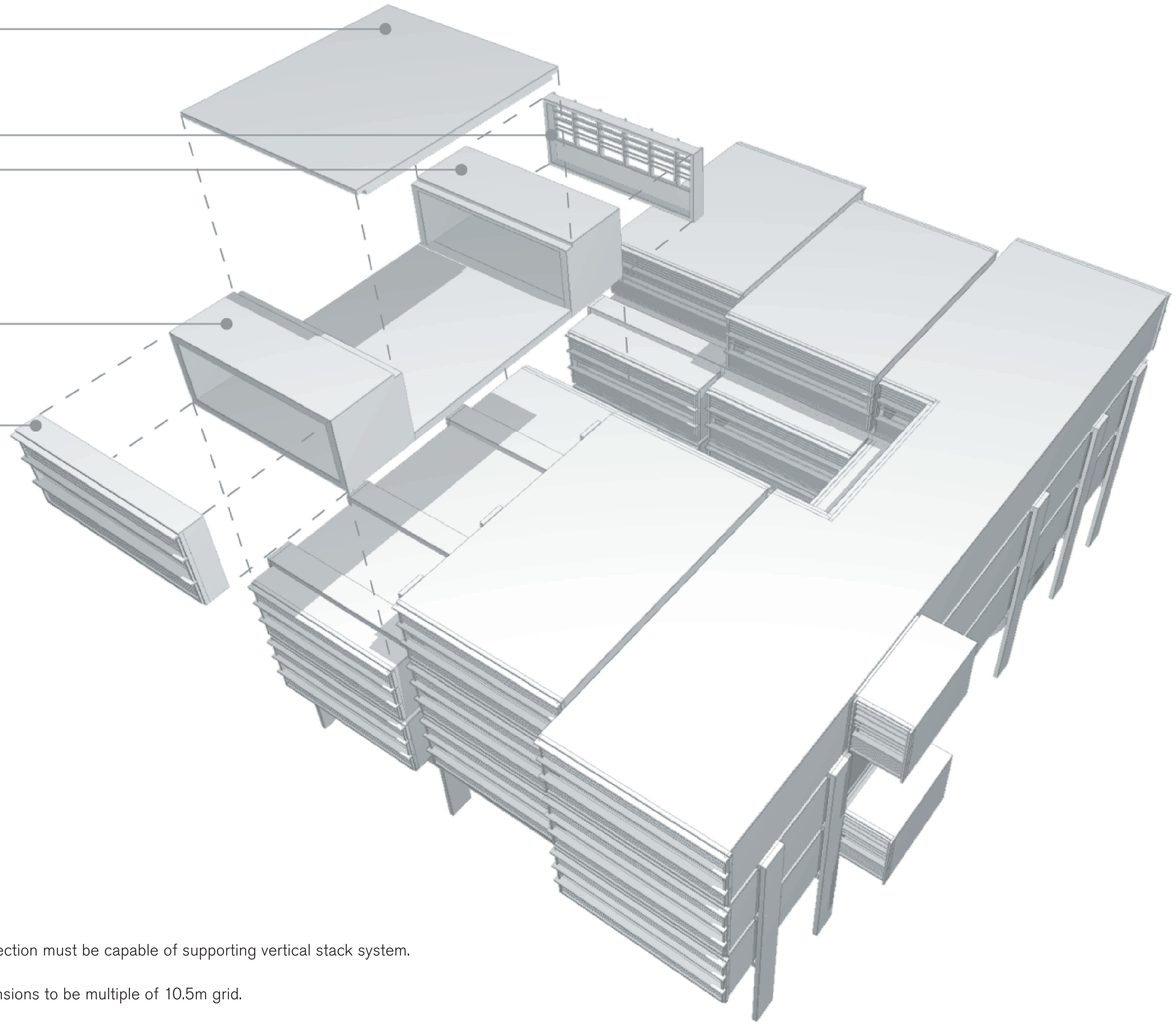
Laboratory Construction - Pod Alternative

Pre-fabricated slab module slots into pods as floor and roof. Must be sized to span open lab space.

North-face cladding system. Light to medium weight structure with glazing and louvres supported off pod structure.

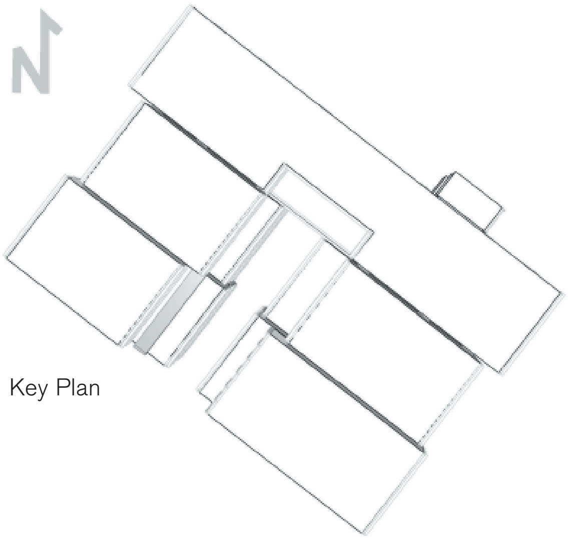
Open pod unit. Section must be transportable.

South-facing cladding system. Light to medium weight structure with glazing and louvres supported off pod structure.



- Connection must be capable of supporting vertical stack system.

- Dimensions to be multiple of 10.5m grid.



Key Plan

Construction Systems

Advantages and Disadvantages - Prefabricated / Pod System

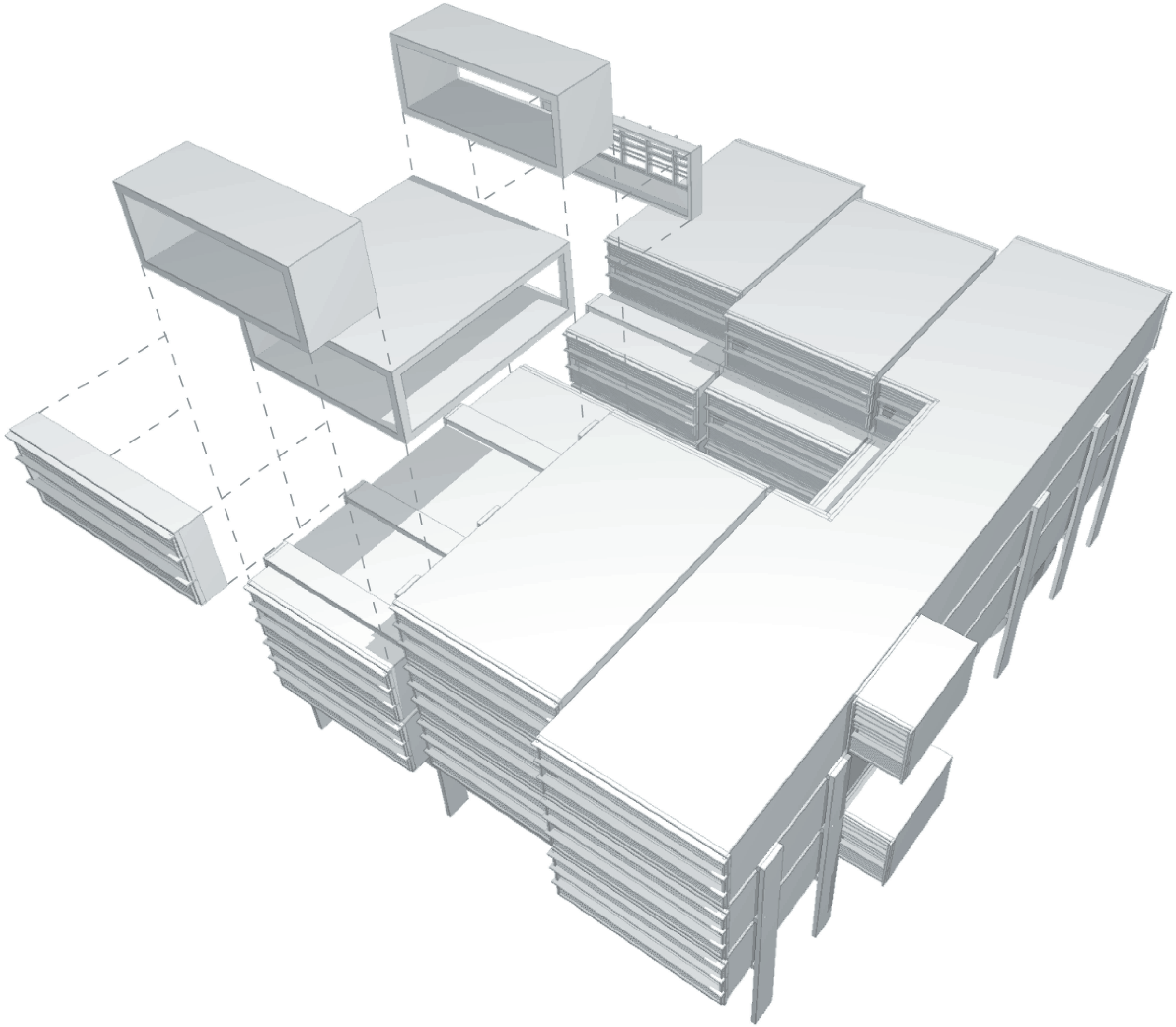
Unitised or pre-assembled pods, designed as self-stacking elements.

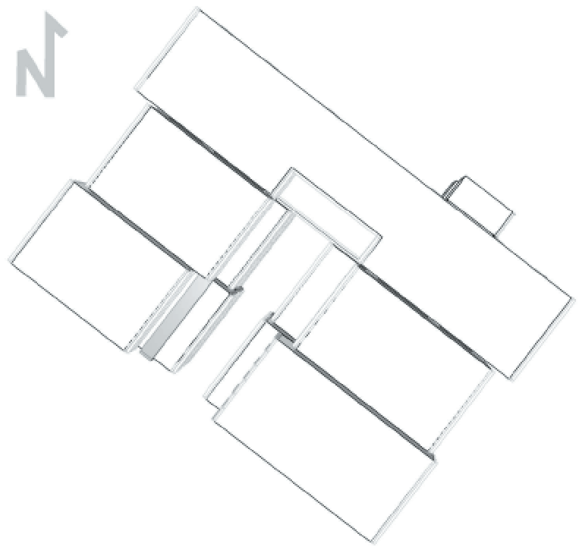
Advantages

- Highly efficient construction.
- Reduced construction time on site.

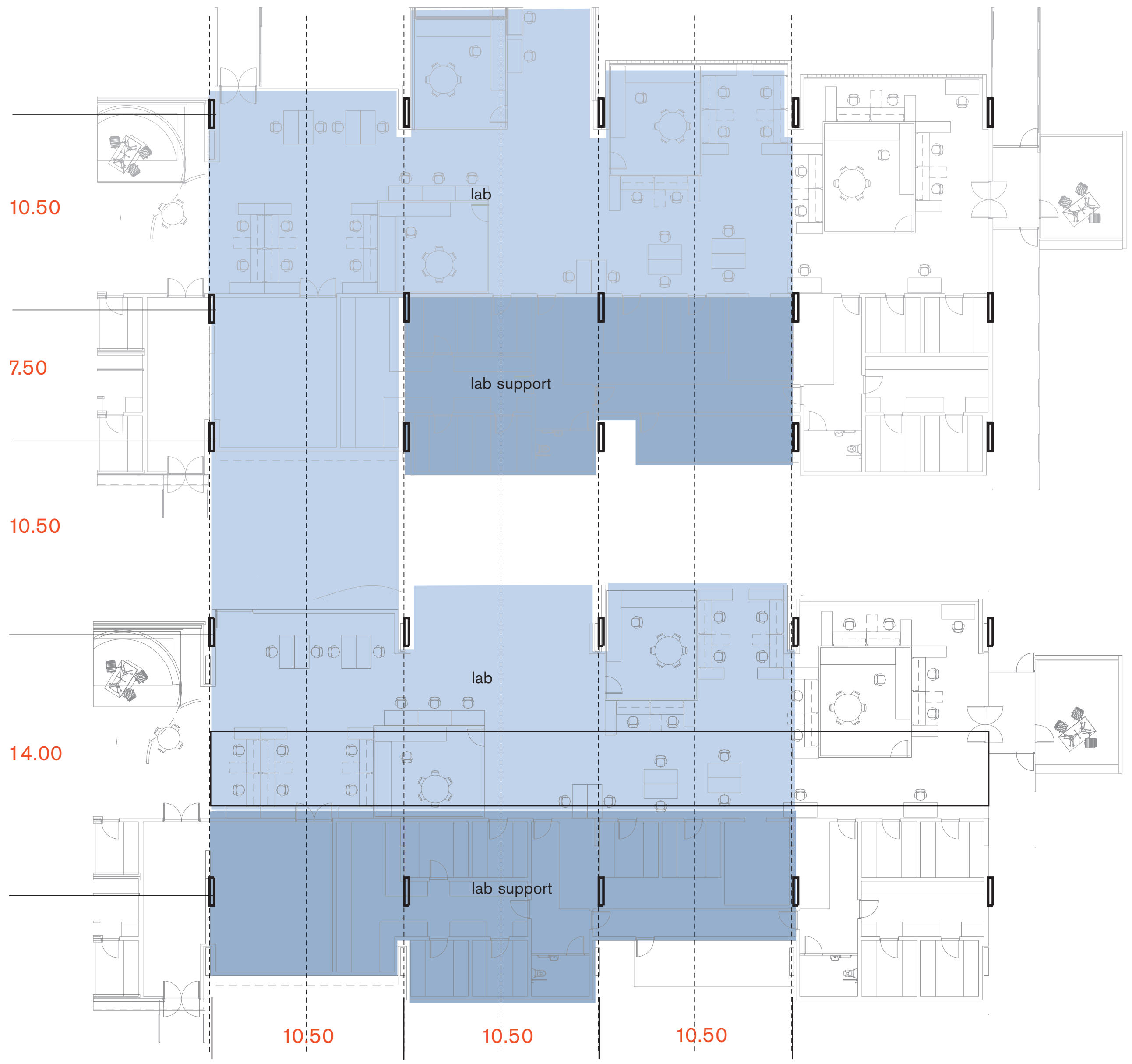
Disadvantages

- Not a common methodology in the UAE.
- Requires careful consideration with regard to vibration, seismic response.
- Reduced adaptibility / flexibility.
- Reduced ability to provide column-free spaces.
- Lifting and transportation to site requires investigation.





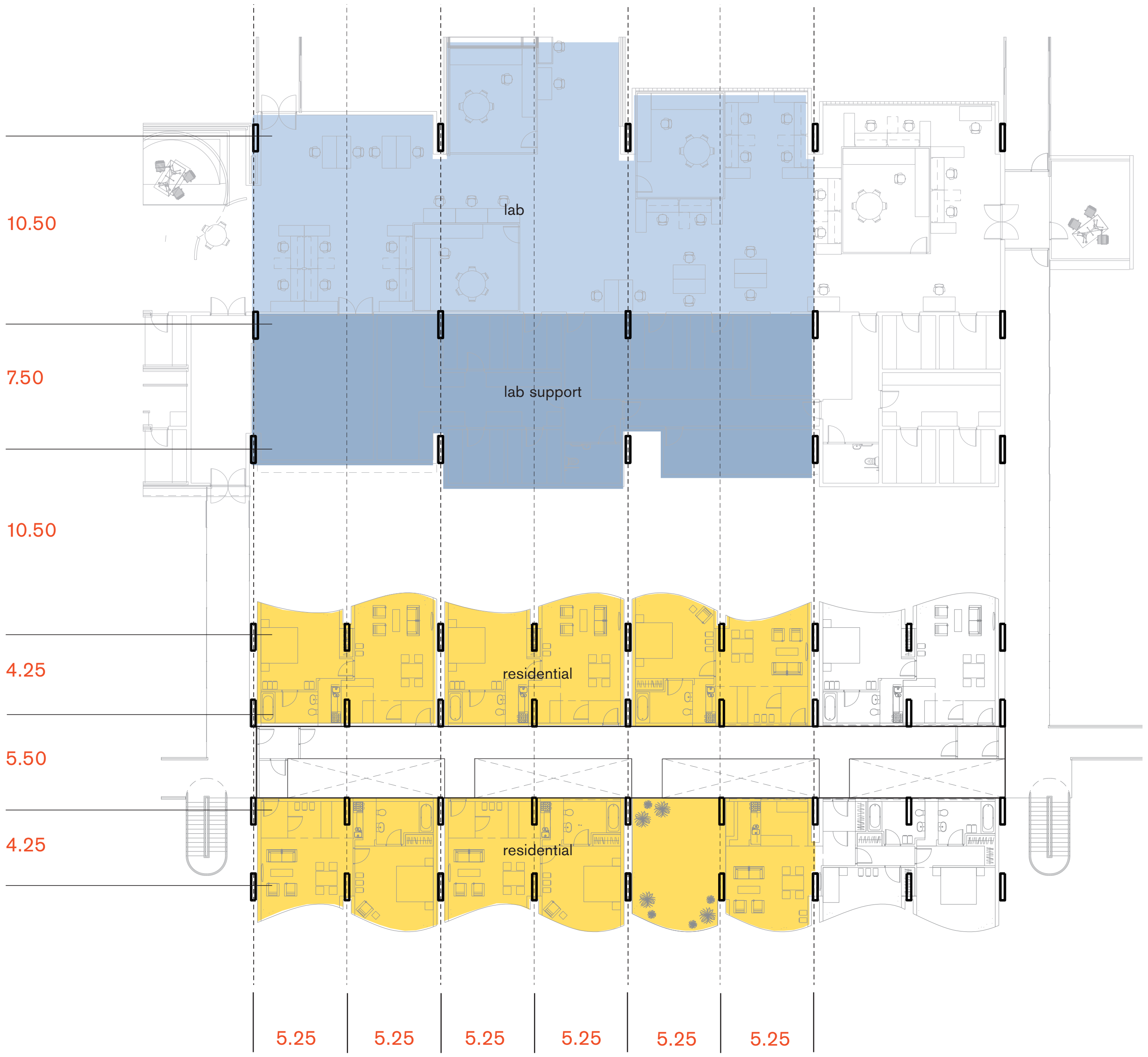
Structural Grid / Option 1



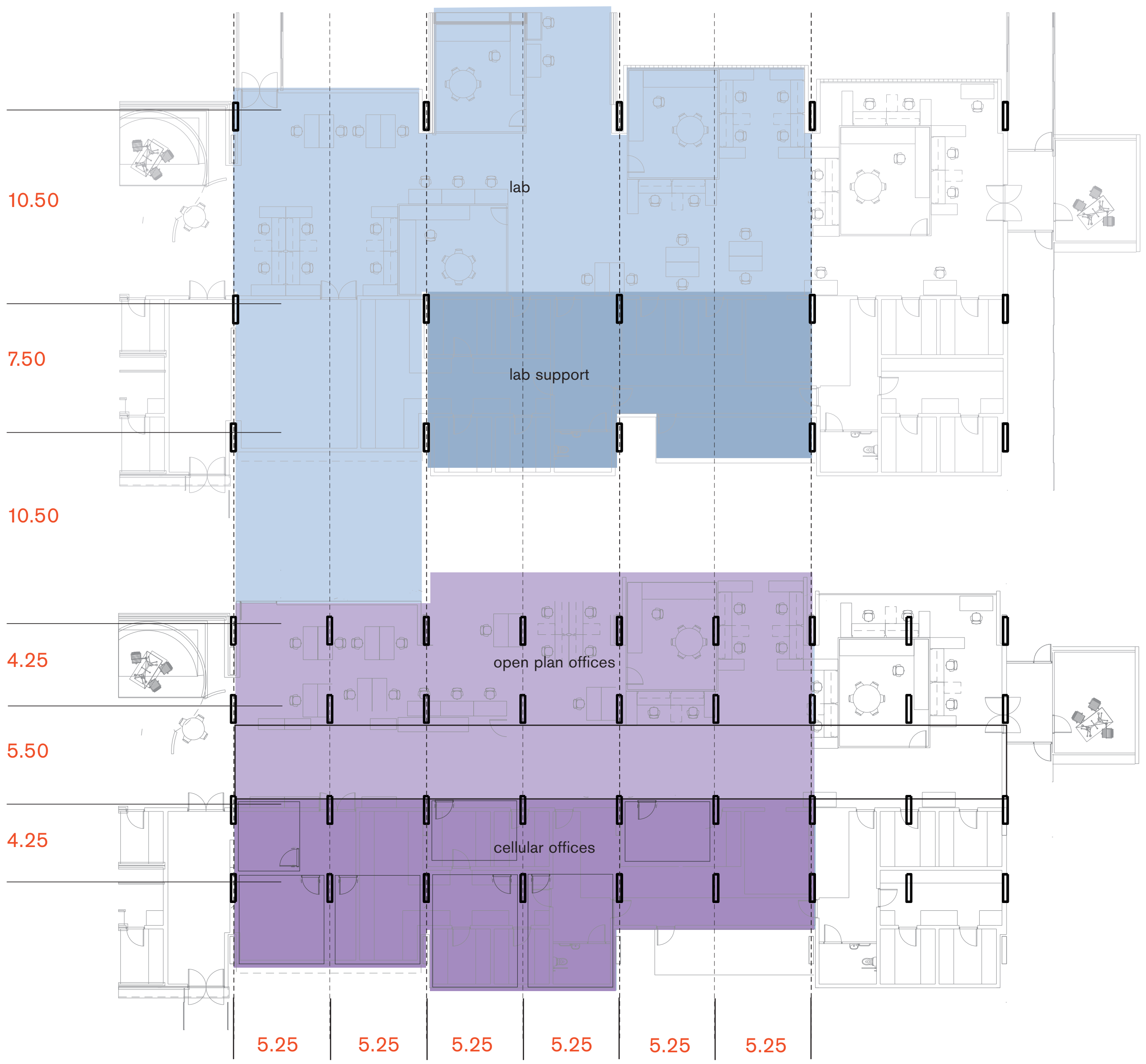
RESIDENTIAL LOADING TO MATCH LAB STRUCTURAL REQUIREMENTS

FUTURE LAB EXPANSION (HIGHER LOADING REQUIREMENT THAN RESIDENTIAL

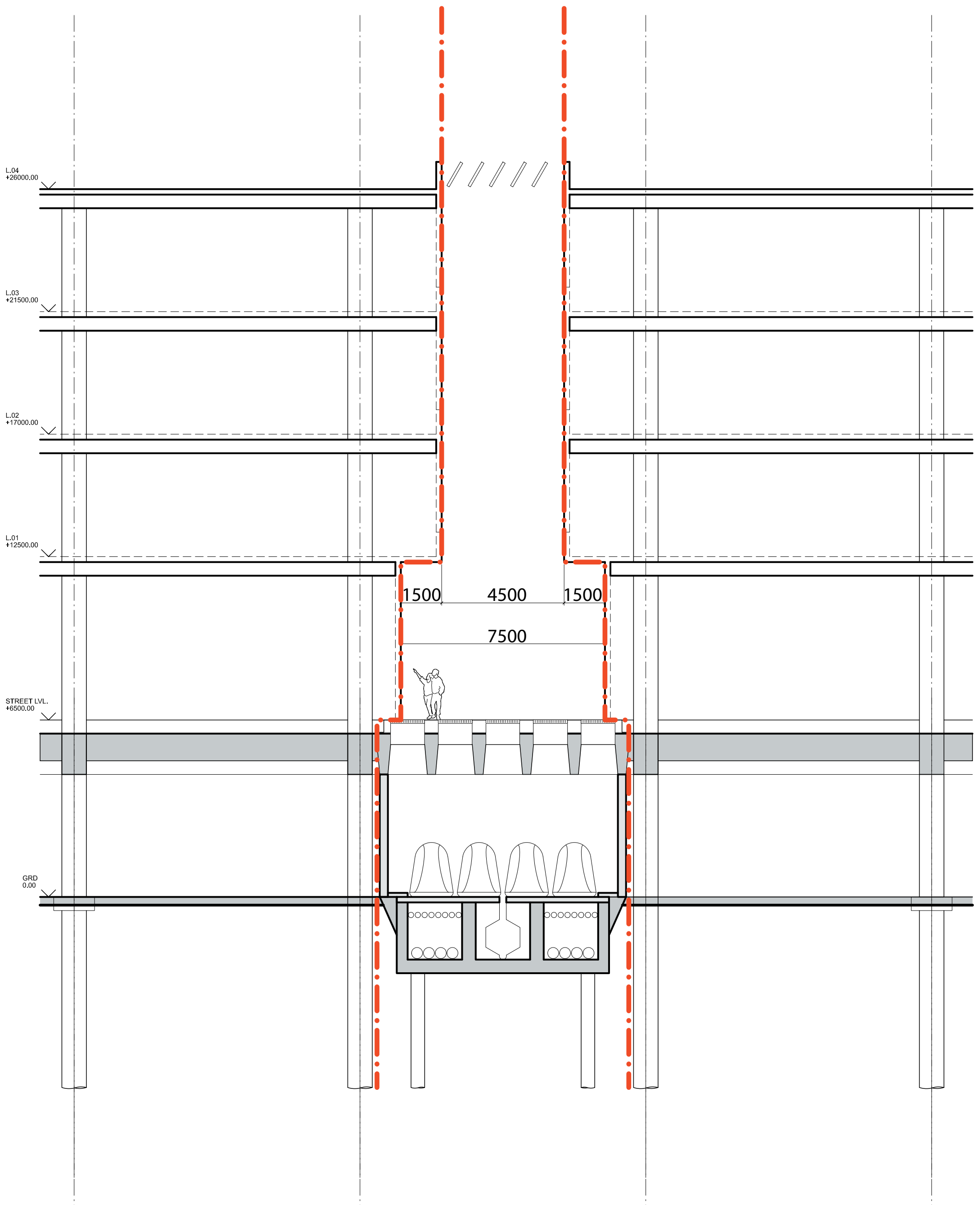
Structural Grid / Option 2



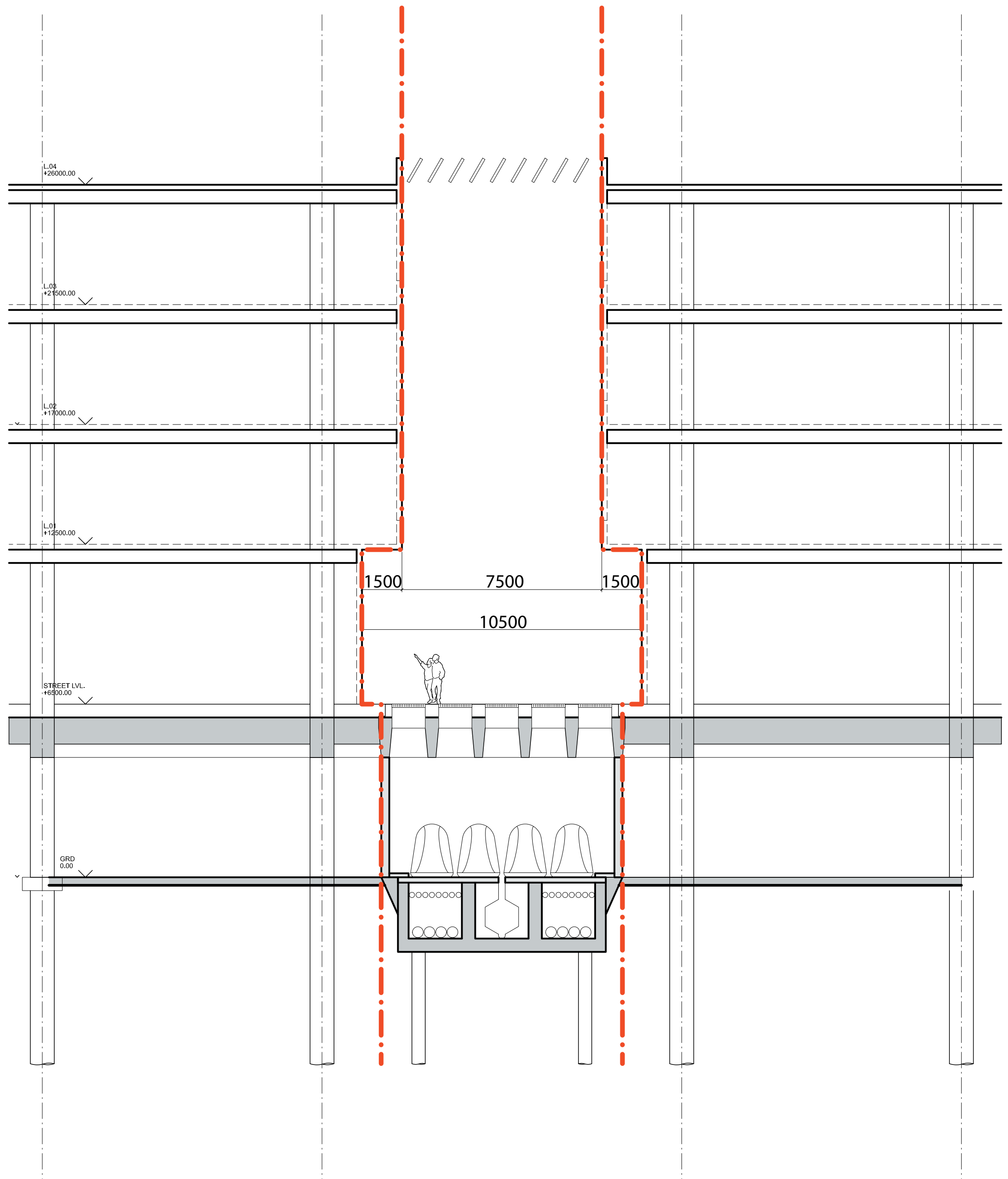
RESIDENTIAL WITH NORMAL LOADING STRUCTURE



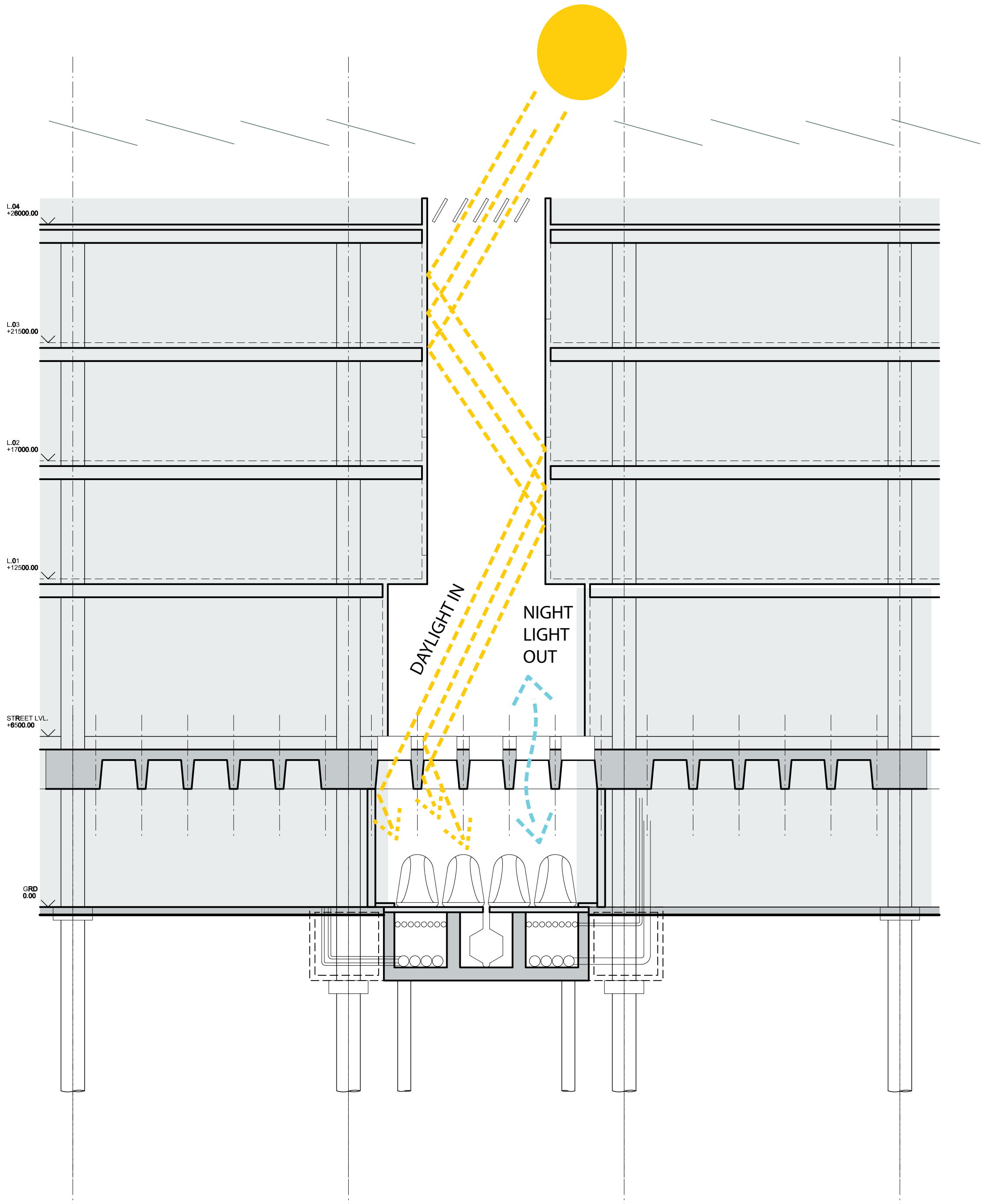
FUTURE OFFICE SPACE EXPANSION (SAME LOADING REQUIREMENTS AS RESIDENTIAL)



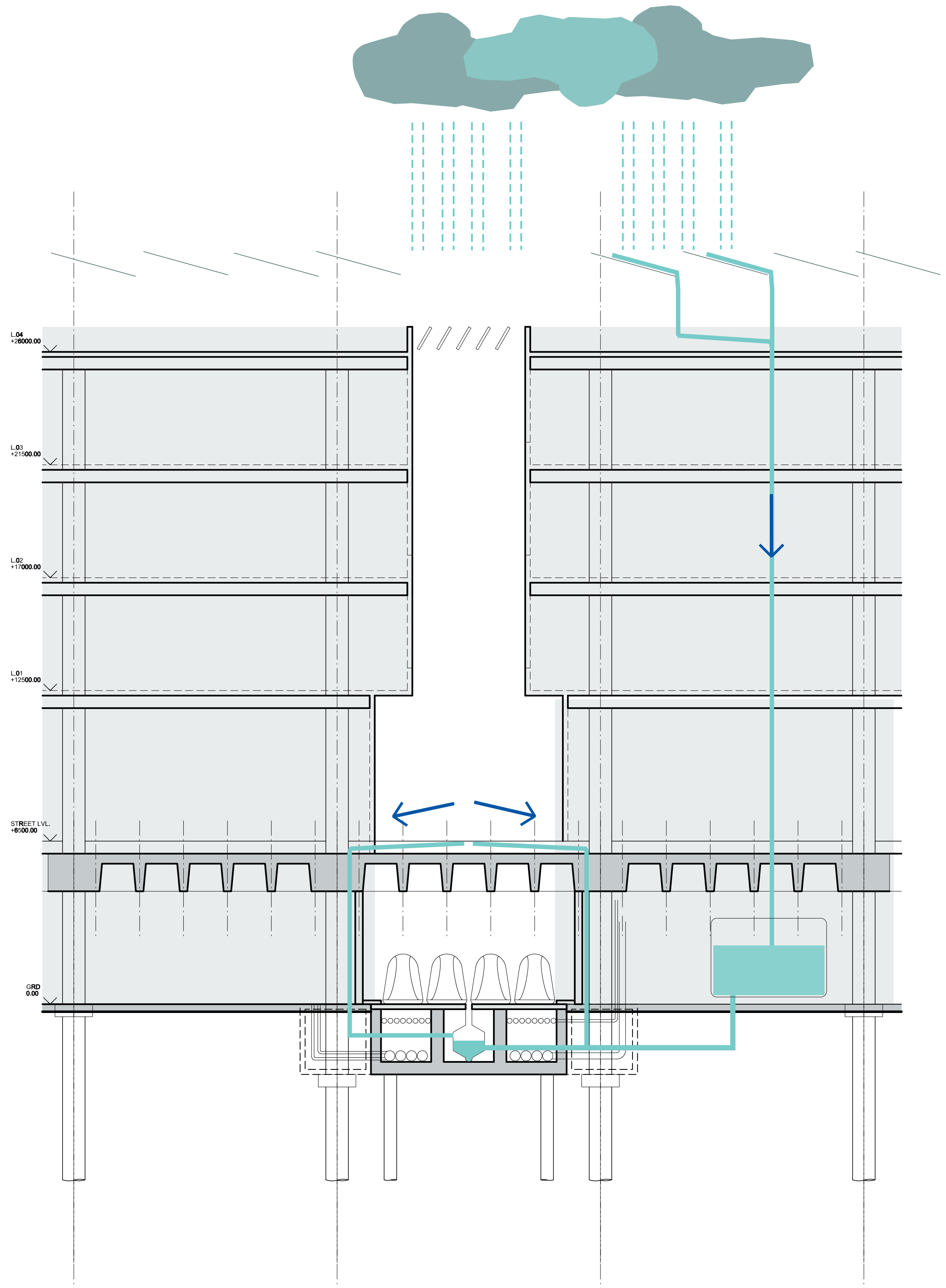
Legal Condition 7m Wide Street



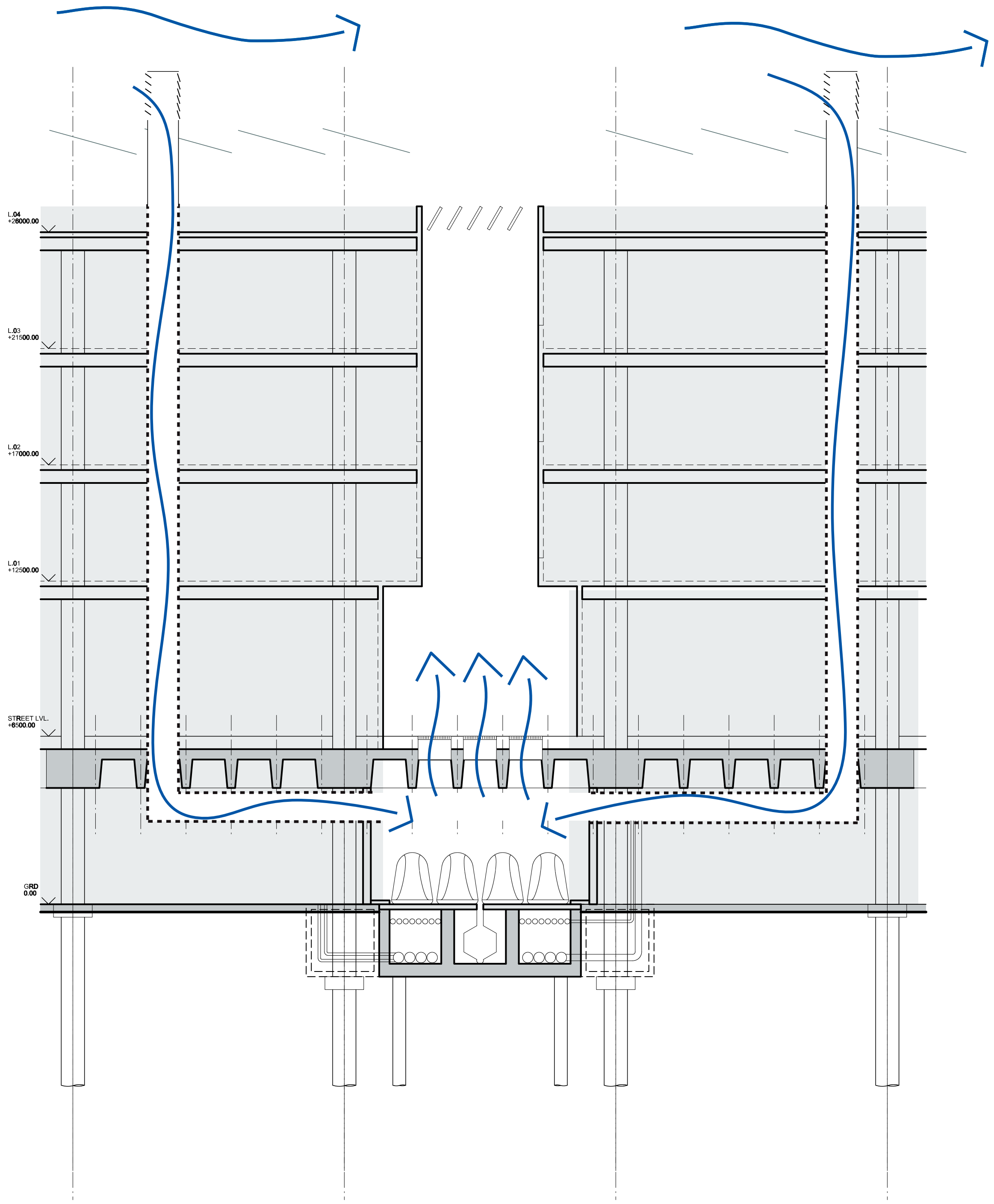
Legal Condition 10m Wide Street



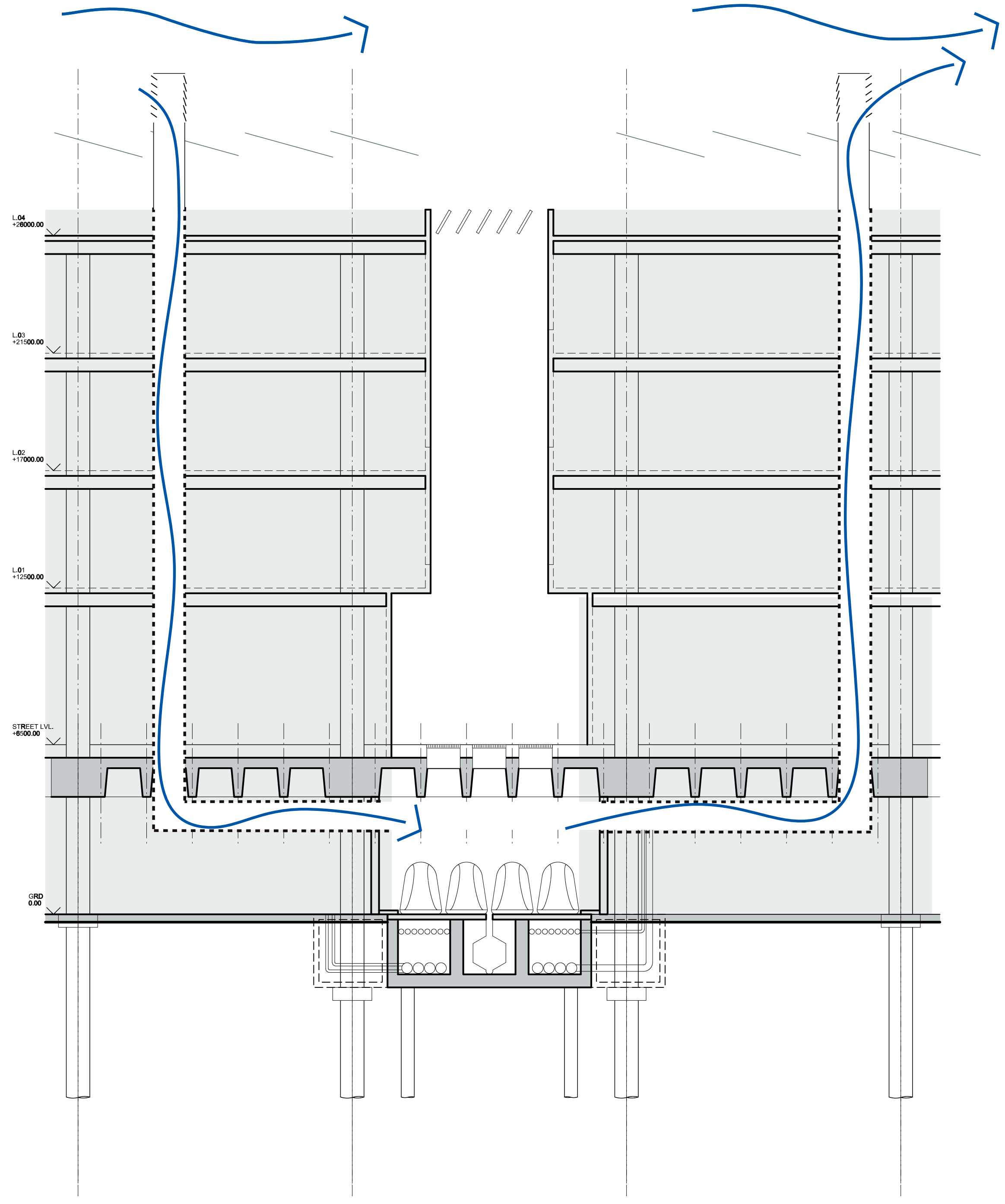
Light



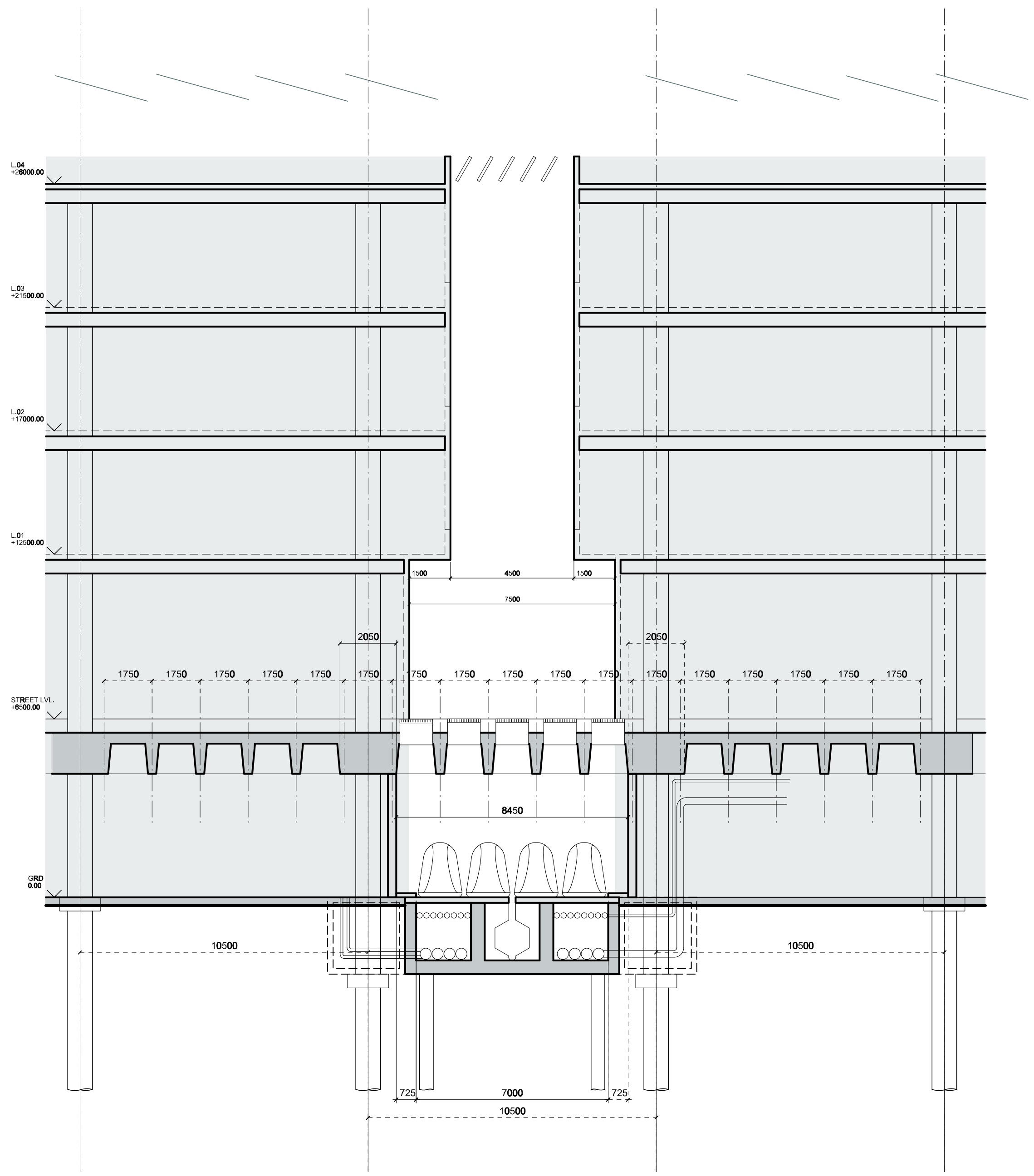
Drainage



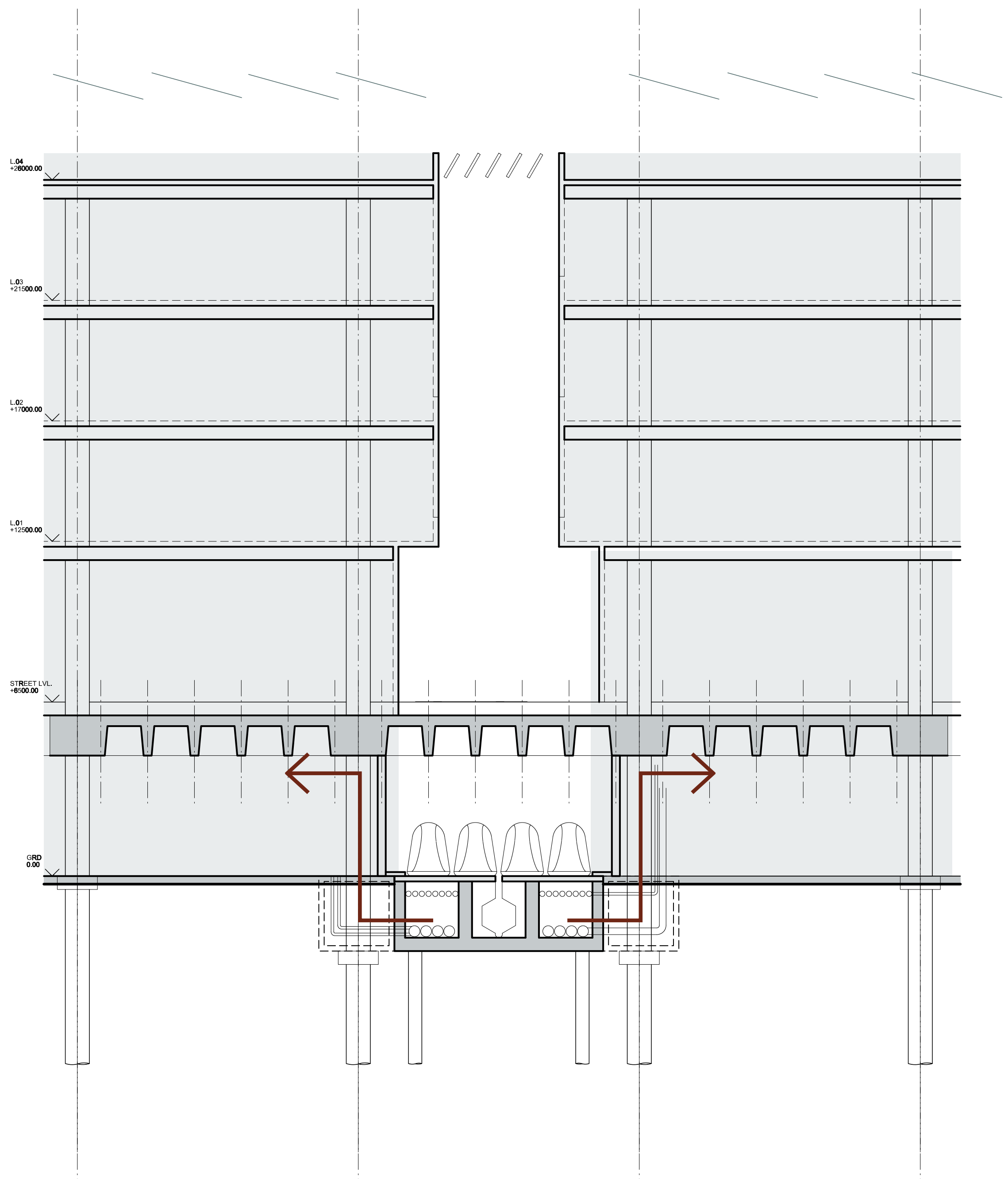
Ventilation Option 1



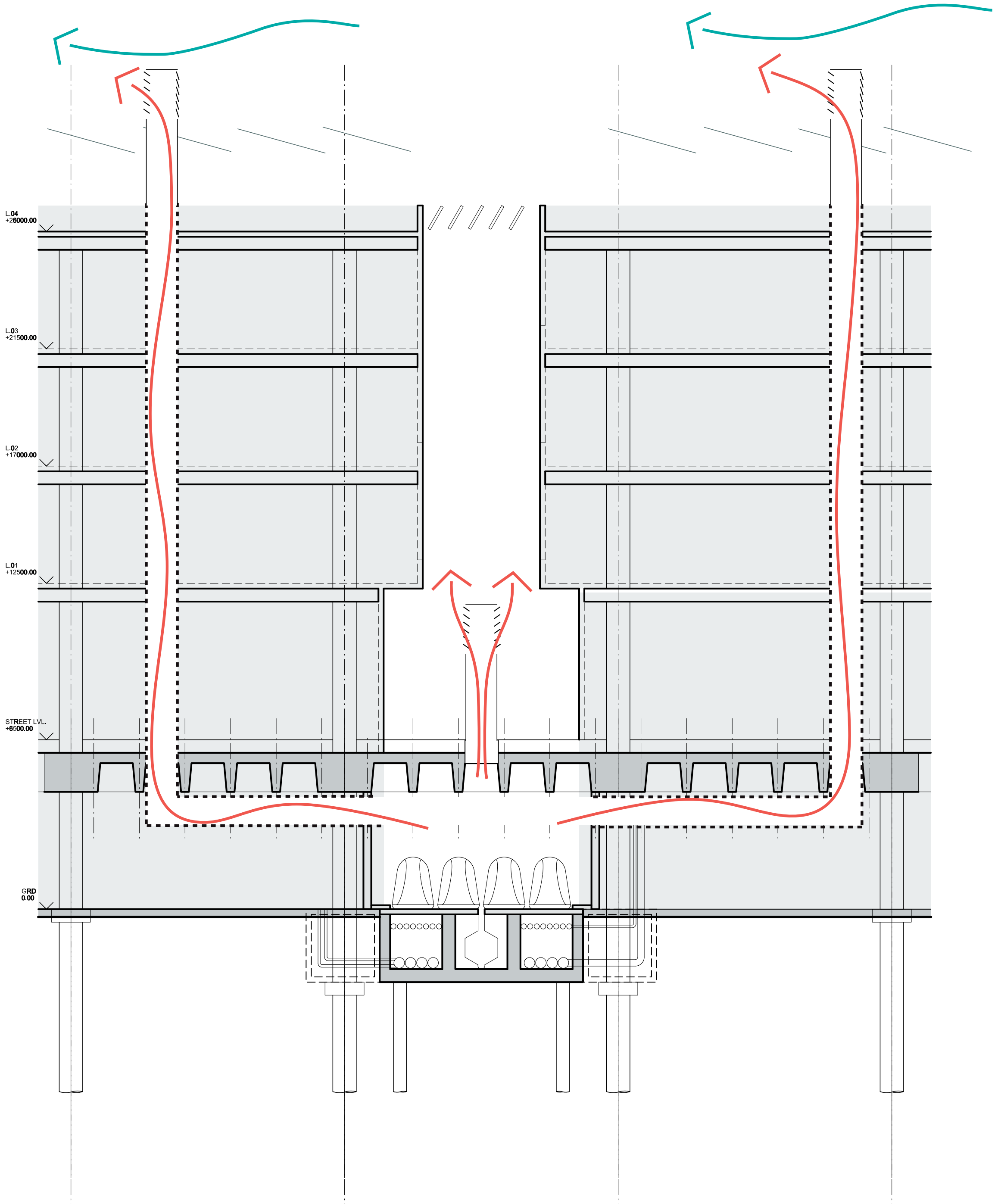
Ventilation Option 2



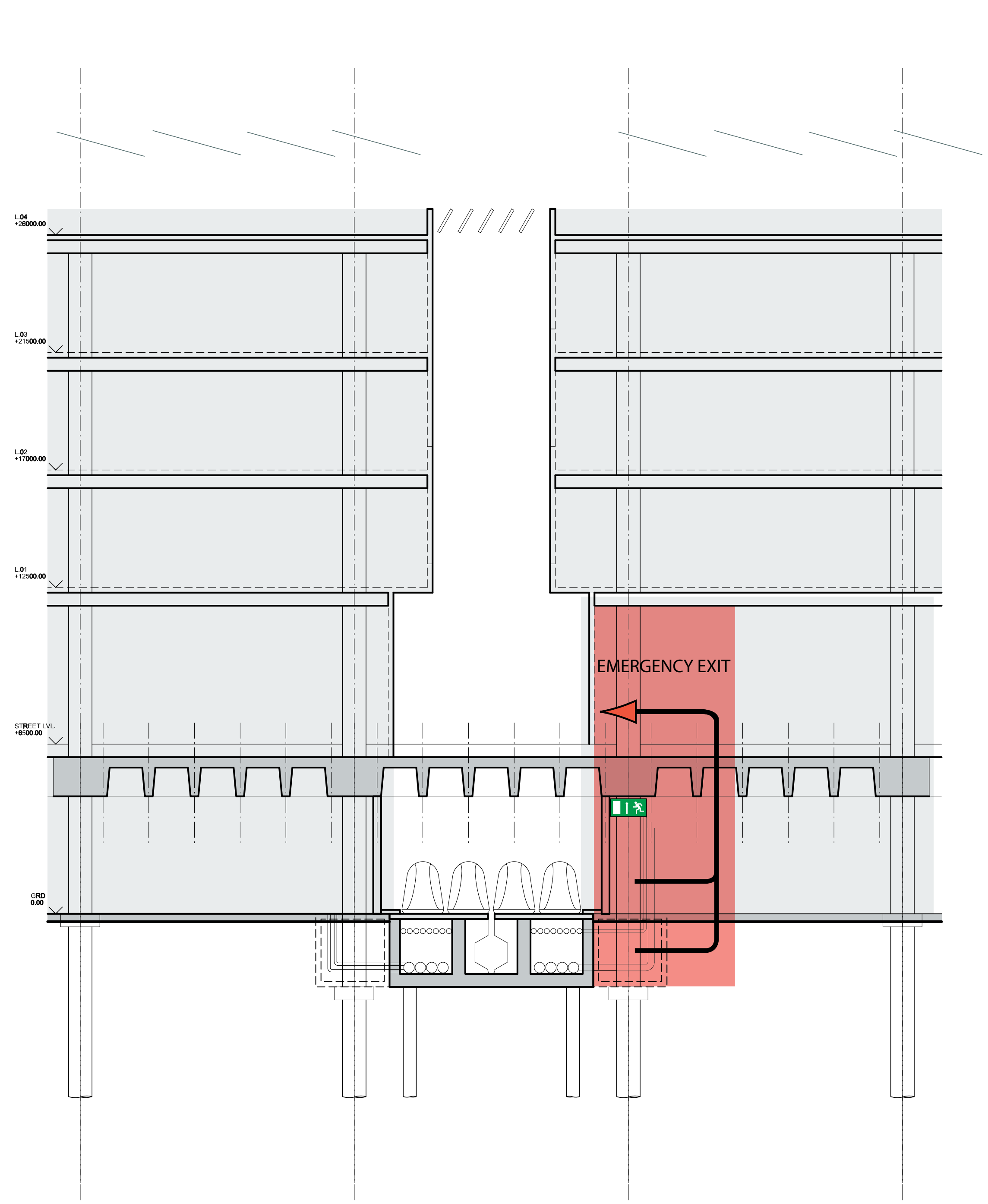
Dimensions



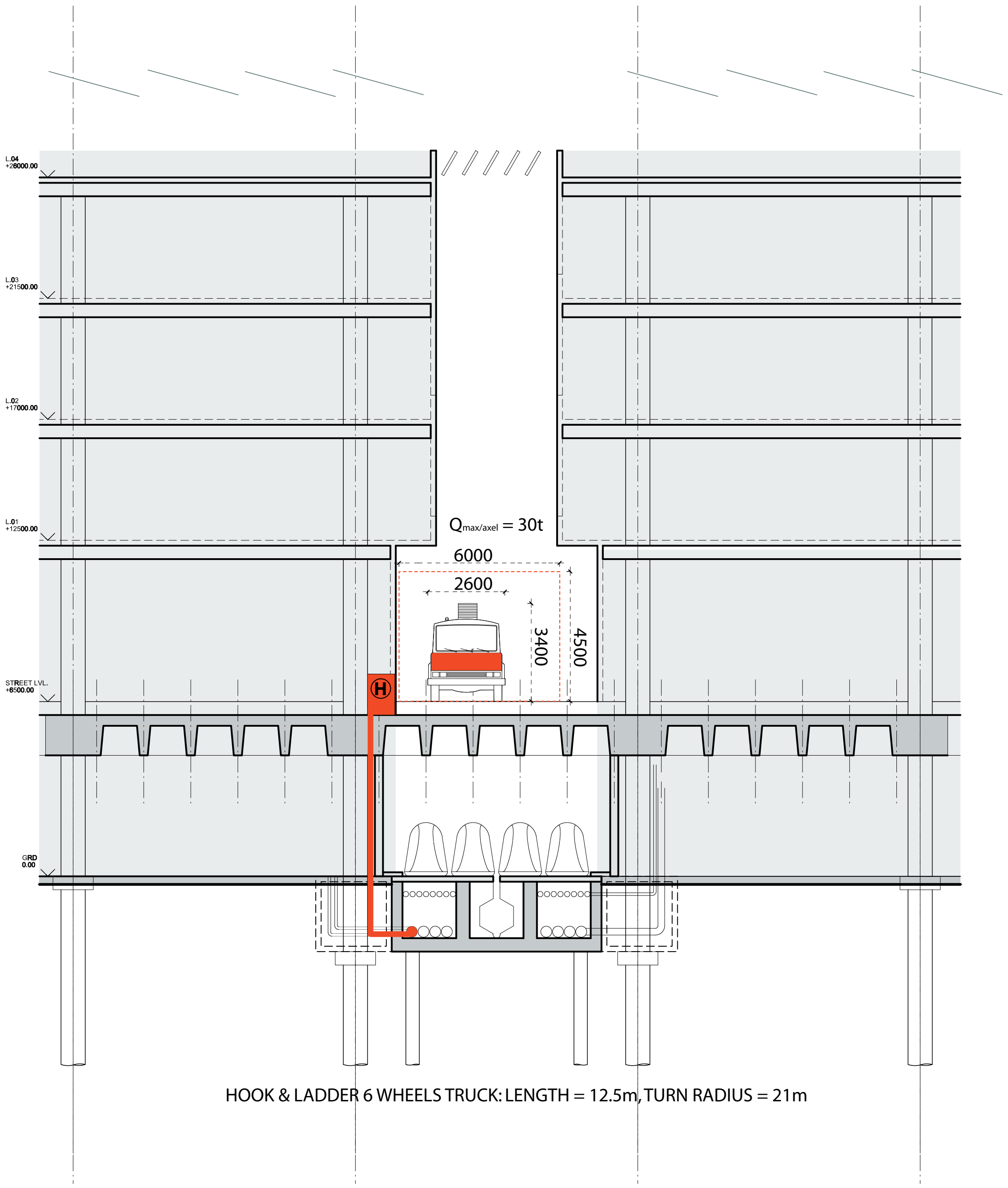
Servicing for Buildings



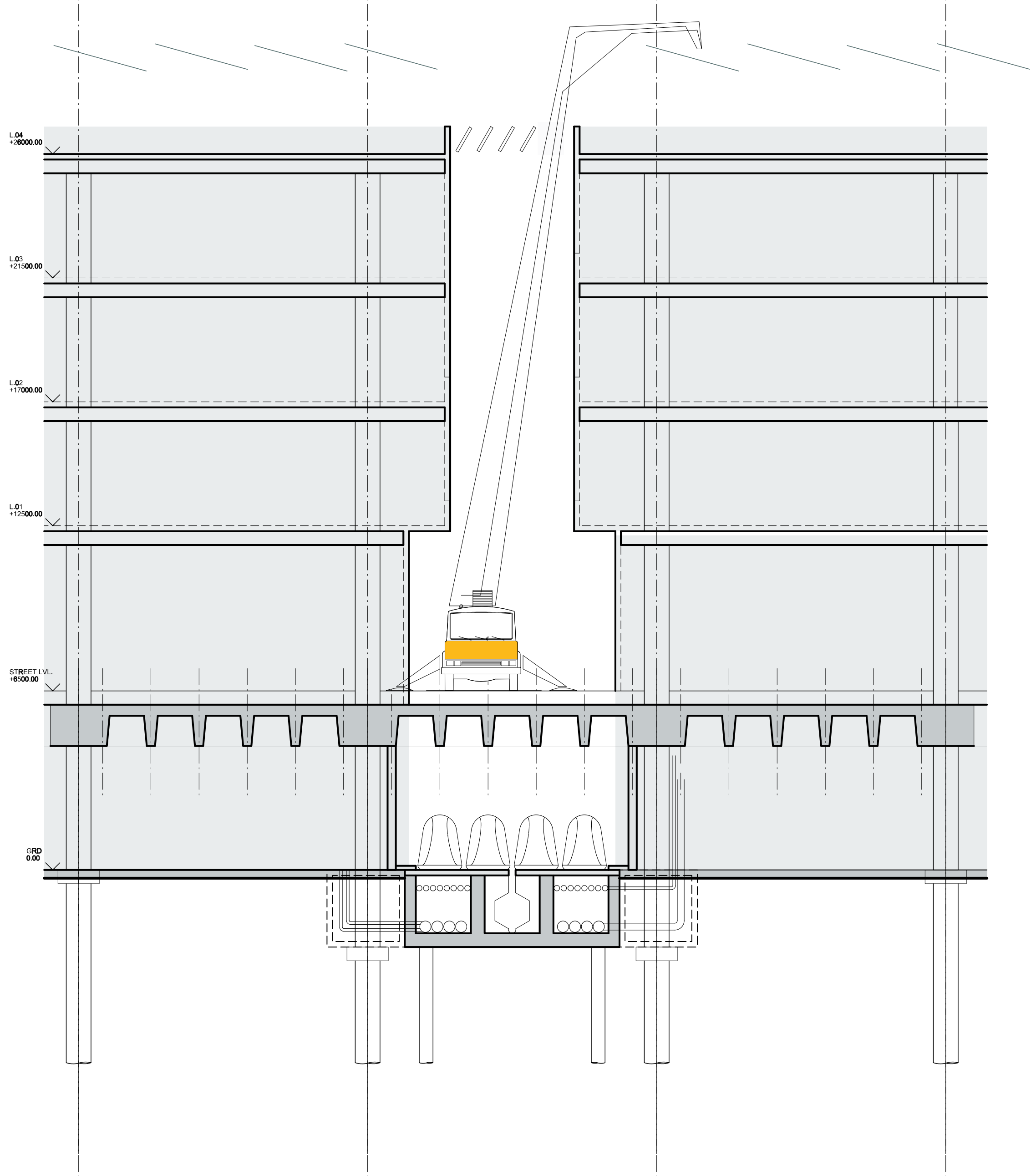
Smoke Extract / Exhaust Strategy



Emergency Exit



Point Loads - Fire Engine



Point Loads - Cranes

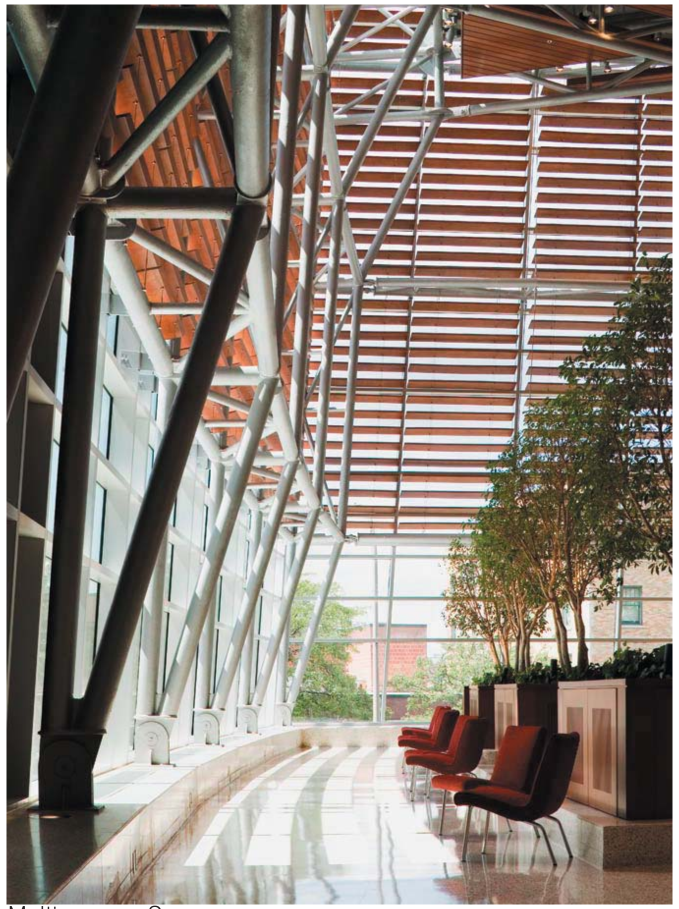
7

Client’s Brief Requirements

Clean Room	TOTAL	500 sqm
	Phase 1A 2009	80 sqm
	Phase 1B 2011	80 sqm
	Phase 2 2014 - future	340 sqm
Large Classroom	TOTAL	500 sqm
	Phase 1A 2009	500 sqm
Library	TOTAL	1200 sqm
	Phase 1A 2009	1200 sqm
Multipurpose Hall	TOTAL	1200 sqm
	Phase 2 2014	1200 sqm
Sport Hall	TOTAL	2400 sqm
	Phase 1A 2009	300 sqm
	Phase 1B 2011	1023 sqm
	Phase 2 2014	1077 sqm
Mosque	TOTAL	1350 sqm
	Phase 2 2014	1350 sqm


Clean Room

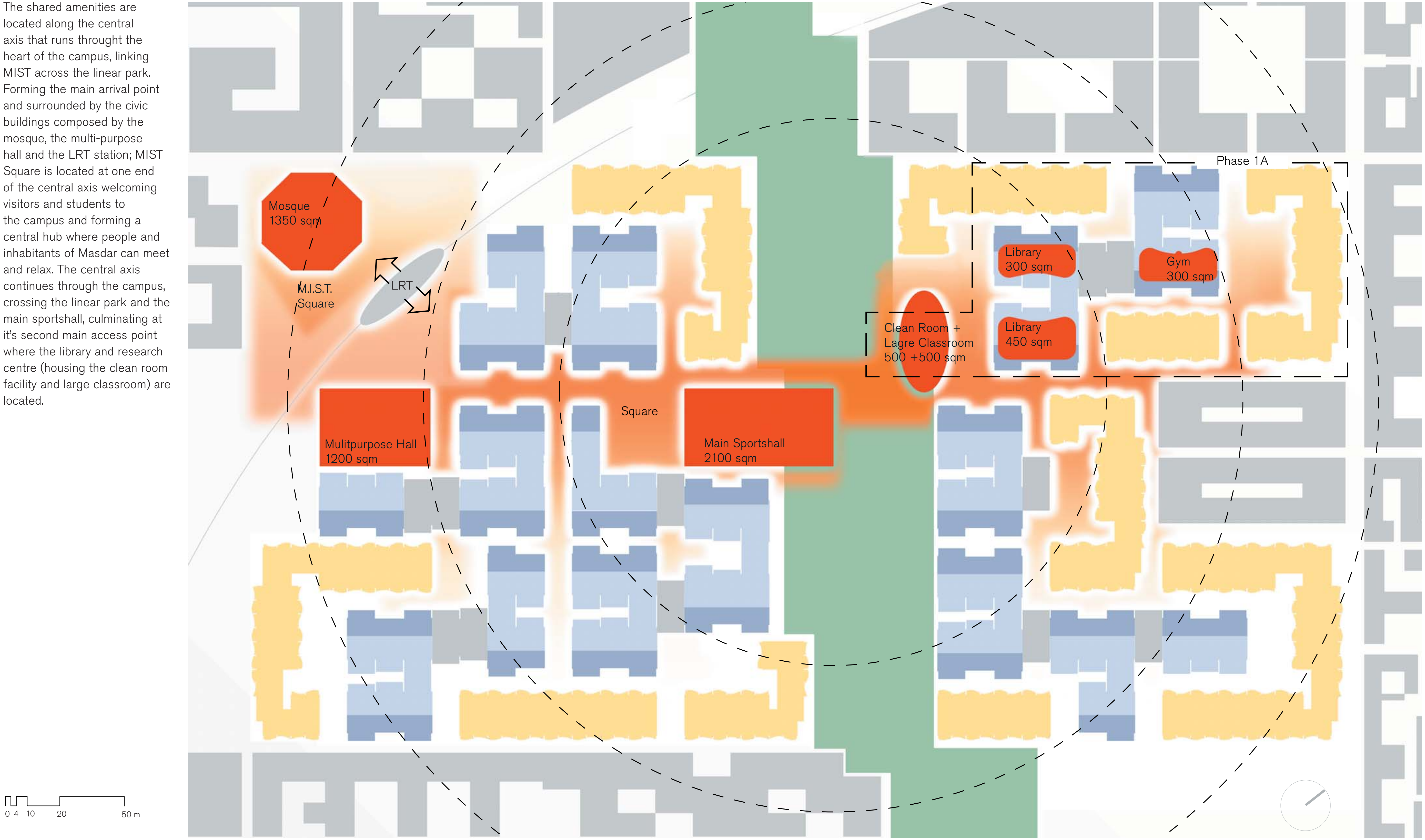

Large Classroom


Multipurpose Space


Sport Hall

Shared Amenities
Location Plan Overall

The shared amenities are located along the central axis that runs throught the heart of the campus, linking MIST across the linear park. Forming the main arrival point and surrounded by the civic buildings composed by the mosque, the multi-purpose hall and the LRT station; MIST Square is located at one end of the central axis welcoming visitors and students to the campus and forming a central hub where people and inhabitants of Masdar can meet and relax. The central axis continues through the campus, crossing the linear park and the main sportshall, culminating at it's second main access point where the library and research centre (housing the clean room facility and large classroom) are located.



Shared Amenities

Location Plan Phase 1A

1. Large classroom area: 360 sqm
2. Total Library area: 200 sqm

Clean room area: 1050 sqm

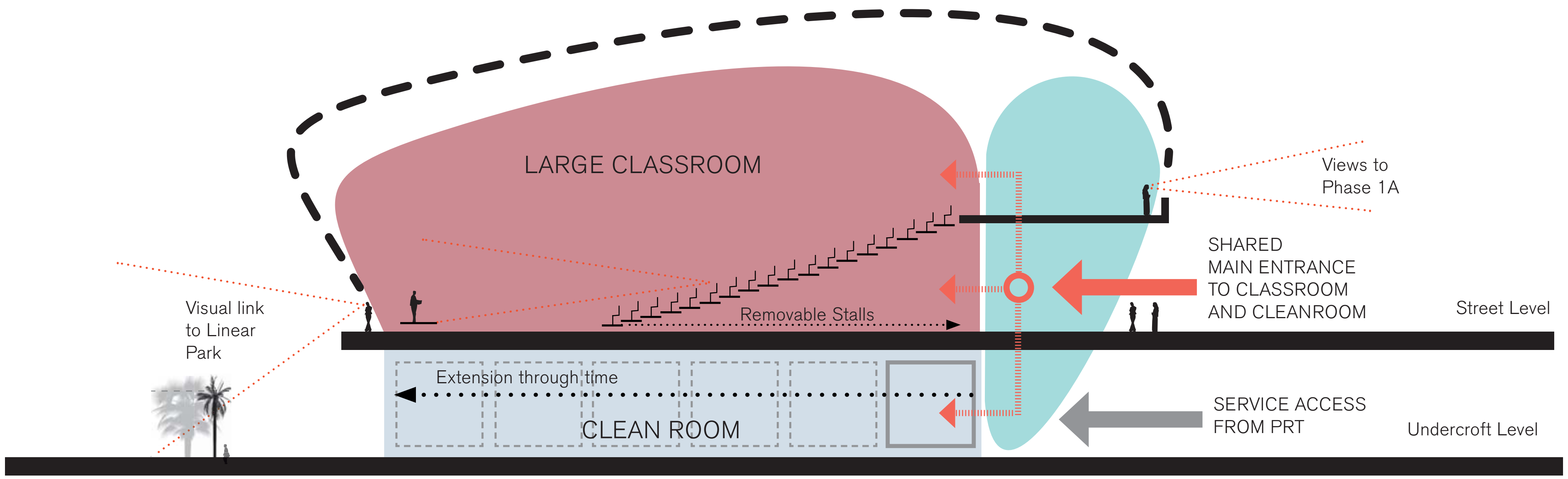
Shared area: 570 sqm

Shared Amenities

Clean Room + Large Classroom

Concept

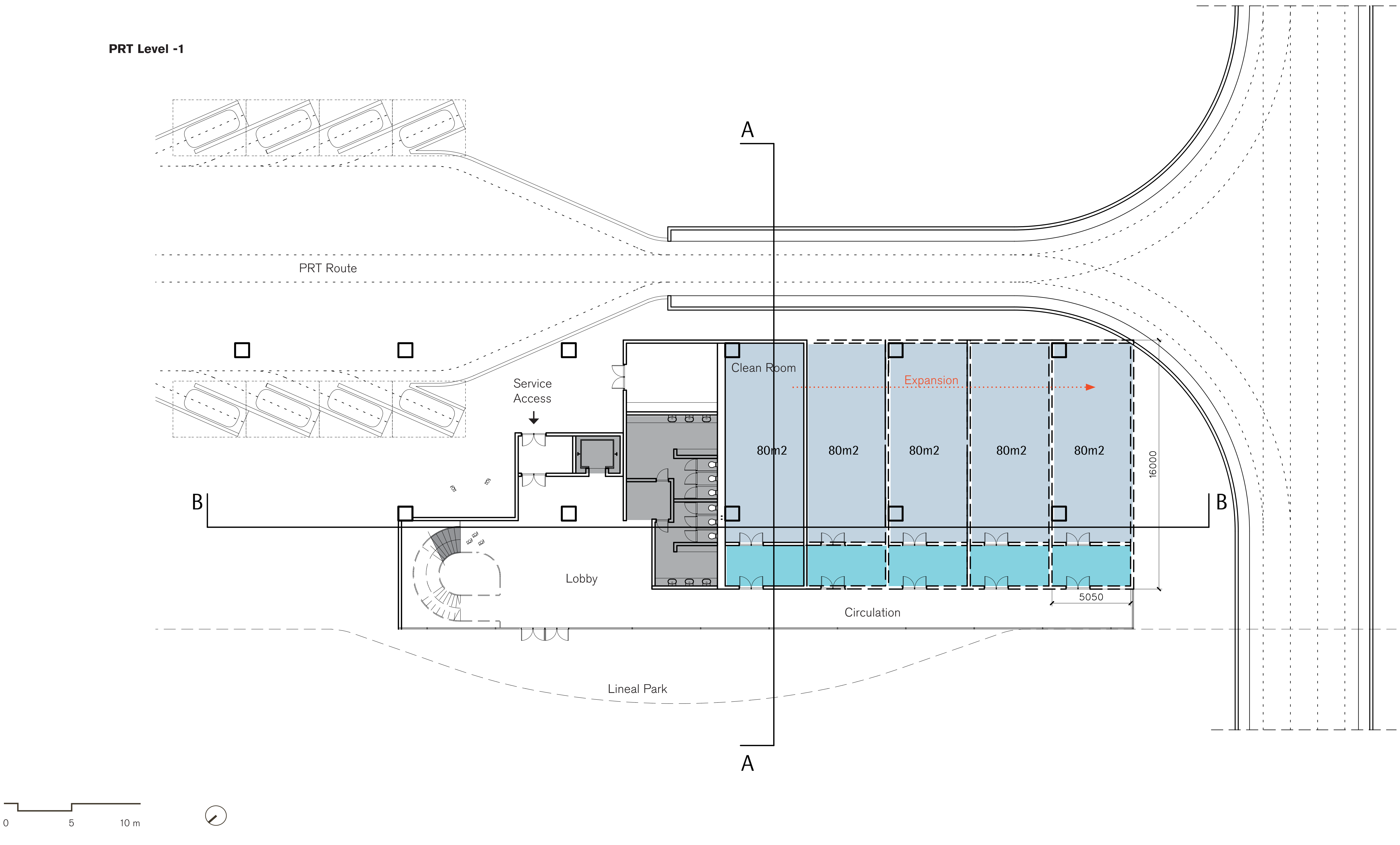
- The Building is centrally located adjacent to the linear park as it is intendeted to be shared by the whole campus. It therefore benefits from visual links to the linear park
- It is our intent tha the large classroom and the clean room assumed an iconic building form on phase 1A
- The clean room and the large classroom share entrance lobby, service access from the PRT and toilet faciolities
- The clean Room is located in the underground level avoiding vibrations and the structural problems caused by the heavy machinery intalled
- The clean room can be extended in a flexible way
- In order to maximize flexibility, we propose that the large classroom's stalls were removable and therefore could be use as a multipurpose space for phase 1A



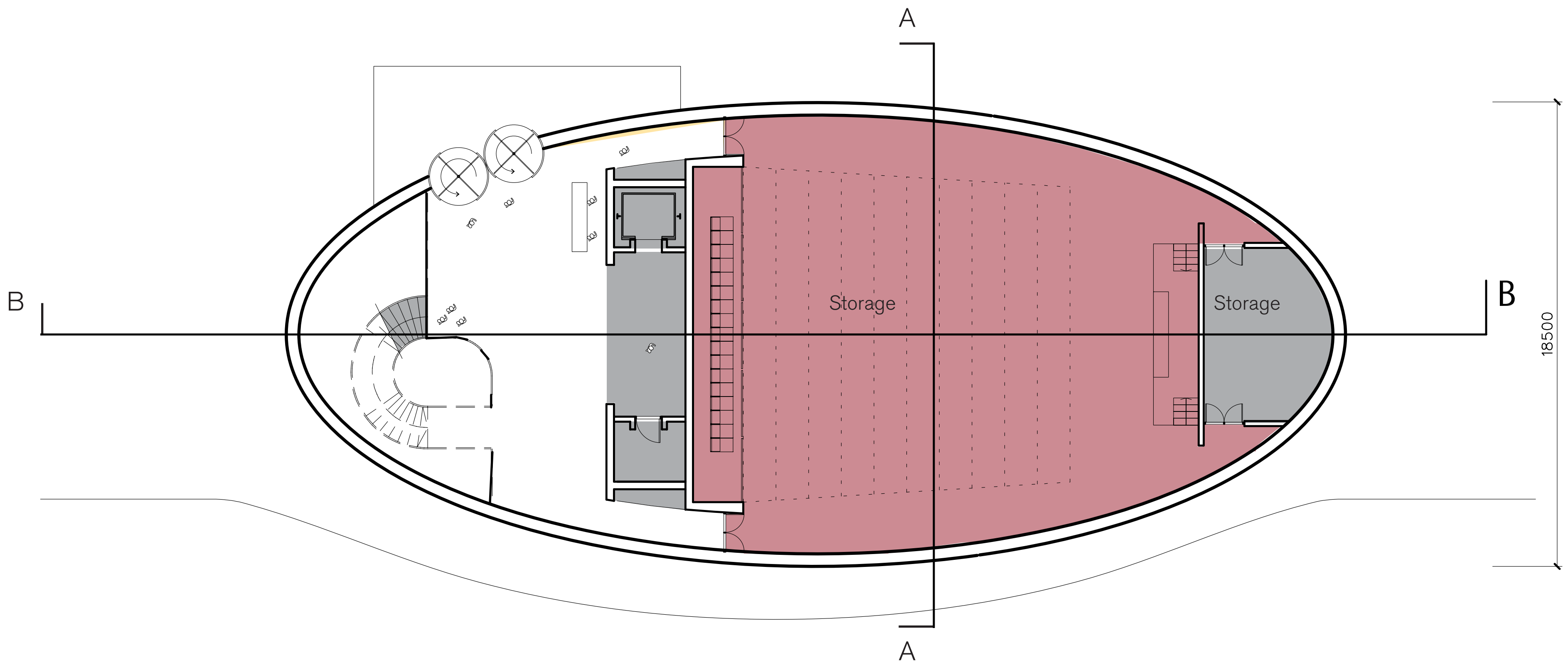
Schematic Section Diagram

Shared Amenities

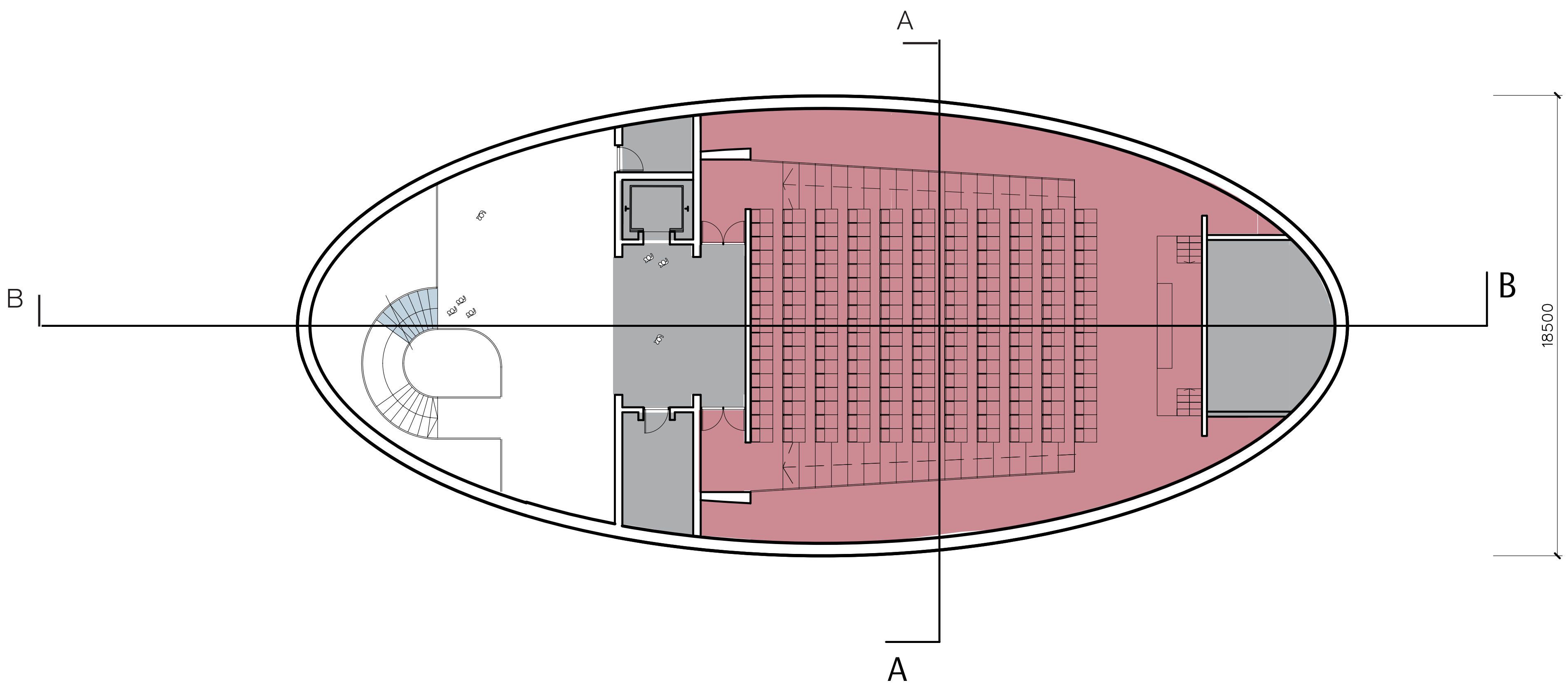
Clean Room + Large Classroom



Street Plan

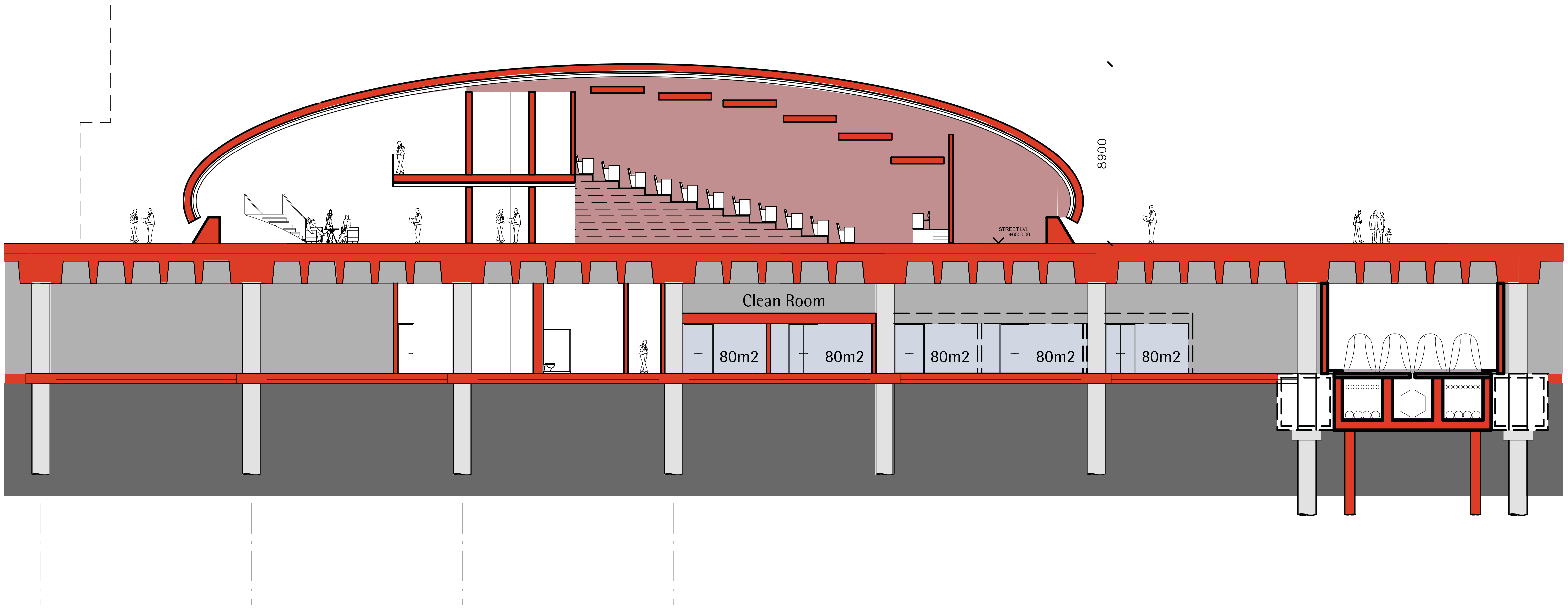


Plan Level 1



Shared Amenities
Clean Room + Large Classroom

Section AA

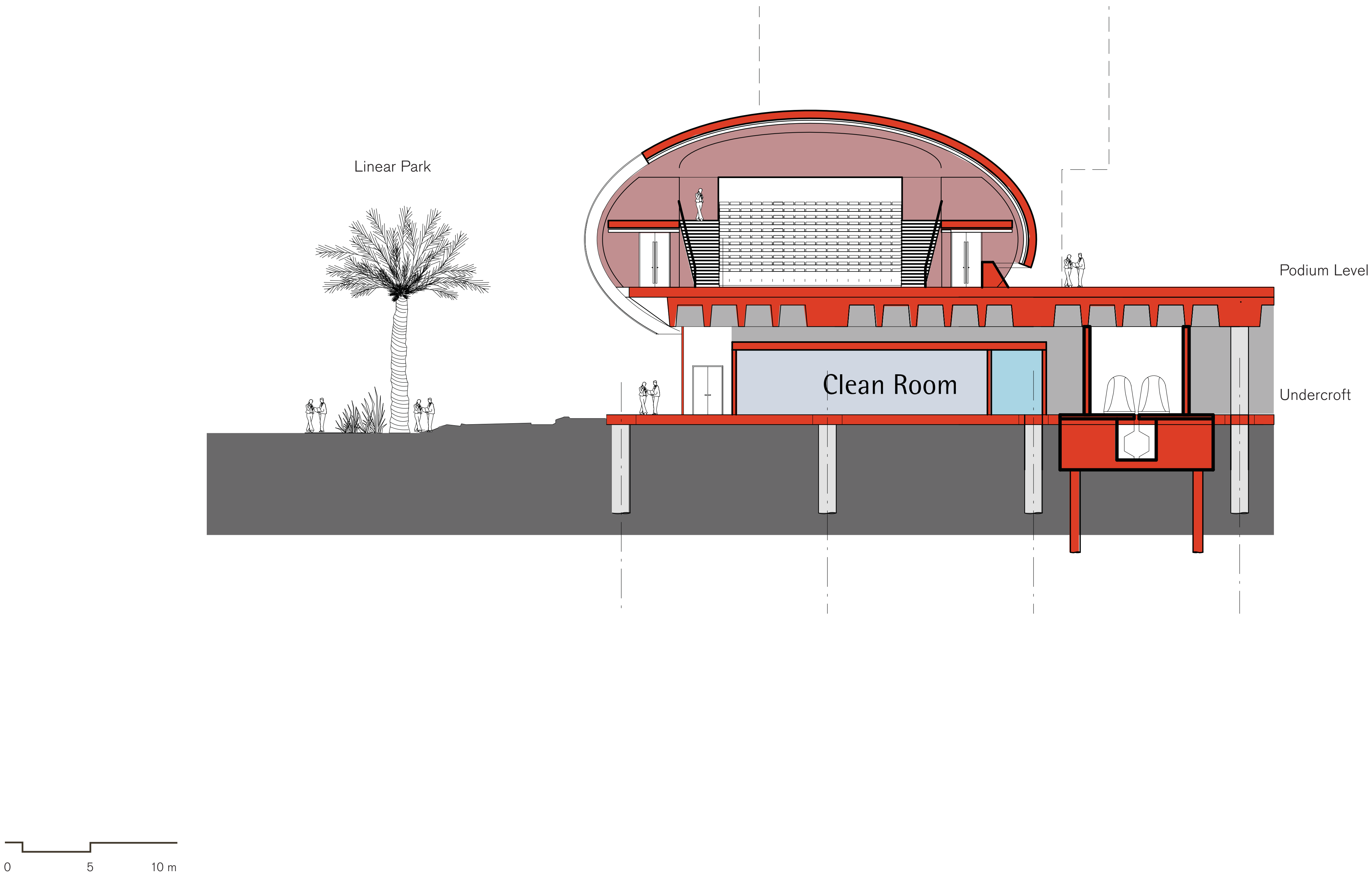


0 5 10 m

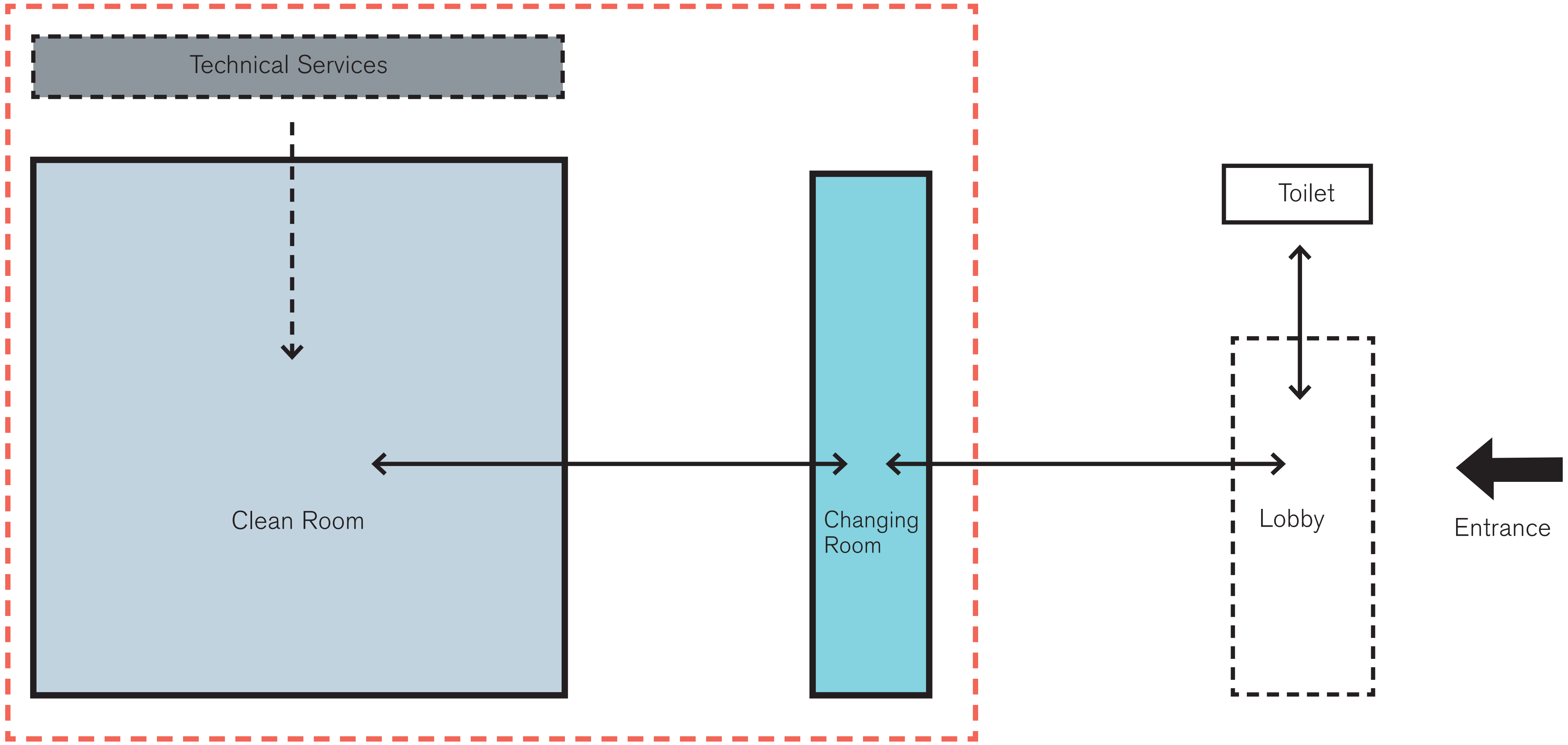
Shared Amenities

Clean Room + Large Classroom

Section BB



Basic Schematic layout



Module of 80 sqm

Clean Zone **Preparation Area** **Pre-Cleaning Area**

Class Criteria

SI	ISO 14644-1	ROOM CLASS	Maximum allowable count per cubic foot of air.				
			0.1p	0.2p	0.3p	0.5p	5p
	Class 1						
M1	Class 2	0					
M1.5	Class 3	1	35	7.5	3	1	
M2.5	Class 4	10	350	75	30	10	
M3.5	Class 5	100		750	300	100	
M4.5	Class 6	1,000				1000	7
M5.5	Class 7	10,000				10000	70
M6.5	Class 8	100,000				100000	700

ISO 14644-1 (per cubic meter)
Fed Std. 209 E USA (per cubic foot)
ISO standard requires results to be shown in cubic meters (1 cubic meter = 35.314 cubic feet)

CRITERIA	CLASS 10 M2.5 ISO 4	CLASS 100 M3.5 ISO 5	CLASS 1,000 M4.5 ISO 6	CLASS 10,000 M5.5 ISO 7	CLASS 100,000 M5.5 ISO 8
Air Changes Per Hr / Min	Per Hour/Per Minute 500-600/8-10	300 To 480 5 To 8	180/3	60/1	30/.5
Filter Coverage %	90 to 100	50 to 70	20 to 30	7 to 15	4 to 5
CFM Per Square Foot	85 to 90	36 to 65	18 to 32	9 to 16	4 to 8
Filter Efficiency	99.9997 (5-9s ULPAs)	99.997 (4-9s HEPAs)	99.997 (4-9s HEPAs)	99.997 (4-9s HEPAs)	99.97 (3-9s HEPAs)
Type of Ceiling	2" Aluminum Painted Grid	2" Aluminum Painted Grid	2" Aluminum Painted Grid	1 1/2" T-Bar Conventional	1 1/2" T-Bar Conventional
Light Fixture Type	Tear Drop or Flow Thru	Tear Drop or 2'x4' C/R Fixture	2' X 4' Cleanroom Fixture	2' X 4' Cleanroom Fixture	2' X 4' STD Fixture Field Sealed
Ceiling Panels	FRP or Epoxy Painted	FRP, Vinylrock or Mylar	Vinylrock or Mylar	Vinylrock or Mylar	Vinylrock or Mylar
Wall System	Modular	Modular	Modular	Modular or Drywall	Modular or Drywall
Floor Covering	Heat Weld Vinyl or Poured Epoxy	Heat Welded Sheet Vinyl	Solvent Welded Sheet Vinyl	Sheet Vinyl or VCT	Sheet Vinyl or VCT
Flooring Base	2" to 6' Cove	Cove or Aluminum Base Channel	Cove or Aluminum Base Channel	Cove or Aluminum Base Channel	Cove or Aluminum Base Channel
Air Returns	Raised Floor or Center Returns	Low Wall on Long Axis	Low Wall at Perimeter	Low Wall	Low Wall or Ceiling

Landscaping

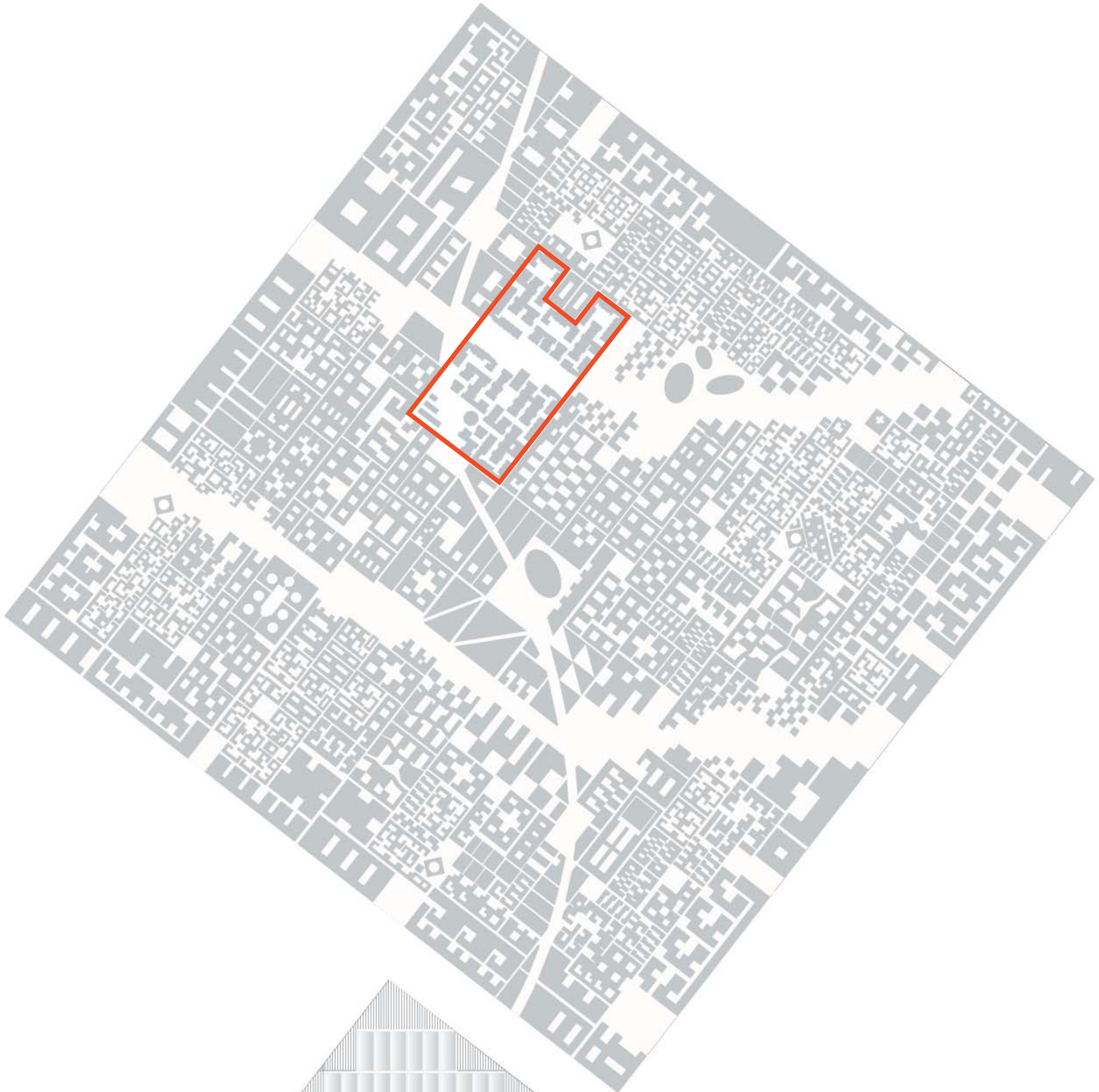
8

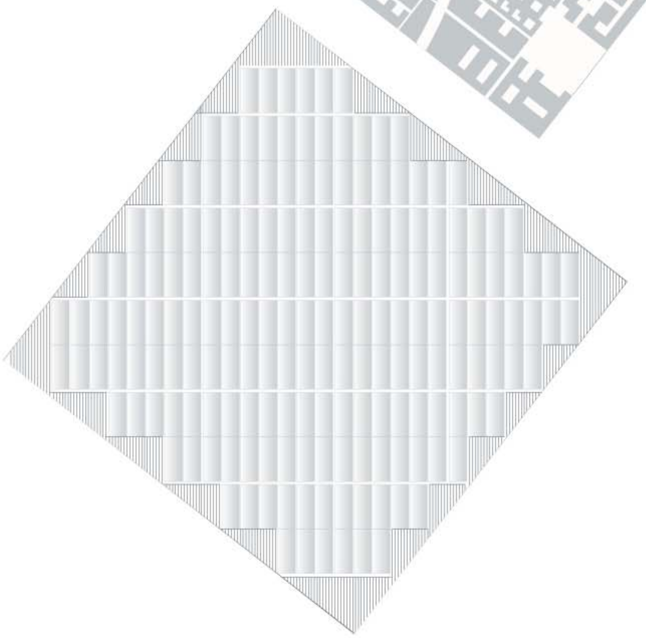
Introduction
This chapter summarises the key landscaping decisions of the Masdar masterplan as set out by Foster + Partners in partnership with Gustafson Porter. Locked deep within the urban grain of the city, the campus is dissected by one of the two linear parks, which run through the city providing a vital break to the high-density, low-rise mix of the masterplan and help ventilate the various districts and suburbs. These pages address the campus both within a citywide context as well as the more enclosed environments of the streets and squares, establishing some of the parameters to consider.

Location Masdar Development

Masdar's development site of 640 hectares supports sustainable planning considerations in terms its strategic location adjacent to the principal urban and regional transport infrastructure of Abu Dhabi. It is located between the principal access roads, Airport Road and Abu Dhabi-Dubai Road, linking Abu Dhabi to the airport and to Dubai beyond. Further, its immediate adjacency to the international airport gives the Masdar development significant potential to become a strategic and emblematic gateway into Abu Dhabi. As such, the Masdar development has the capacity to be the first and parting emblem of Abu Dhabi's sustainable development and environmentally sensitive socio-economic growth.

It's proximity to the airport is also a vital link in attracting world partners. Within the global community ease of access for businesses, visiting specialists, and guest lecturers alike ensure the Masdar development is tied in with the expanding economy. It would be a mistake to outpost this centre of research. It's success relies upon being embraced within the centre of the new developments as a living example of a successful zero carbon community.





N

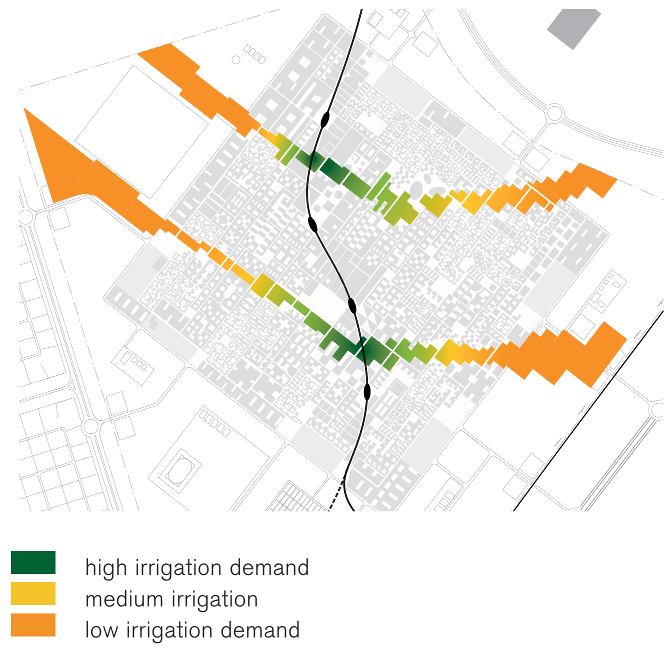
aerial view of Abu Dhabi and Dubai

aerial view of the site and Abu Dhabi Airport

Landscaping
Green Focal Point

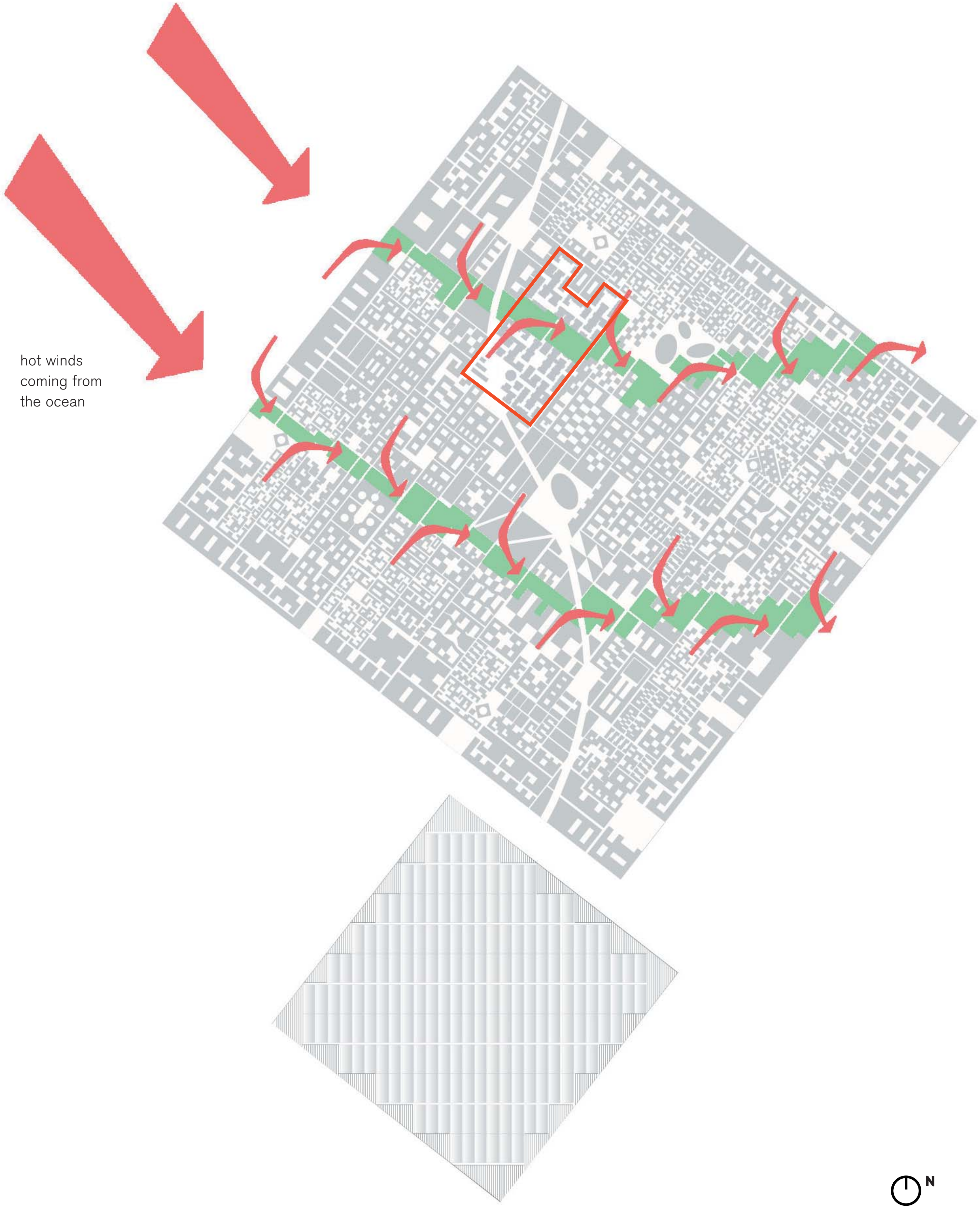
Linear Park

- continous coherent open space running from city centre to site boundary
- gradiation of lushly planted green space with use of both indigenous and mediterranean plants in the urban centre to more drought tolerant indigenous species outside the centre (mediterranean to arid)
- softer more naturalistic planting than urban squares and gardens
- continous linear water feature with stone floor within city centre such as rille, channel, chadar and fountains
- shade structures such as planted pergola and mature shade trees
- responds functionally to surrounding land use
- high level walkways connect to surrouding buidling entries
- proportion of soft to hard landscape: 50:50
- high quality materials throughout such as stone paving, stainless steel balustrades/ hadrails

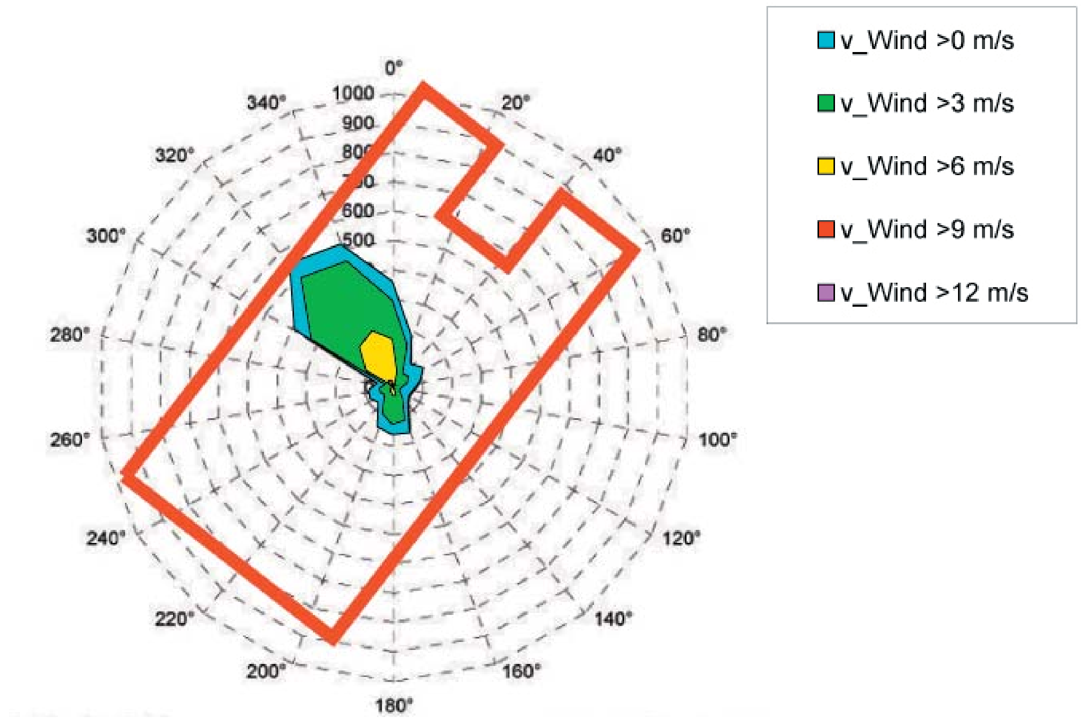


Landscaping

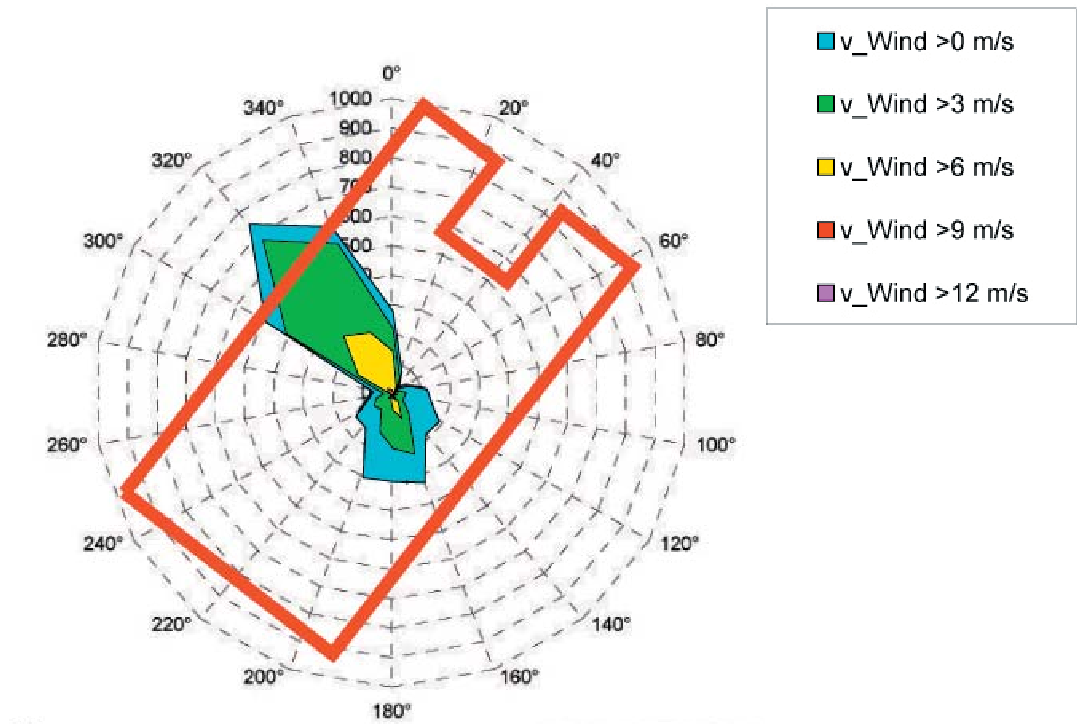
Site Constraints - Hot Wind



Hot Winds

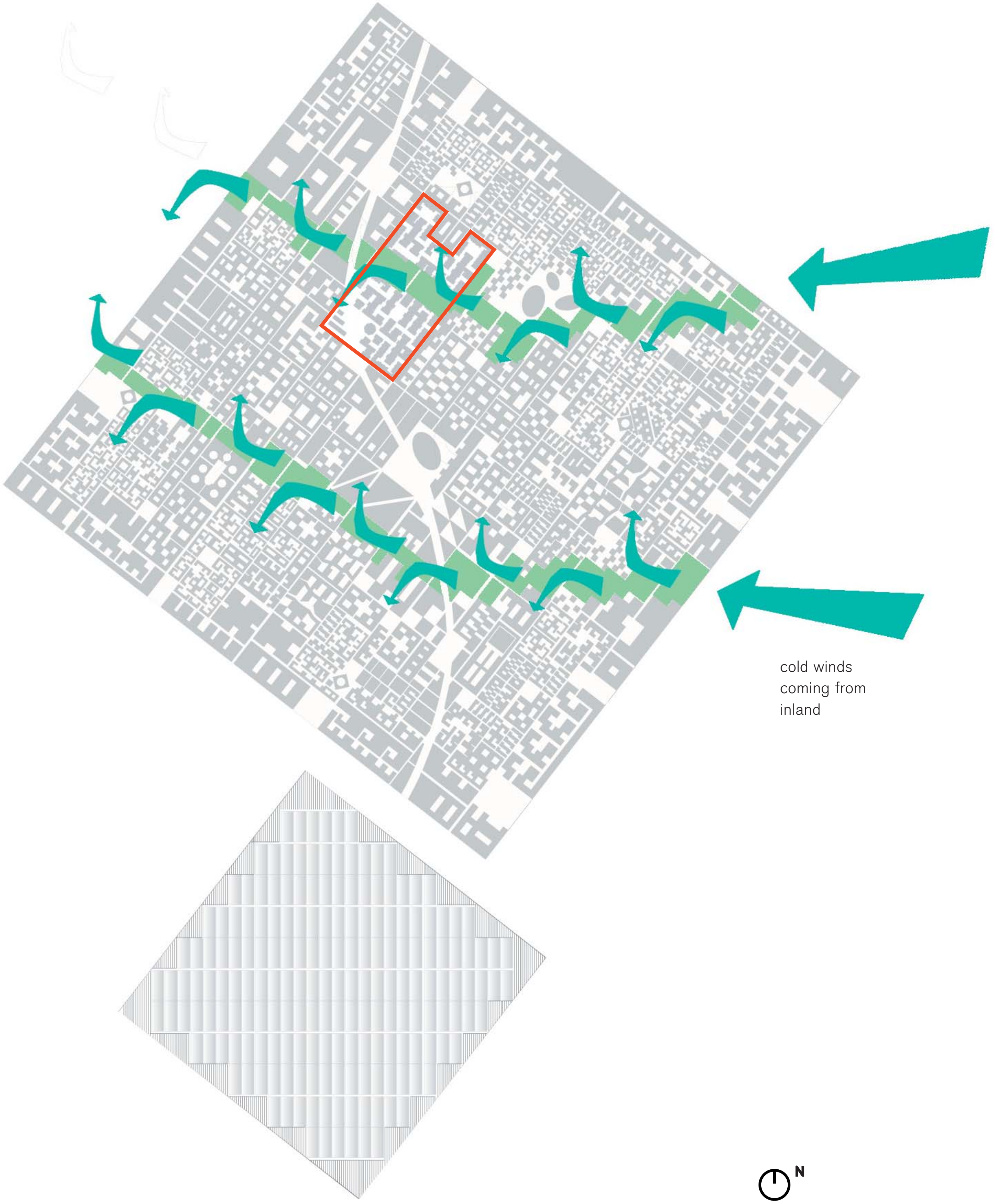


Winds at Daytime

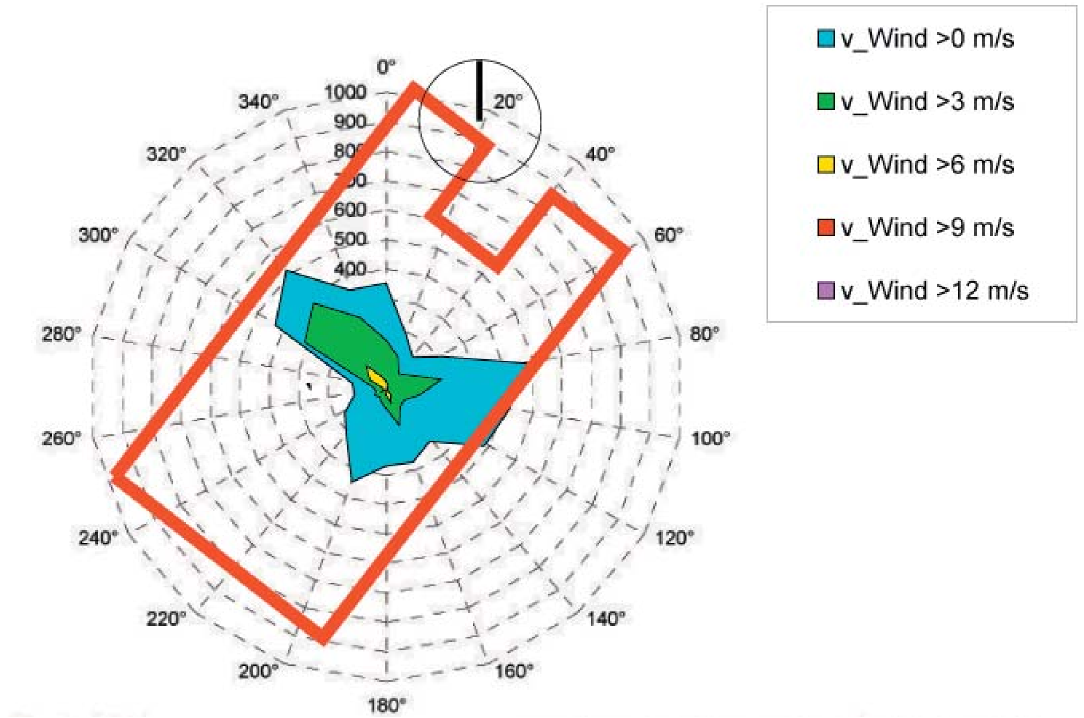


Landscaping

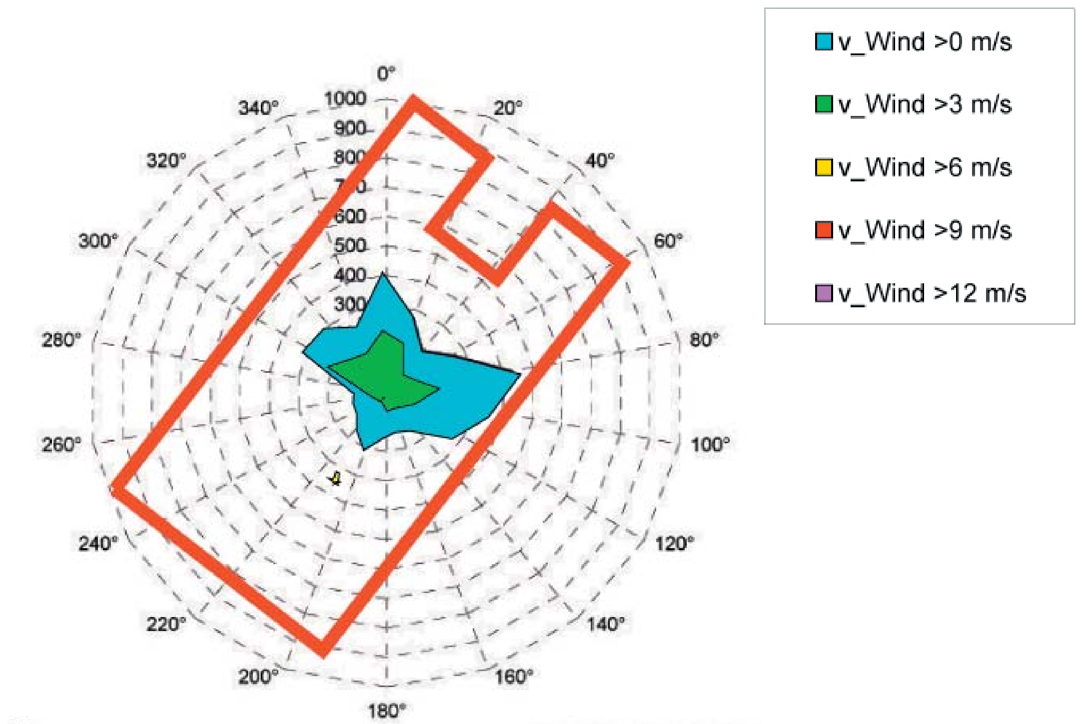
Site Constraints - Cold Wind



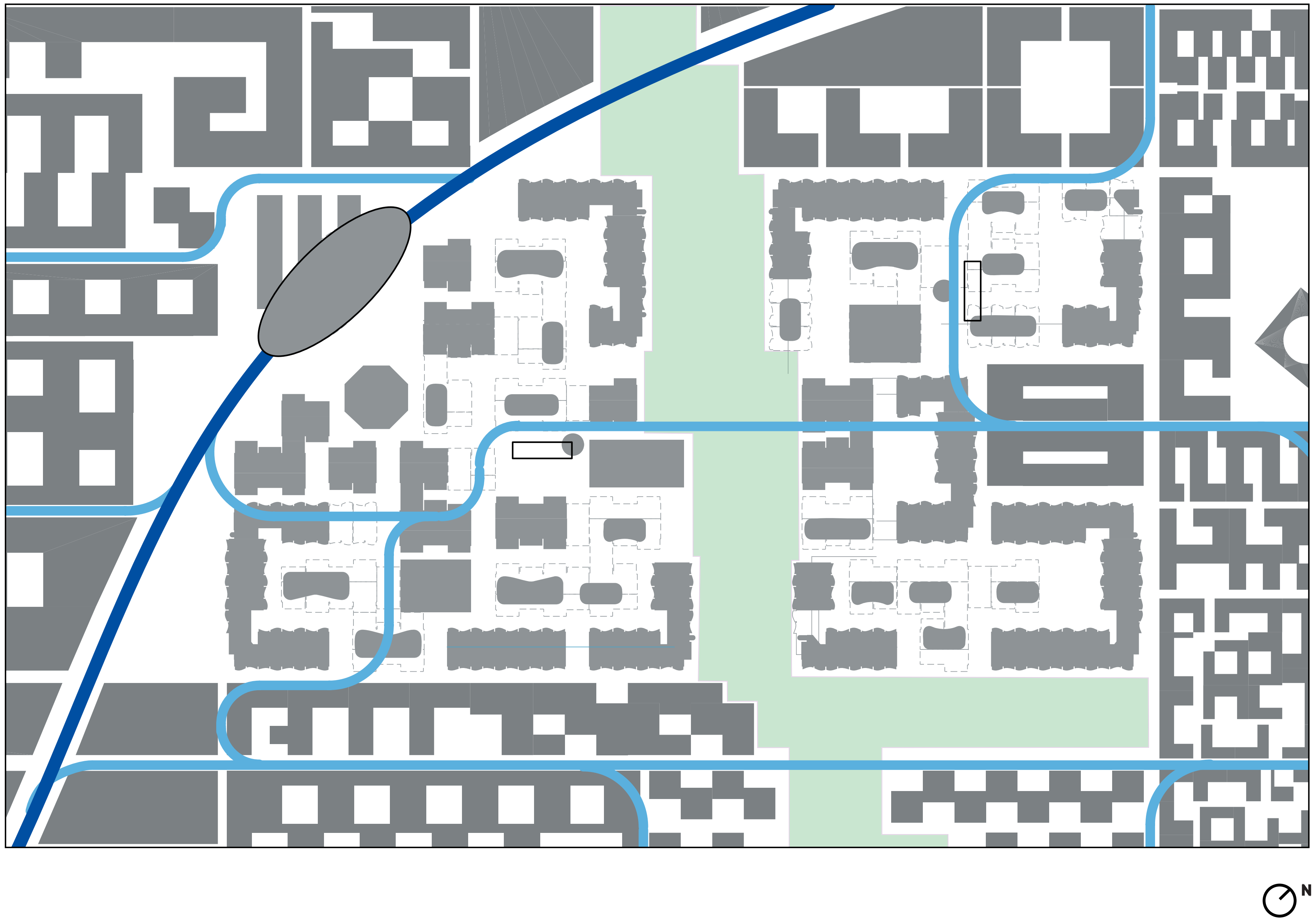
Cold Winds



Winds at Nighttime



Landscaping
LRT and PRT Routes

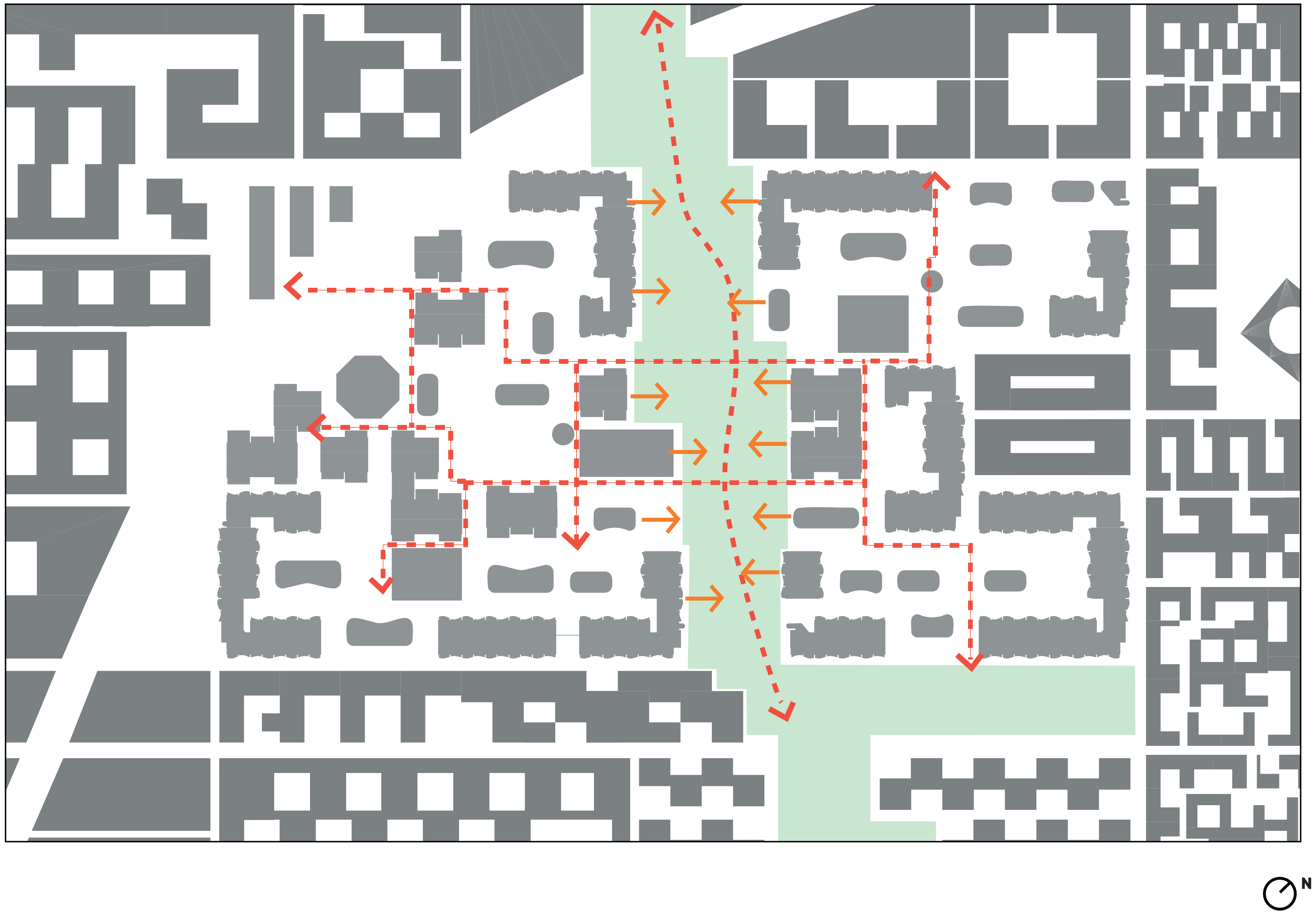


LRT spine
PRT network
LRT Station
PRT Station

0 5 10 20m

Landscaping

Pedestrian Routes



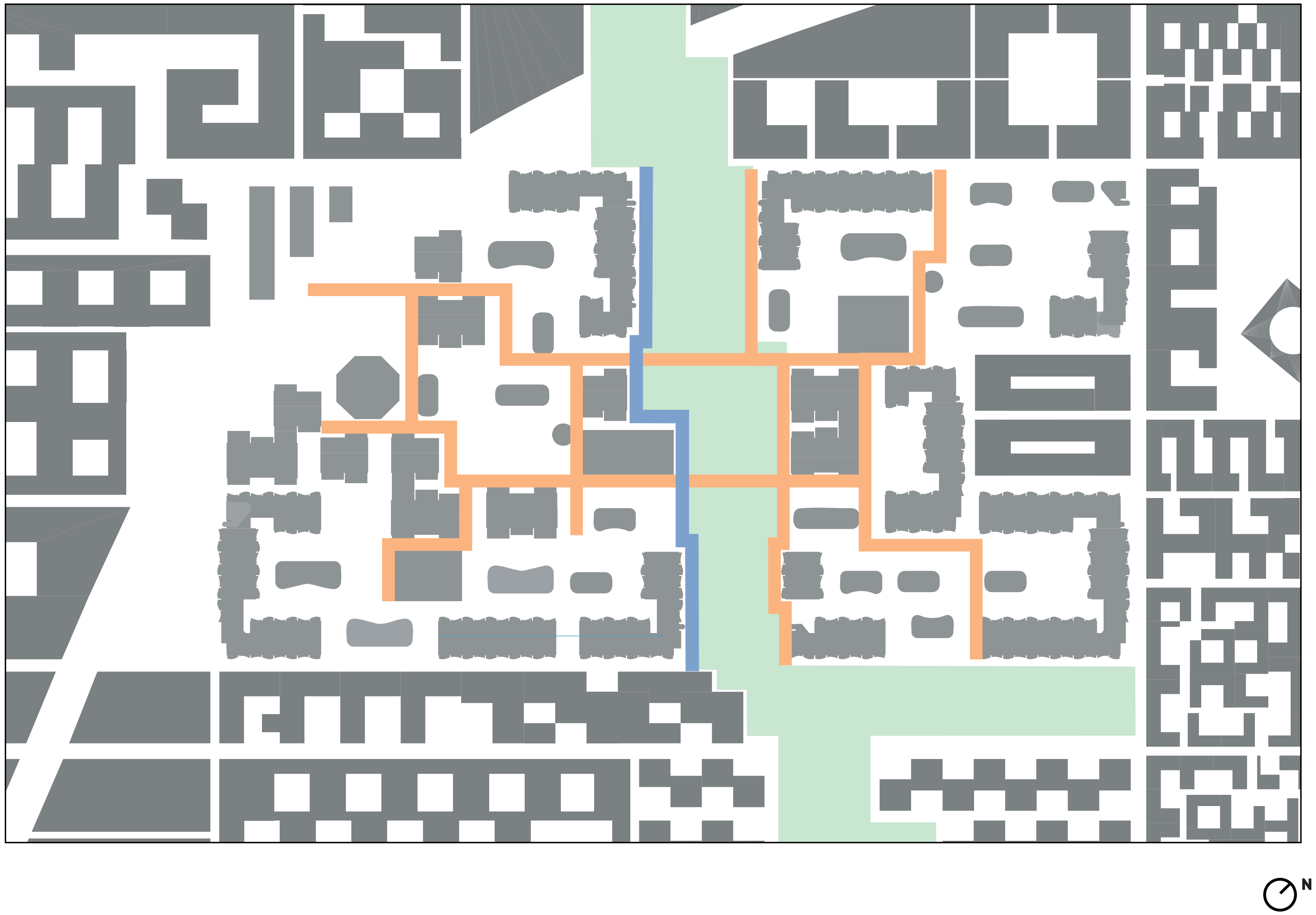
primary pedestrian network

secondary pedestrian network, public front of buildings

linear park landscaping

0 5 10 20m

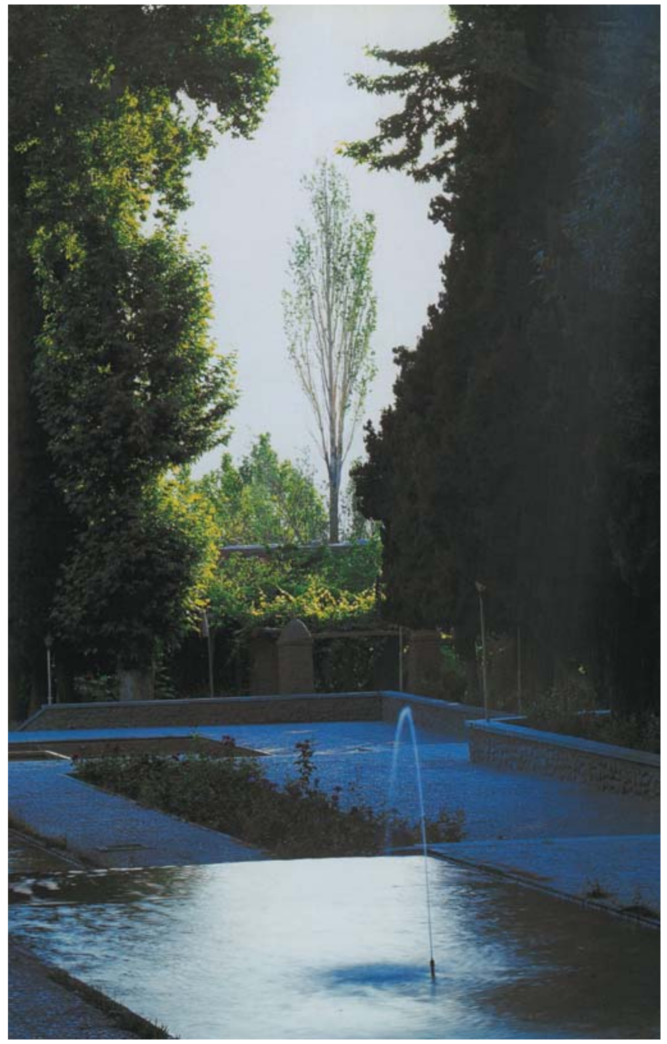
Landscaping
Walkways and Streets



pedestrian covered
walkway connection
high quality paving
uncovered paved walkway
linear park landscaping

0 5 10 20m

Landscaping
Sun + Sunpath / Shadow



linear park/ landscaping

area of most intensive shadowing

0 5 10 20m

Landscaping
Squares and Gardens

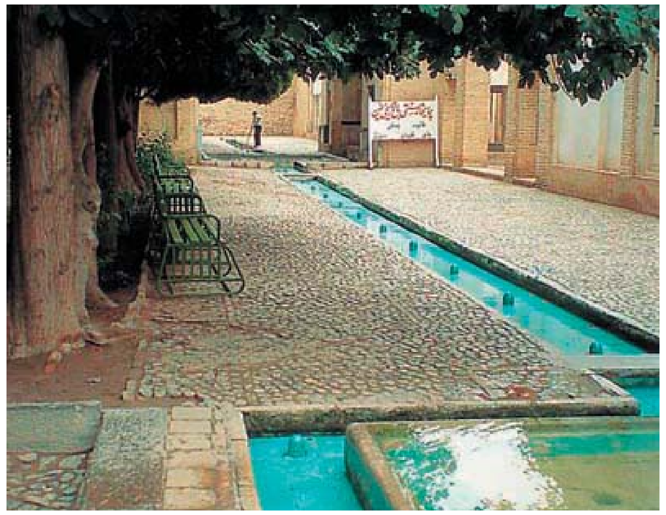
Squares
- predominantly hard spaces with mature shade trees and shade structures
-clibming gardens in form of vertical green on building facade and pergola structure
- able to accomodate local events
- water feature such as shallow rille and chadar, thin sheets of water over the stone floor and fountains set within the paving
- proportion of soft to hard landscape 20:80%

Gardens
- green spaces with use of both indigenous and mediterranean plants to create an impression of an urban 'Paradise Garden'
- more formal in layout and planting than linear park
- water features such as shallow rille, chadar and fountains
- proportion of soft to hard landscape 60:40%

Both:
- running of water feature to be co-ordinated with usage pattern of square (i.e. potential for peak time use only)
- scrim (thin sheet of water over hard paving) only during evening hours to minimize evaporation losses; can be used to cool down surfaces in the evening as part of a nightly water event
- high quality materials throughout such as stone paving, stainless steel balustrades/ handrails and light fittings
- flexible lighting adapted to local usage pattern

Squares

Gardens



Water Bassins and Fountains within Squares and Gardens

Landscaping

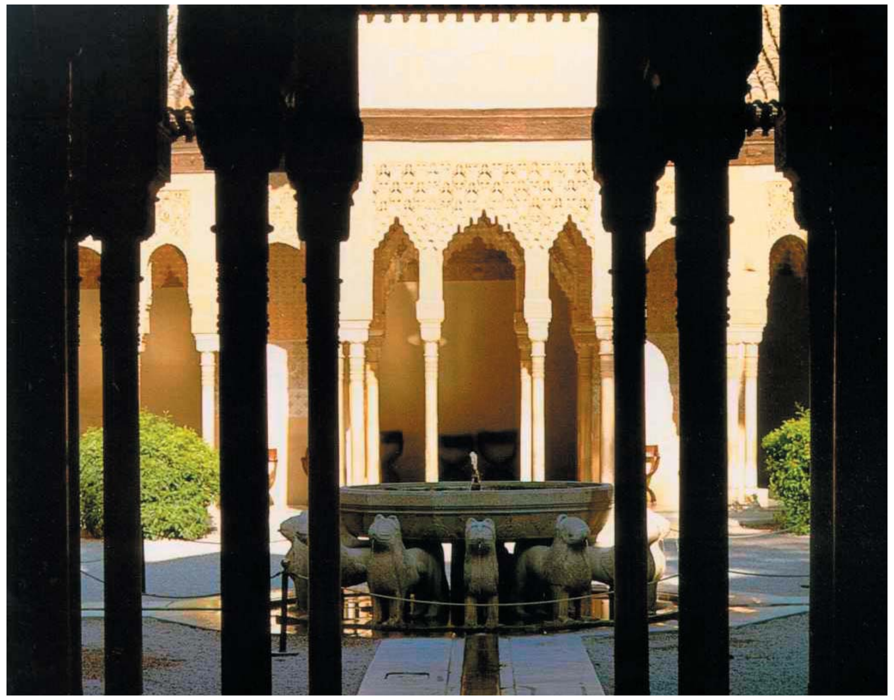
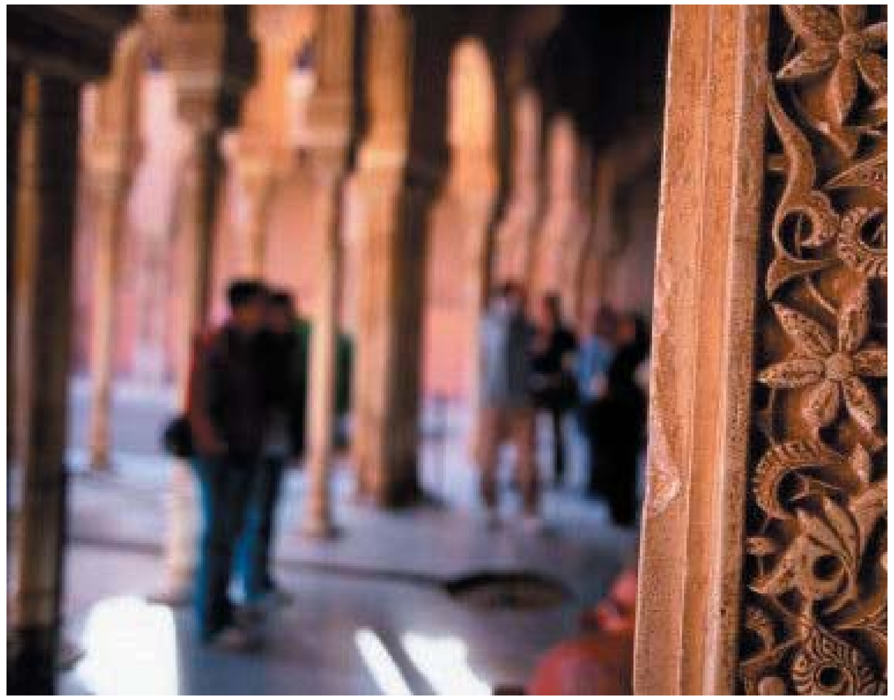
Areas Requiring Shade

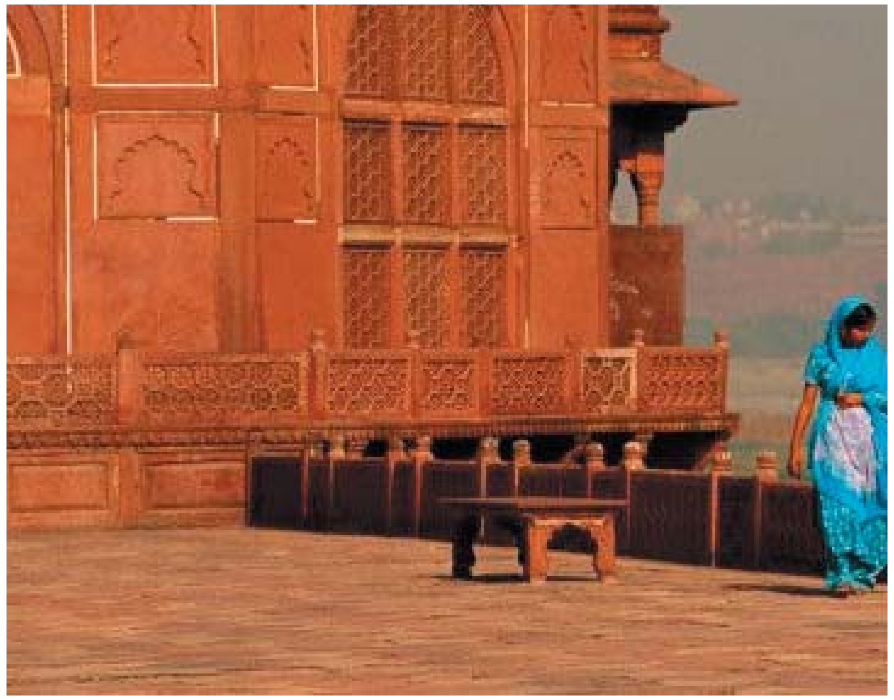
Shading through Parasols

Fabric Shading Devices

Shading through Walls

Shading through Plants




Water Features
- used throughout scheme to provide cooling
- due to the preciousnesness of water in the region water will be used sparringly and effectively
- moving water is generally better than standing water which attracts mosquitos
- water features will be located where the greatest number of people can enjoy them and could be prgrammed to be in use during peak time only
- all water features will use either grey sweet water chemically treated to bathing water standard or fresh desalinated sweet water
- if fresh desalinated water is used, it may be possible to rely on UV treatment rather than having to use chemicals such as chlorine or bromides

Water Features within Linear Park
- continous linear features such as a series of water channels with steps, chadar and fountain jets

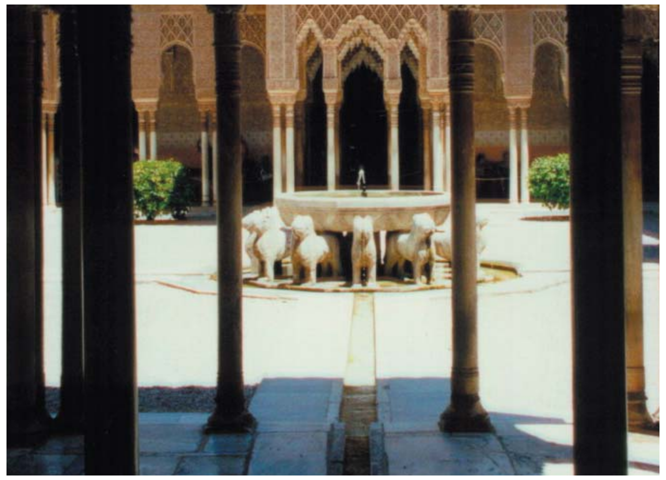
Water Features within Courtyards and Squares
- narrow channels, small bassins, water tables and small fountains
- squares could be filled with shallow sheets of water over part of their surface in the evening. This reflective surface could then be lit to great effect


fountain in the Alhambra, Spain


Alhambra Granada


water channel leading towards the entrance of a building


fountain Bagh-e Shadzeh, Iran


Courtyard Alhambra, Spain


water bassin, garden in Bagh-e Fin, Iran

University Masterplan
Introduction

The M.I.S.T Masterplan presents a summary of the development of options explored thus far. Various principles of urban design and planning were tested while ensuring sustainability is woven through the urban fabric and an environment is sought which provides orientation, a sense of place and a unique campus lifestyle.

It charts the development of the Masterplan over a timeline of phasing from 2009 until 2015. Studies were also conducted into the potential expansion of the research laboratories within the campus and its extension into the surrounding urban fabric of MASDAR beyond 2015 to further test the scheme's flexibility.

Specific analysis is explored into the potential pedestrian walkway and circulation systems which may prove essential in the climate upon which M.I.S.T is located. Fundamental to the success of the systems are ultimately the understanding of the social activities and interaction levels of M.I.S.T, while being mindful of the underlying sustainable principles.

Through an on-going process of drawings, models and workshops, Foster + Partners and M.I.S.T have been able to establish basic Masterplan concepts and arrangements. This will evolve through further discussions to form overall strategies and ultimately a schematic Masterplan design for M.I.S.T.

University Masterplan
Area Breakdown - Academic

□ 100 m^2

	Phase 1a 2009 (100 students)	Phase 1b 2011 (441 students)	Phase 2 2014 (790 students)	Phase 3 2015 (800 students)
Lab related space: - Lab positions - Write up positions - Lab support	+ 4600 m^2 / 4600 m^2	+15686 m^2 / 20286 m^2	+13714 m^2 / 34000 m^2	+2800 m^2 / 36800 m^2
Special machine lab	+ 300 m^2 / 300 m^2	+ 1500 m^2 / 1800 m^2	+ 0 m^2 / 1800 m^2	+ 0 m^2 / 1800 m^2
Clean room	+80 m^2 / 80 m^2	+ 80 m^2 / 160 m^2	+ 340 m^2 / 500 m^2	+ 0 m^2 / 500 m^2
Computer lab	+ 300 m^2 / 300 m^2	+ 0 m^2 / 300 m^2	+ 0 m^2 / 300 m^2	+ 0 m^2 / 300 m^2
Server room	+ 150 m^2 / 150 m^2	+ 0 m^2 / 150 m^2	+ 0 m^2 / 150 m^2	+ 0 m^2 / 150 m^2
Classroom	+ 750 m^2 / 750 m^2	+ 750 m^2 / 1500 m^2	+ 1500 m^2 / 3000 m^2	+ 0 m^2 / 3000 m^2
Larger classroom	+ 500 m^2 / 500 m^2	+ 0 m^2 / 500 m^2	+ 0 m^2 / 500 m^2	+ 0 m^2 / 500 m^2
Meeting room	+ 200 m^2 / 200 m^2	+ 682 m^2 / 882 m^2	+ 596 m^2 / 1478 m^2	+ 122 m^2 / 1600 m^2
Library positions	+ 1200 m^2 / 1200 m^2	+ 0 m^2 / 1200 m^2	+ 0 m^2 / 1200 m^2	+ 0 m^2 / 1200 m^2
Academic staff cellular offices	+ 900 m^2 / 900 m^2	+ 423 m^2 / 1323 m^2	+ 894 m^2 / 2217 m^2	+ 183 m^2 / 2400 m^2
Non-academic staff cellular offices	+ 300 m^2 / 300 m^2	+ 30 m^2 / 330 m^2	+ 224 m^2 / 554 m^2	+ 46 m^2 / 600 m^2
Non-academic open plan desks	+ 300 m^2 / 300 m^2	+ 85 m^2 / 385 m^2	+ 262 m^2 / 647 m^2	+ 53 m^2 / 700 m^2

University Masterplan

Area Breakdown -Shared Amenities, Residential

	Phase 1a 2009	Phase 1b 2011	Phase 2 2014	Phase 3 2015
	100 students	441 students	790 students	800 students
Multipurpose hall	0 m²	0 m²	+ 1200 m² / 1200 m²	+ 0 m² / 1200 m²
Catering facilities	+ 480 m² / 480 m²	+ 303 m² / 783 m²	+ 529 m² / 1312 m²	+ 108 m² / 1420 m²
Sports and other shared facilities	+ 300 m² / 300 m²	+ 1023 m² / 1323 m²	+ 1077 m² / 2400 m²	+ 0 m² / 2400 m²
Mosque	0 m²	0 m²	+ 1350 m² / 1350 m²	+ 0 m² / 1350 m²
Student accomodation single	+4590 m² / 4590 m²	+15652 m² / 20242 m²	+13678 m² / 33920 m²	+2800 m² / 36720 m²
Student accomodation with spouse	+720 m² / 720 m²	+2455 m² / 3175 m²	+2146 m² / 5321 m²	+439 m² / 5760 m²
Student accomodation with family	+450 m² / 450 m²	+1535 m² / 1985 m²	+1341 m² / 3326 m²	+274 m² / 3600 m²
Residential Floor Area	**5760 m²**	**25 402 m²**	**42 567 m²**	**46 080 m²**
Total Floor Area	**16 540 m²**	**56 663 m²**	**95 168 m²**	**102 000 m²**

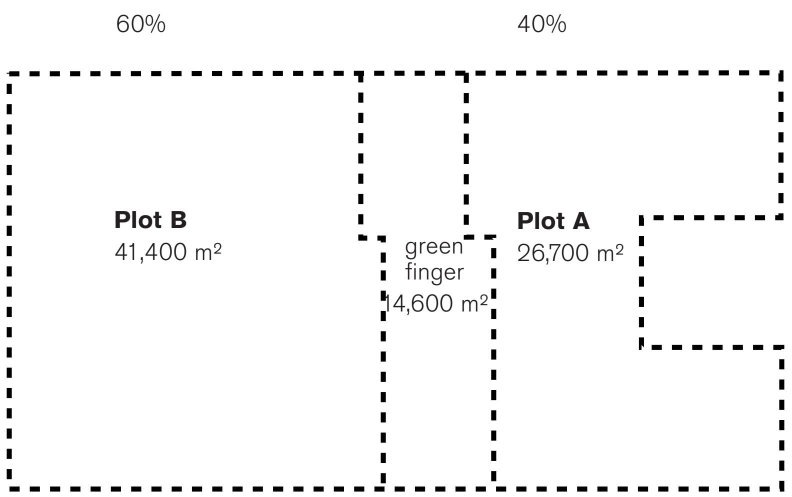
University Masterplan

Masdar Development

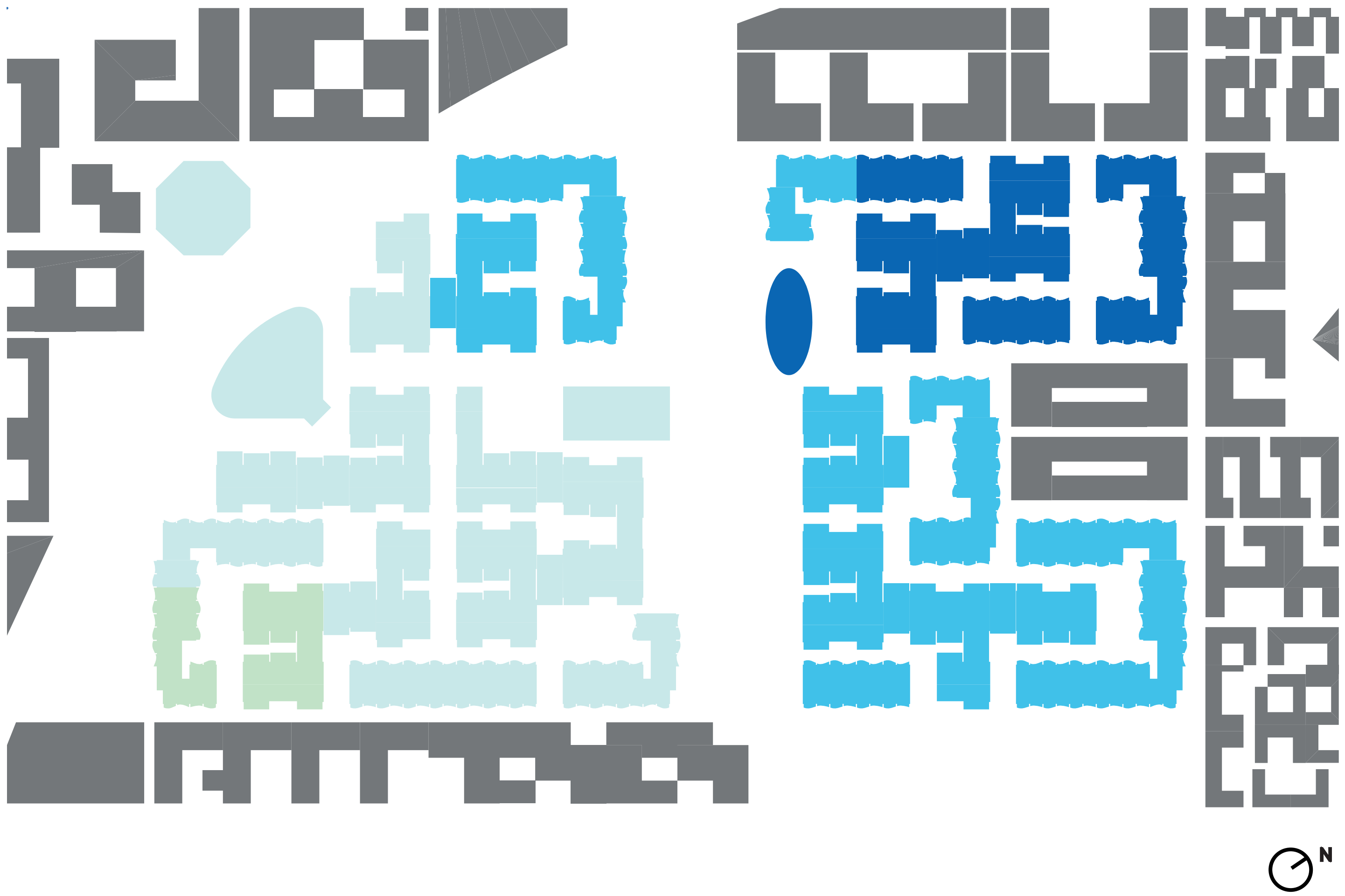
University Masterplan

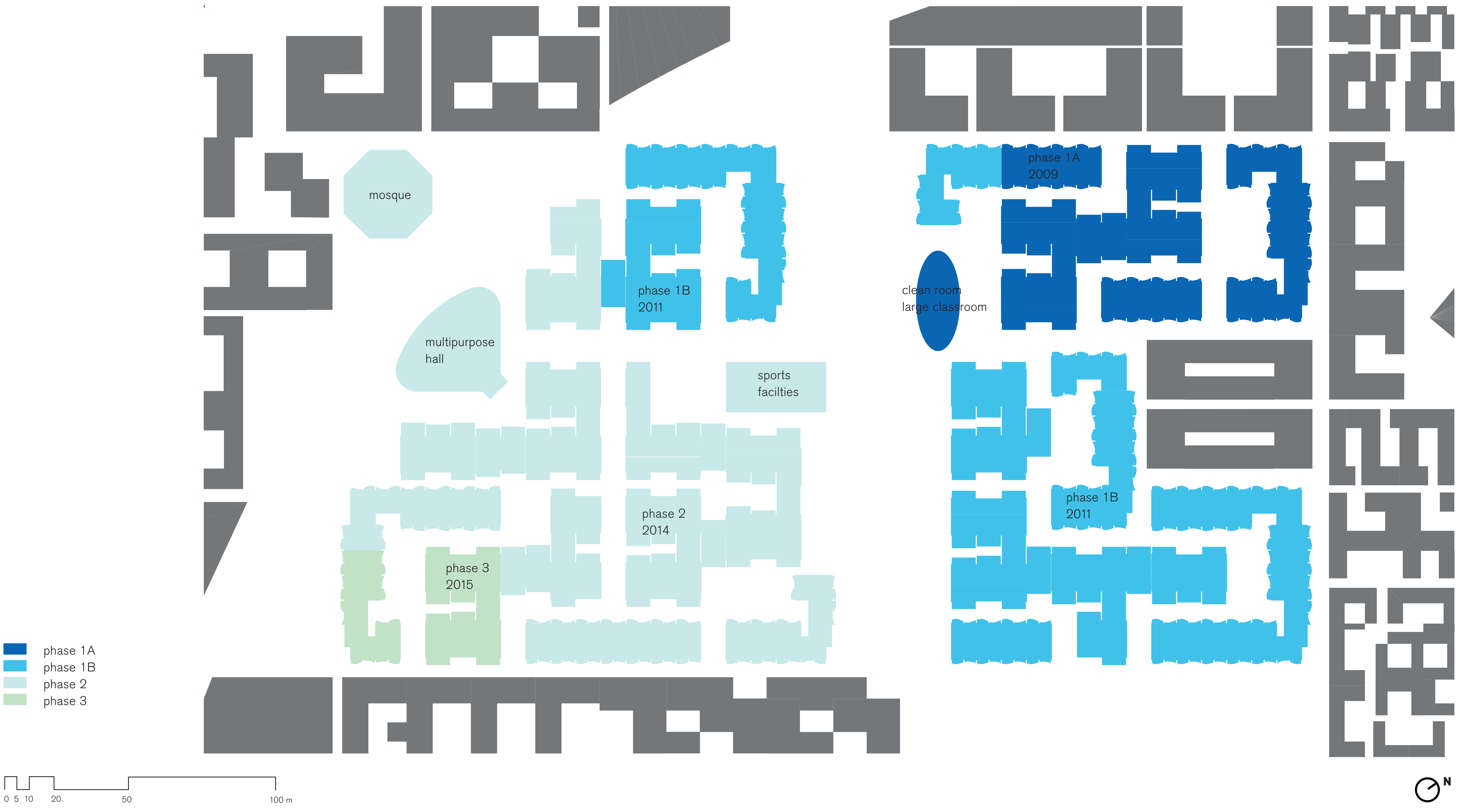
Phasing - Data Sheet

	Phase 1A 2009	Phase 1B 2011	Phase 2 2014	Phase 3 2015
Brief				
lab	4 600 m²	20 286 m² (+15 686)	33 334 m² (+13 048)	36800 m² (+3 466)
student accomodation	90	397 (+307)	665 (+268)	720 (+55)
Masterplan				
lab	6 058 m²	18 286 m² (+12 228)	35 556 m² (+17 270)	36 970 m² (+1 414)
student accomodation	91 (101%)	436 (110%) (+345)	626 (94%) (+190)	673 (93%) (+47)

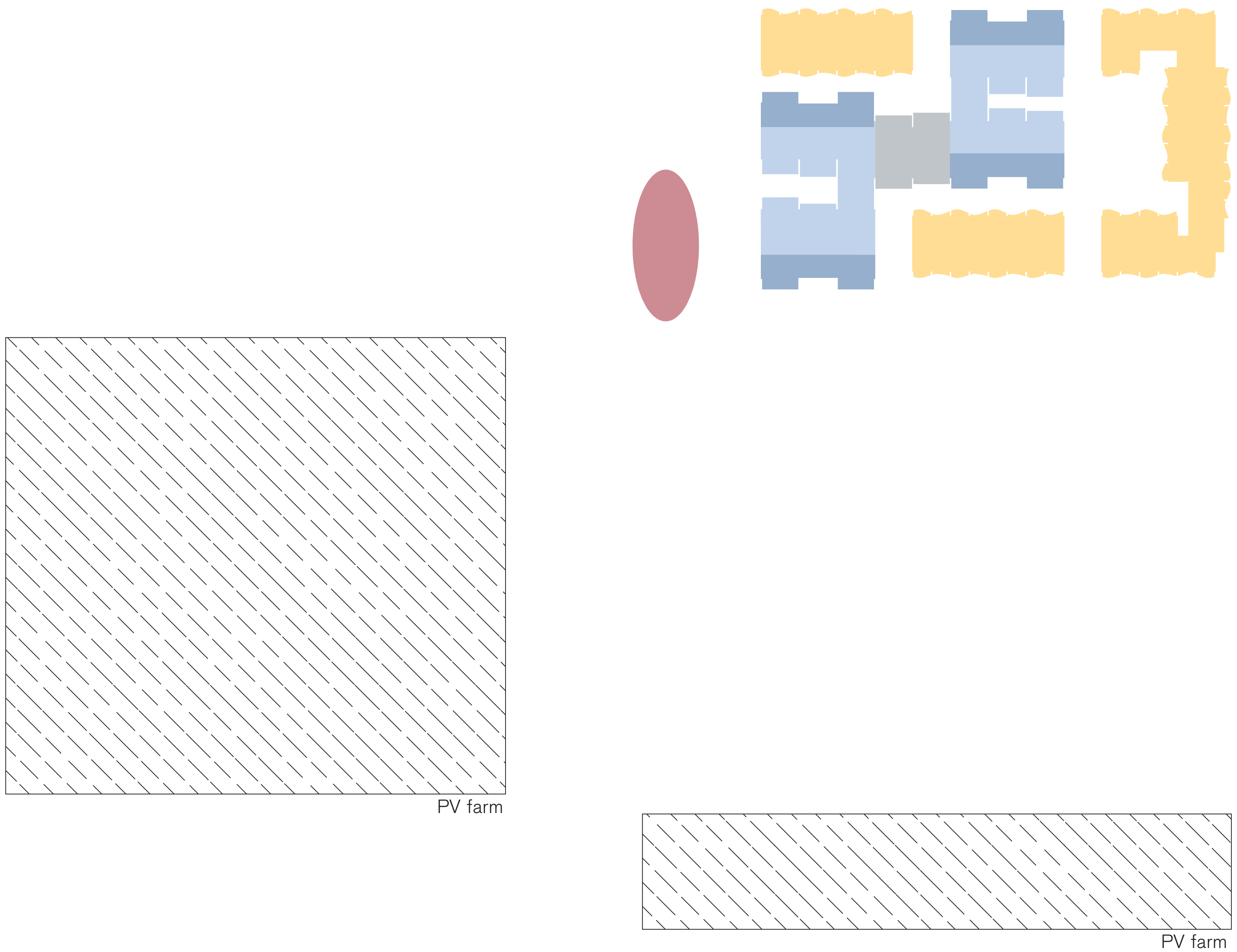


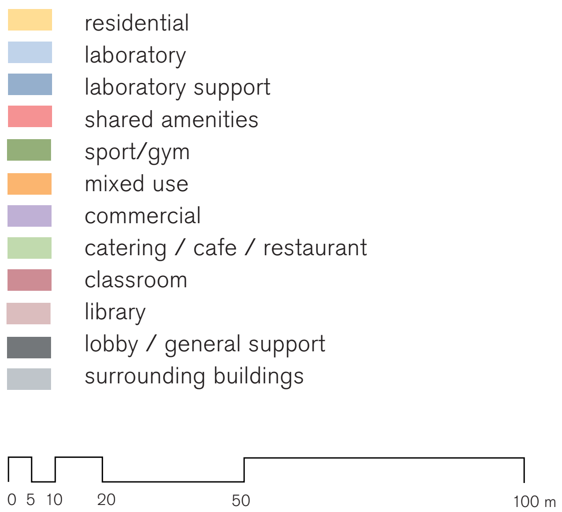
- phase 1A
- phase 1B
- phase 2
- phase 3




mosque
phase 1B
2011
multipurpose
hall
sports
facilties
phase 2
2014
phase 3
2015
phase 1A
2009
clean room
large classroom
phase 1B
2011
phase 1A
phase 1B
phase 2
phase 3
0 5 10 20 50 100 m
N

Phase 1A / 2009

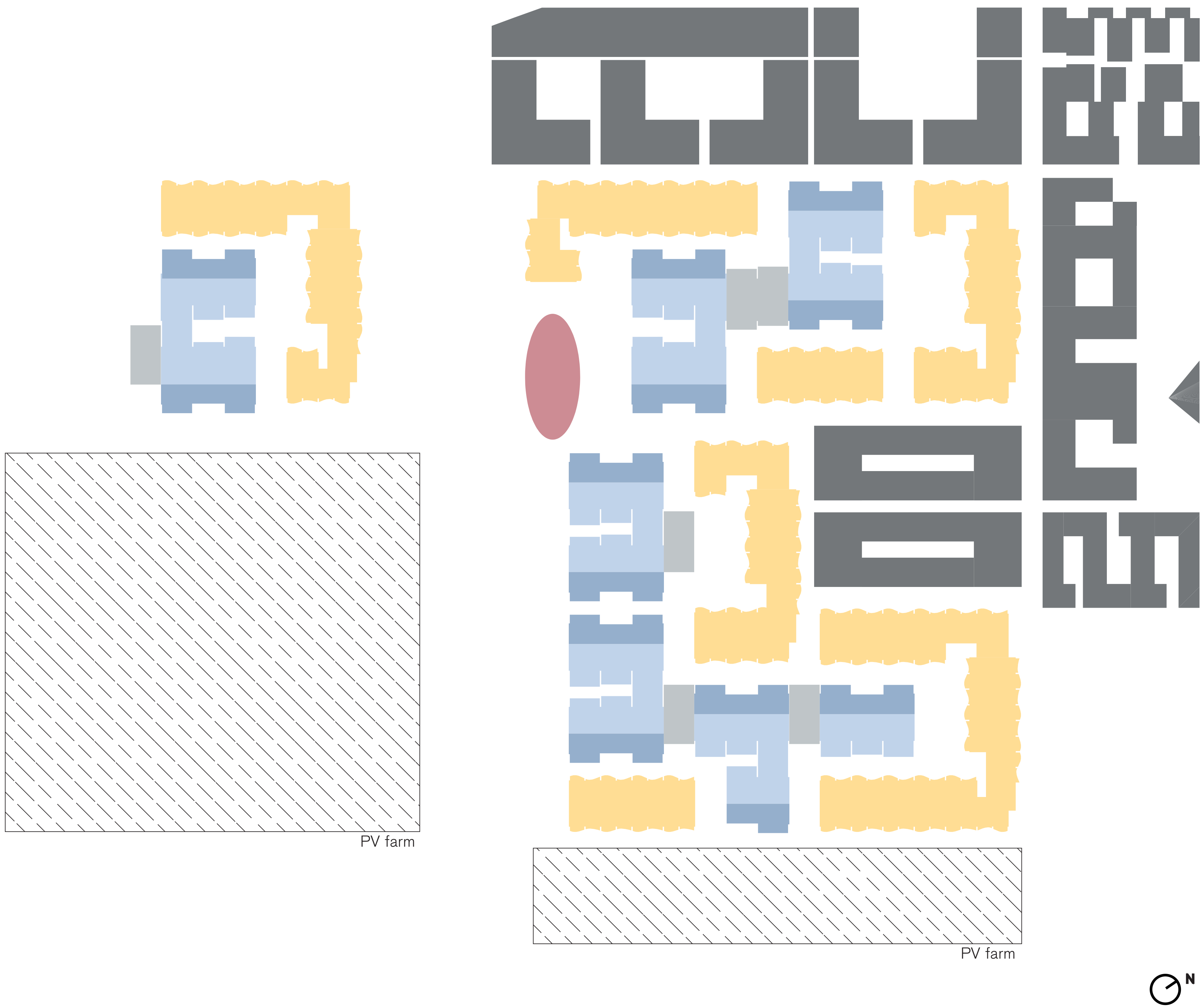




University Masterplan

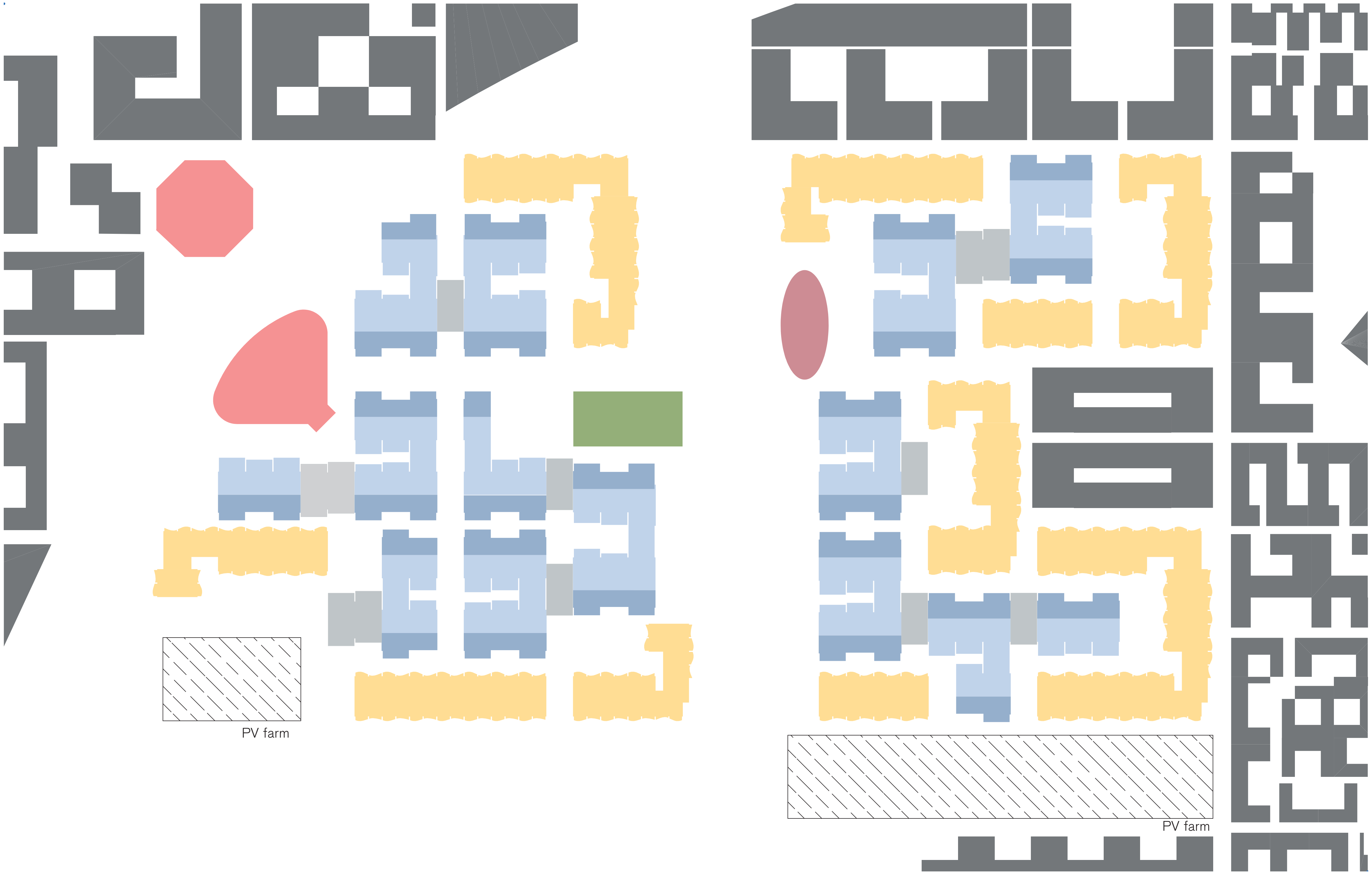
Phasing - Timeline of Expansion

Phase 1B / 2011



- residential
- laboratory
- laboratory support
- shared amenities
- sport/gym
- mixed use
- commercial
- catering / cafe / restaurant
- classroom
- library
- lobby / general support
- surrounding buildings

Phase 2 / 2014

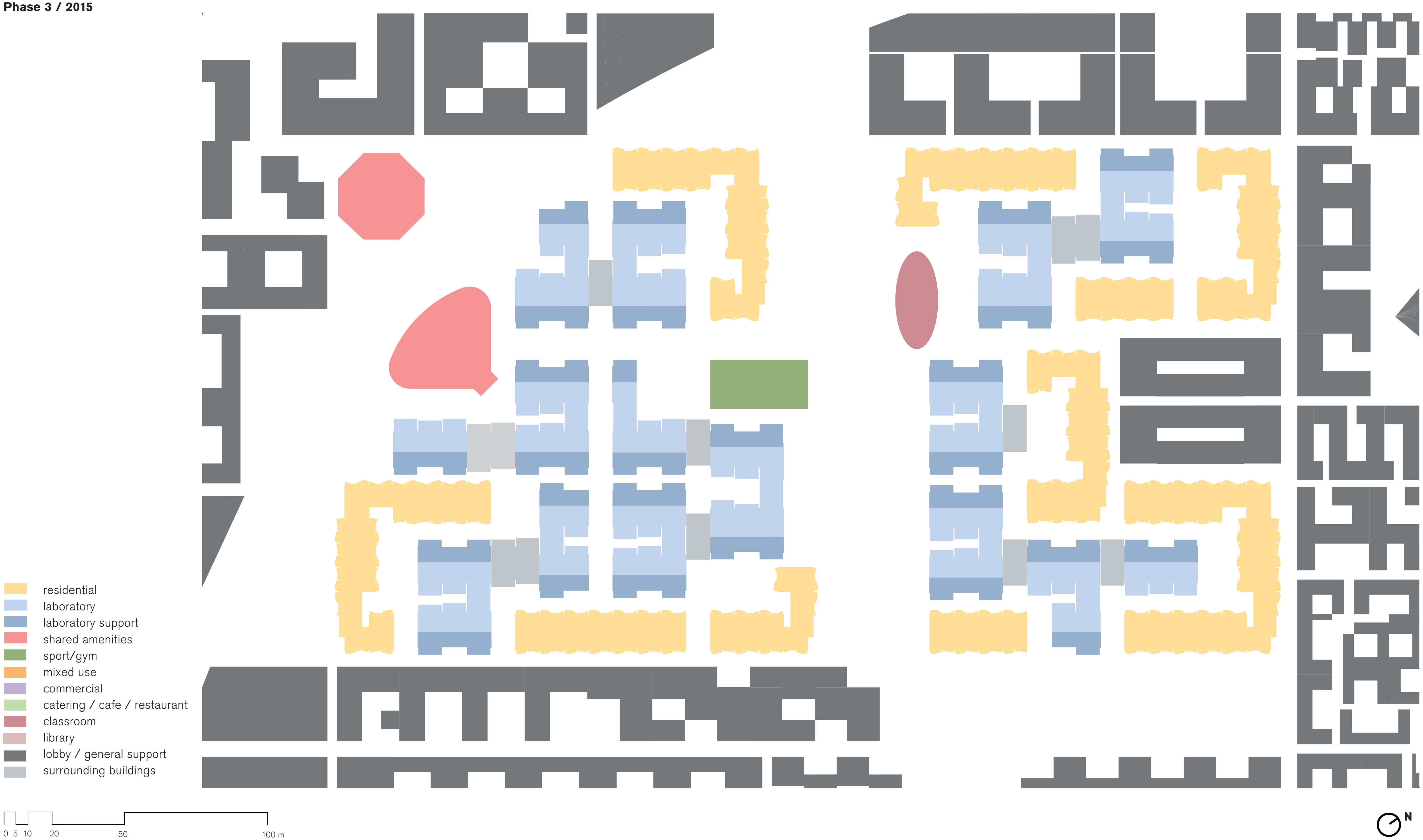


- residential
- laboratory
- laboratory support
- shared amenities
- sport/gym
- mixed use
- commercial
- catering / cafe / restaurant
- classroom
- library
- lobby / general support
- surrounding buildings

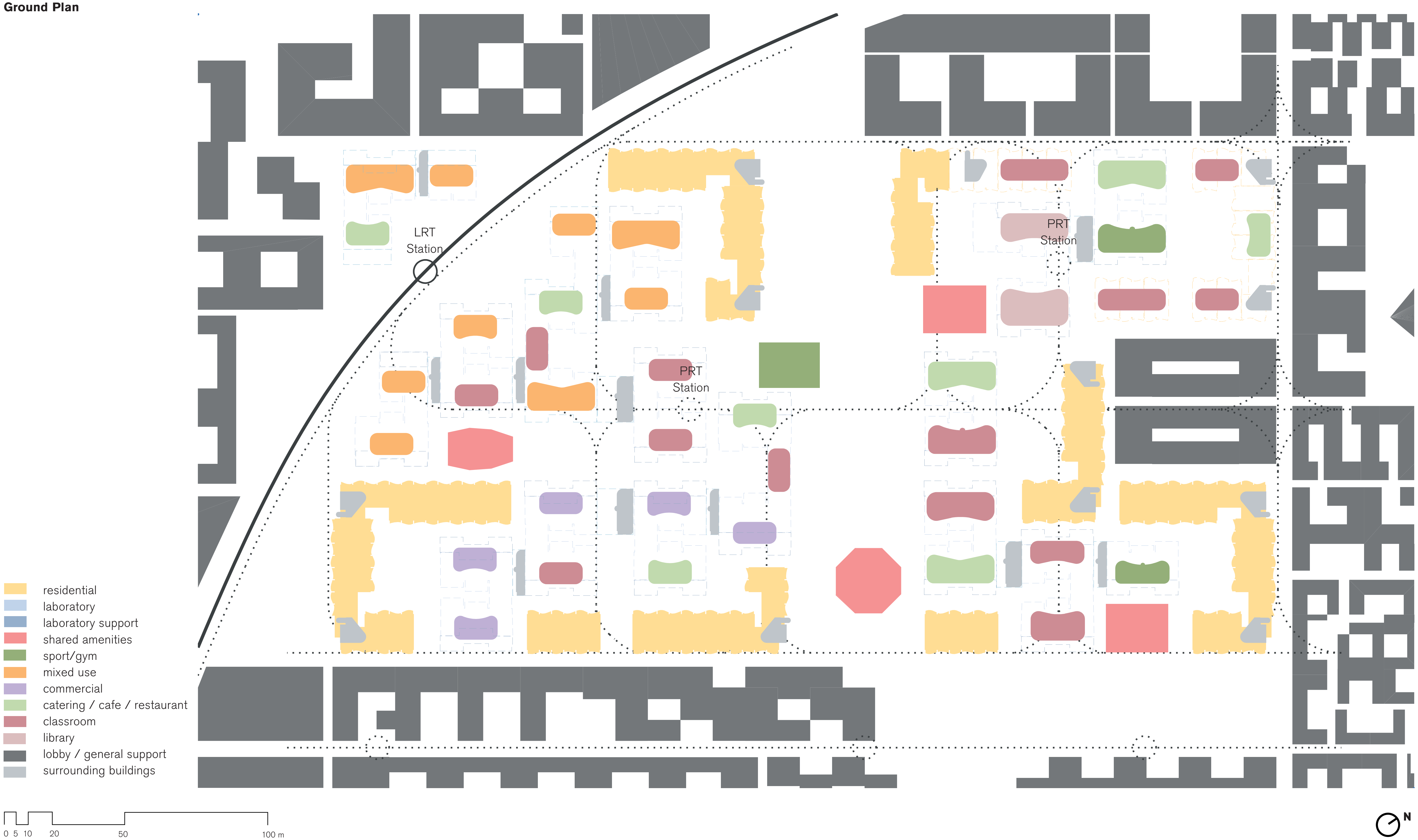
0 5 10 20 50 100 m

N

Phase 3 / 2015


residential
laboratory
laboratory support
shared amenities
sport/gym
mixed use
commercial
catering / cafe / restaurant
classroom
library
lobby / general support
surrounding buildings
0 5 10 20 50 100 m
N

Ground Plan

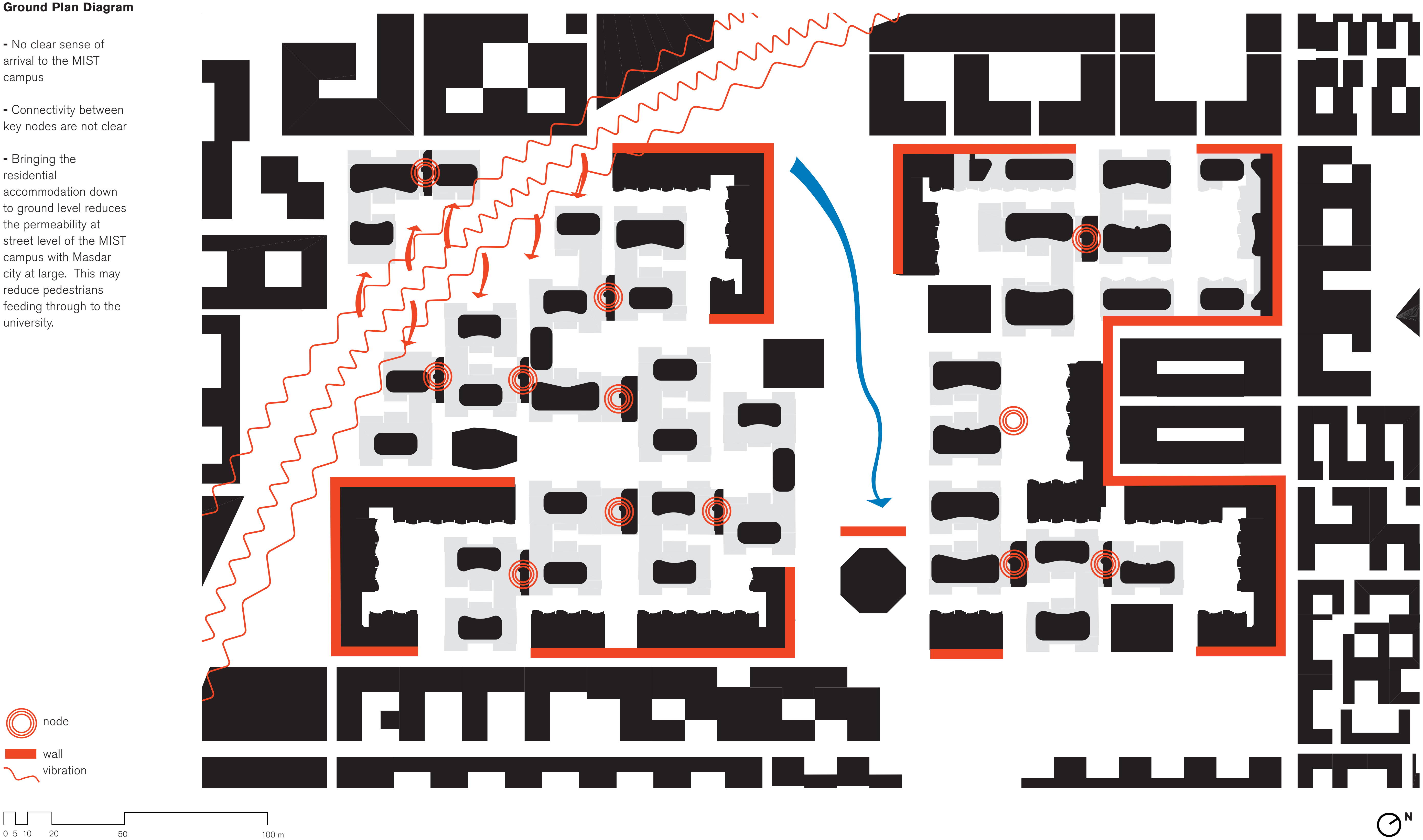

LRT
Station
PRT
Station
PRT
Station
residential
laboratory
laboratory support
shared amenities
sport/gym
mixed use
commercial
catering / cafe / restaurant
classroom
library
lobby / general support
surrounding buildings
0 5 10 20 50 100 m
N

Ground Plan Diagram

- No clear sense of arrival to the MIST campus

- Connectivity between key nodes are not clear

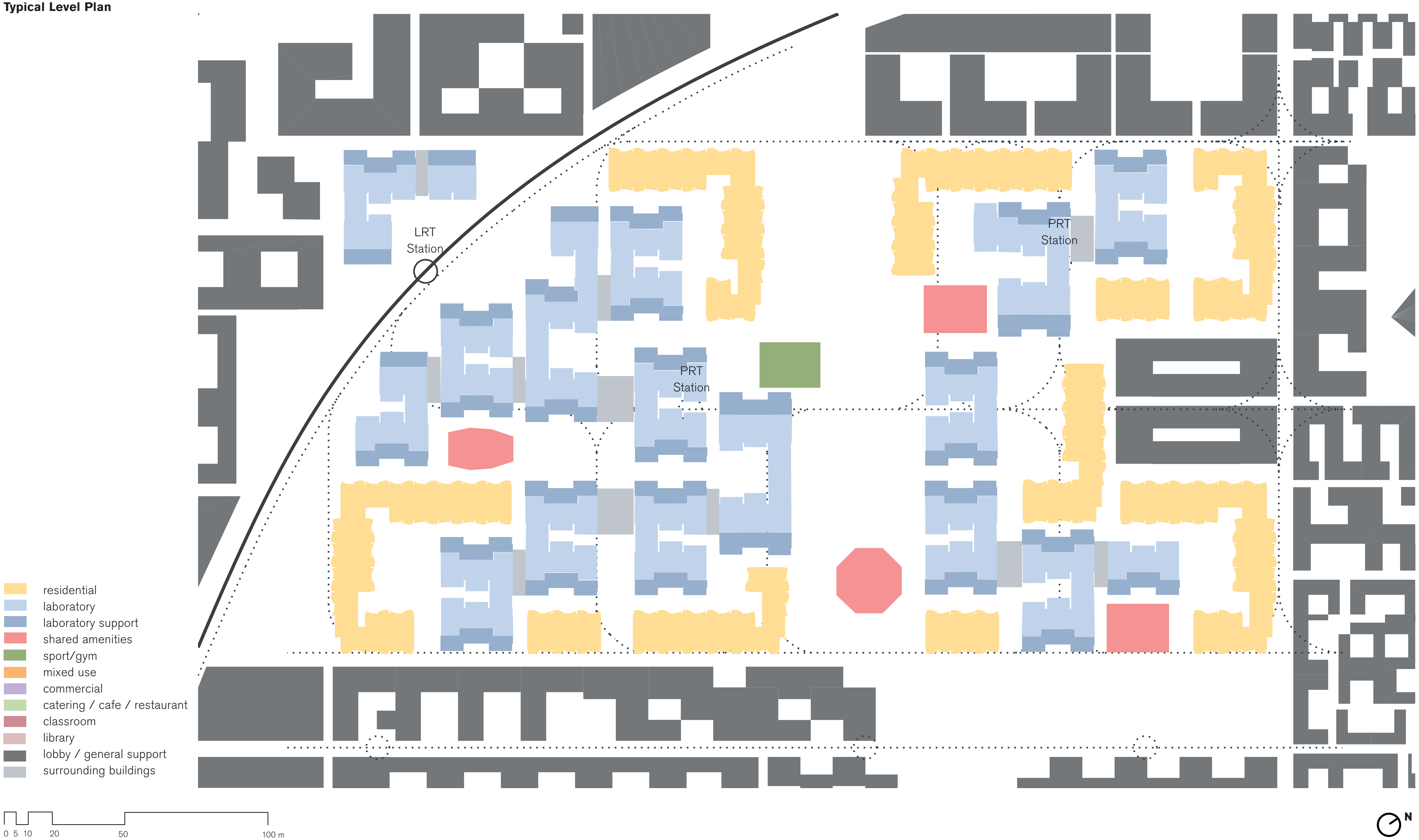
- Bringing the residential accommodation down to ground level reduces the permeability at street level of the MIST campus with Masdar city at large. This may reduce pedestrians feeding through to the university.



University Masterplan

Master Plan Strategy - Option 1: WFES Scheme

Typical Level Plan

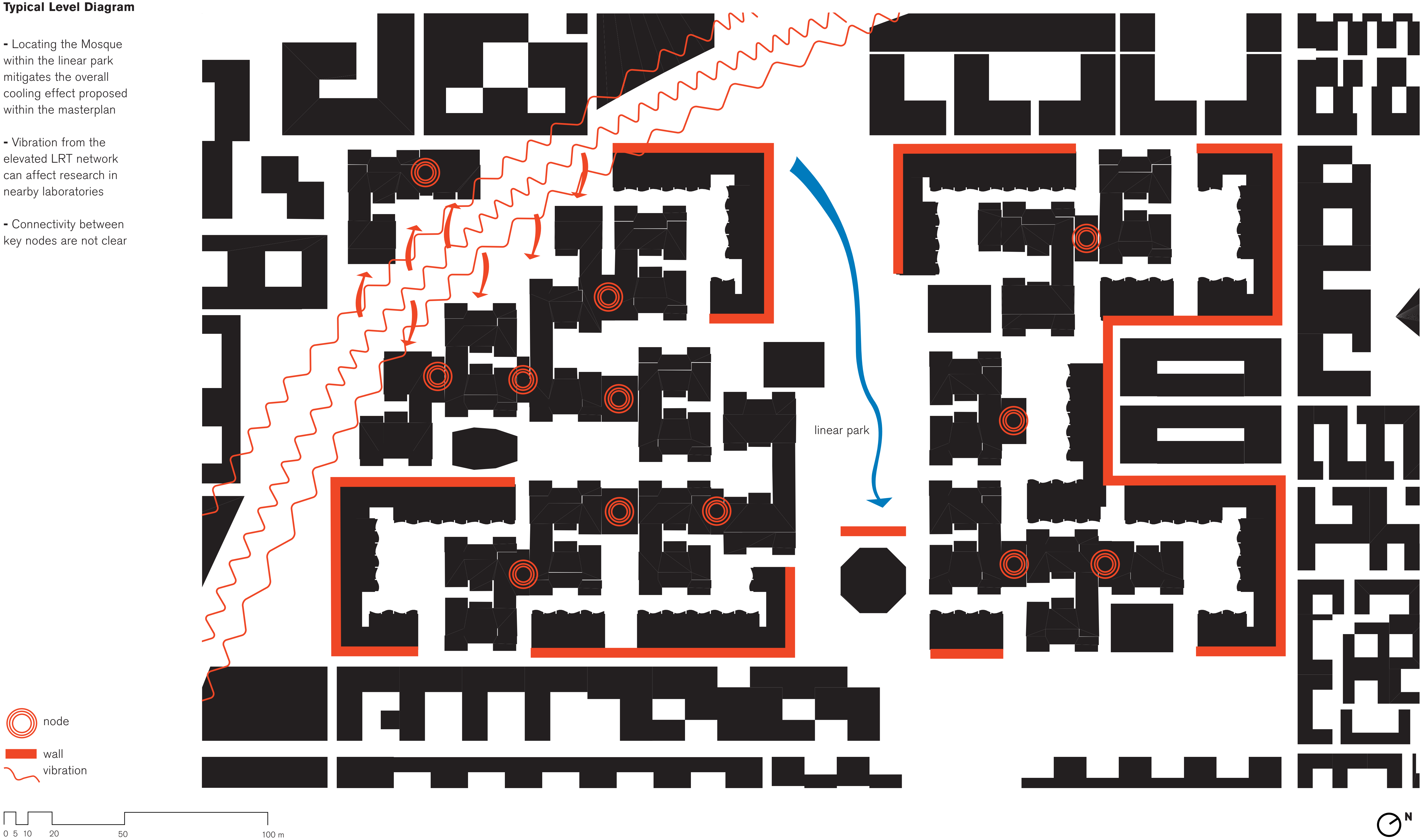


Typical Level Diagram

- Locating the Mosque within the linear park mitigates the overall cooling effect proposed within the masterplan

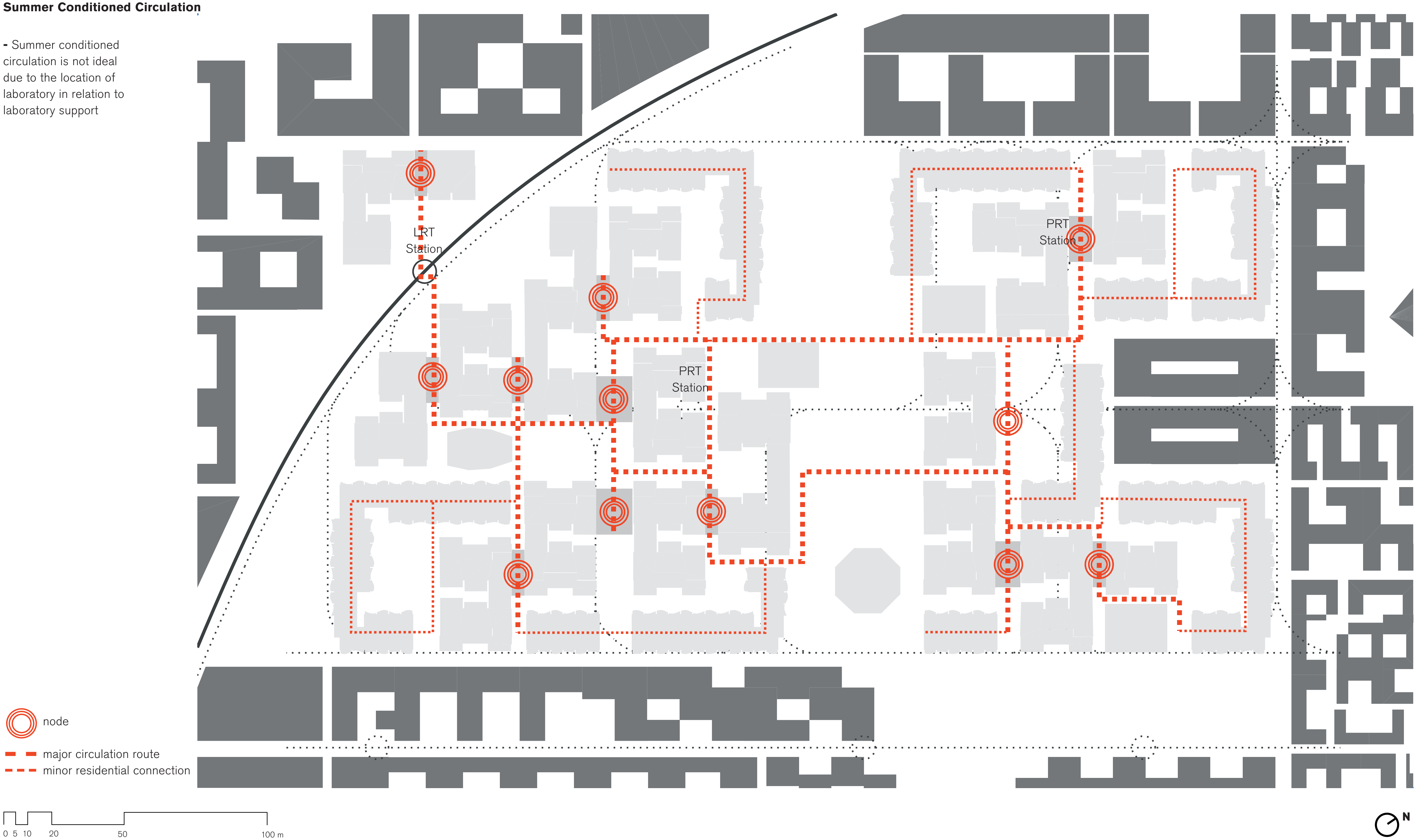
- Vibration from the elevated LRT network can affect research in nearby laboratories

- Connectivity between key nodes are not clear



Summer Conditioned Circulation

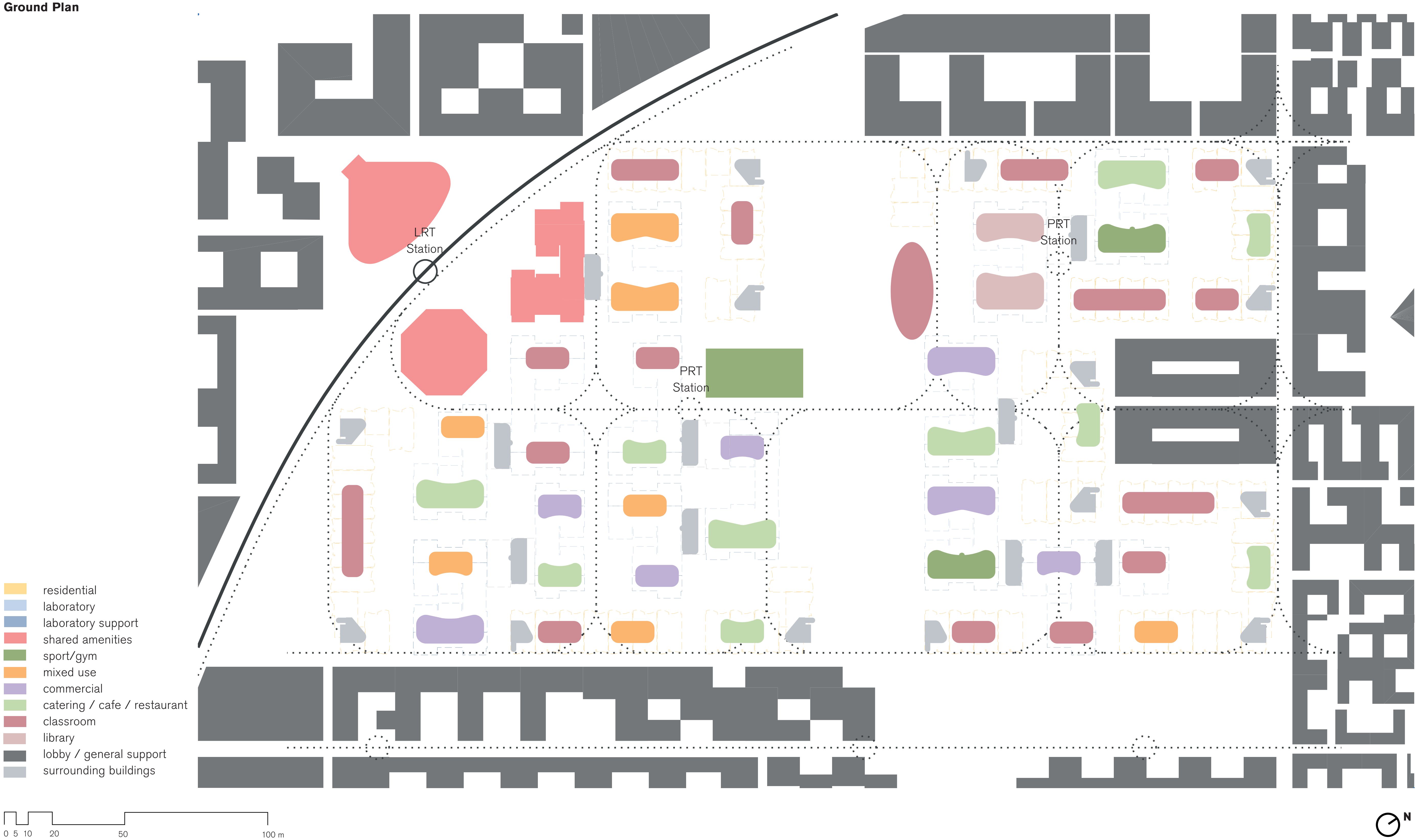
- Summer conditioned circulation is not ideal due to the location of laboratory in relation to laboratory support



University Masterplan

Master Plan Strategy - Option 2: Squares

Ground Plan

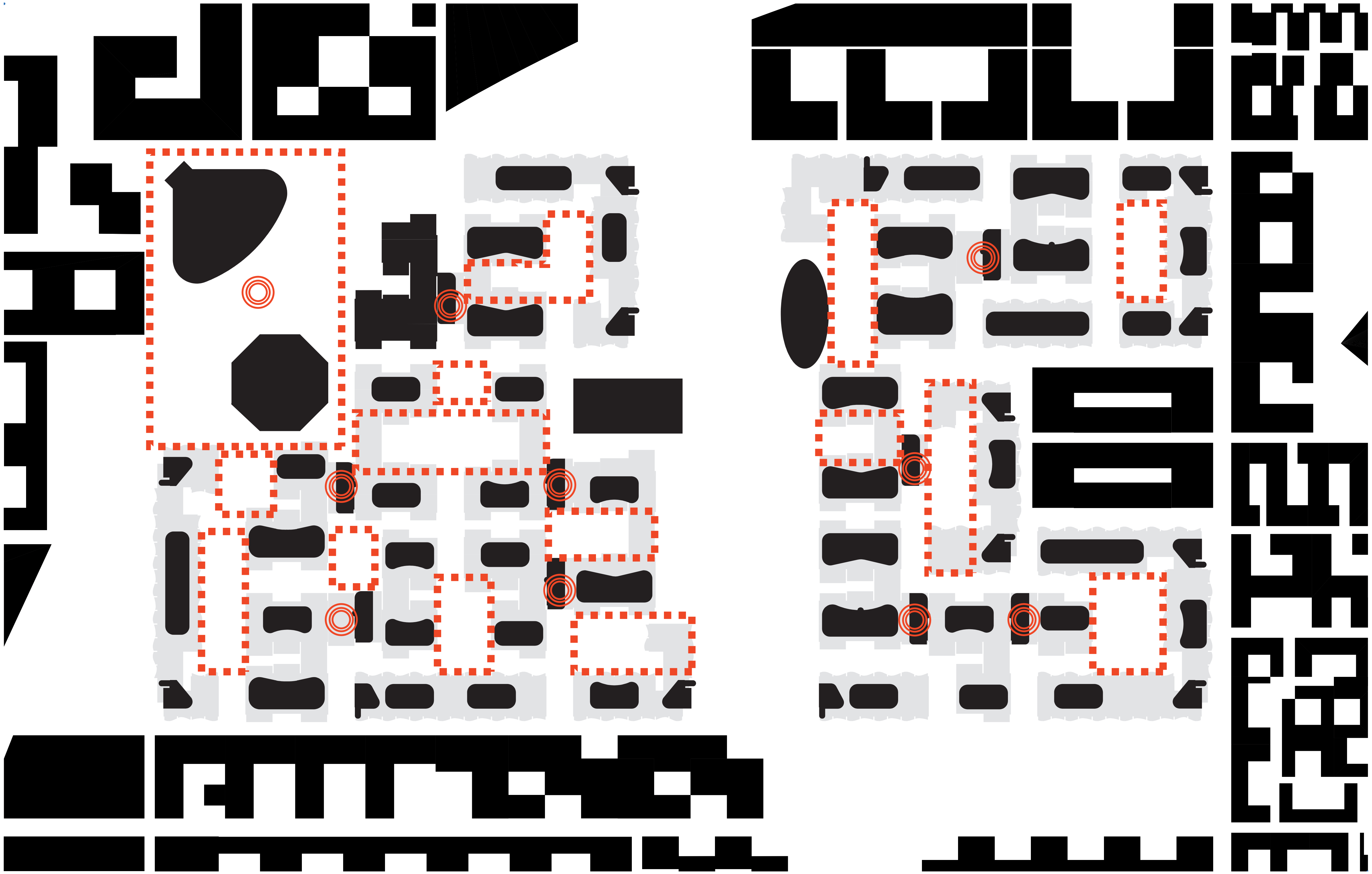


Ground Plan Diagram

- Connectivity between key nodes are improved through alignment to the campus gird

- Public squares are created at various scales, with nodal connections between each

- Residential accommodation and laboratories are removed from the ground plane to allow greater permeability throughout



node

squares

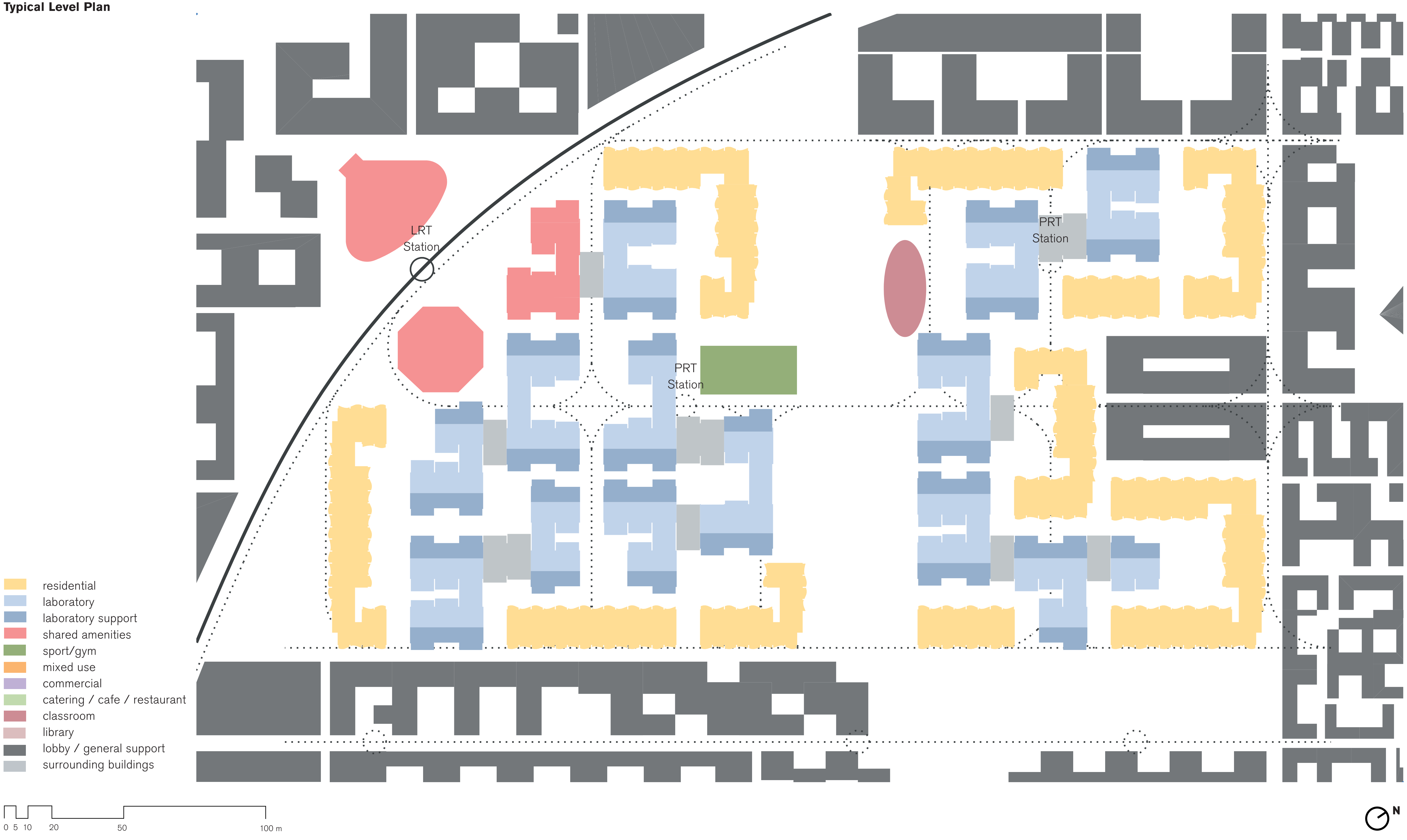
0 5 10 20 50 100 m

N

University Masterplan

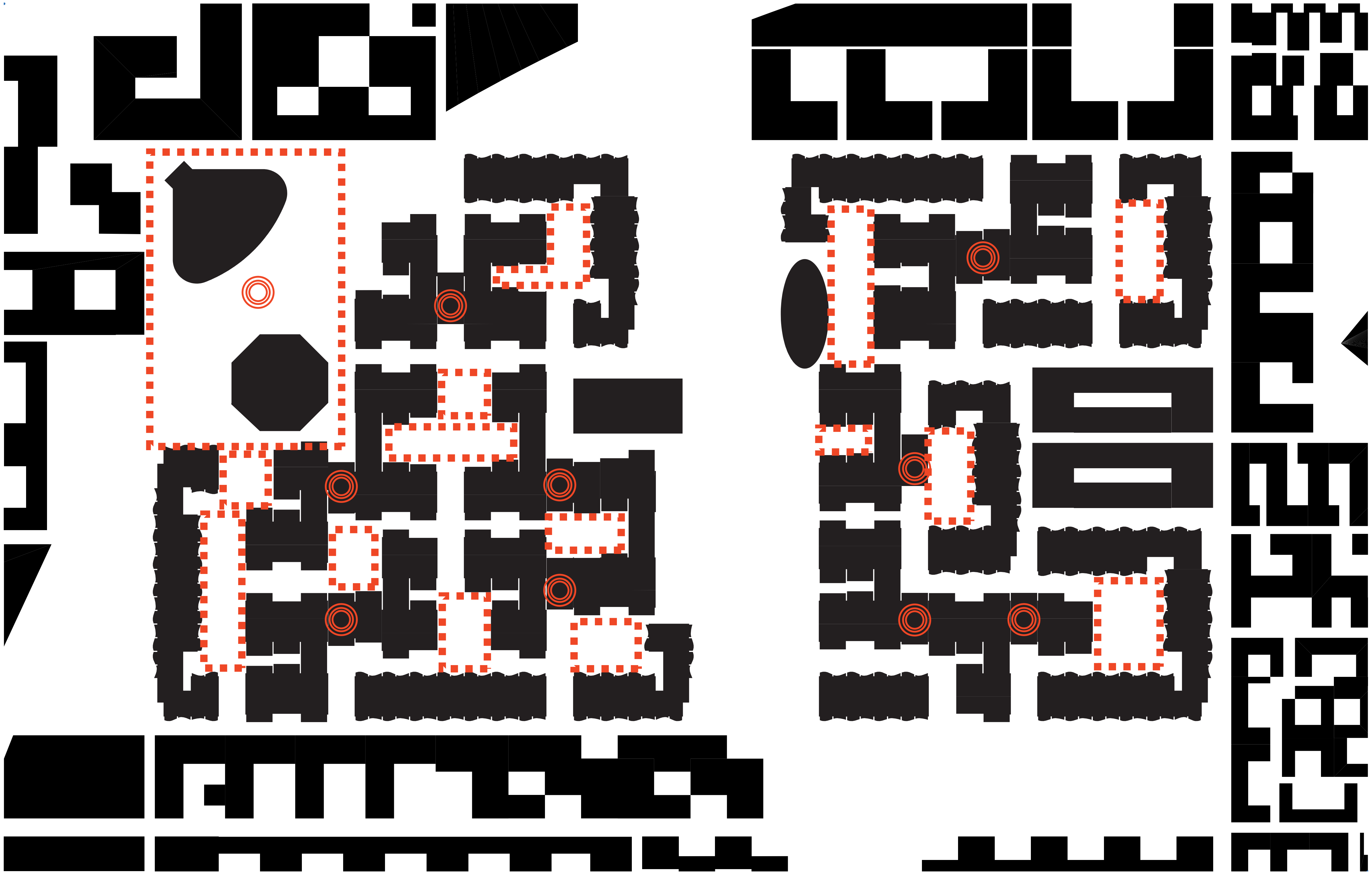
Master Plan Strategy - Option 2: Squares

Typical Level Plan



Typical Level Diagram

- The relocation of the mosque and multipurpose hall help form a civic square and point of arrival from the LRT station
- The civic square helps form a buffer zone isolating the laboratories from vibration of the elevated LRT
- Connectivity between key nodes are improved through alignment to the campus gird
- Public squares at the ground plane receive partial daylight due to overhanging facades
- Laboratories are aligned to allow for potential expansion



node

squares

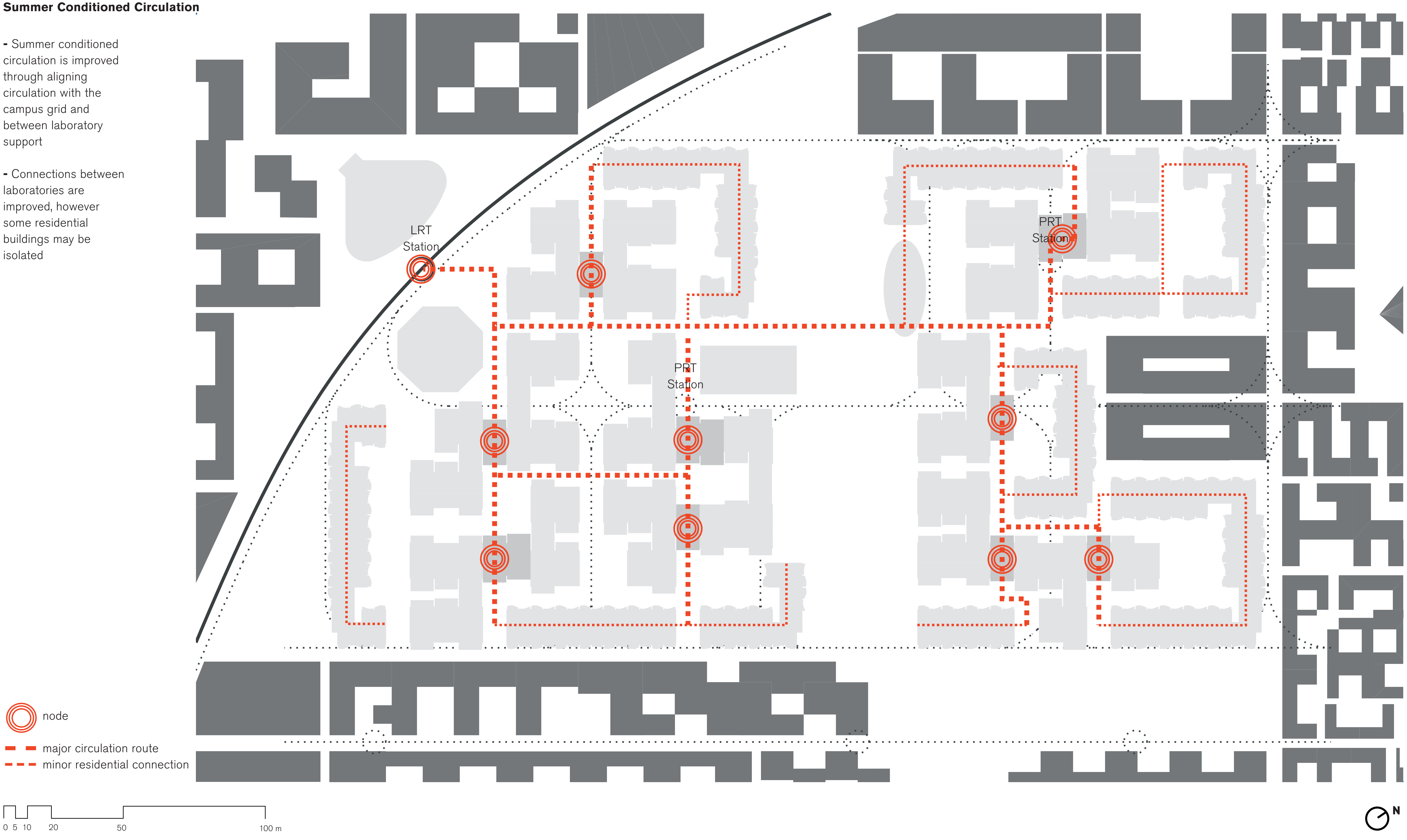
0 5 10 20 50 100 m

N

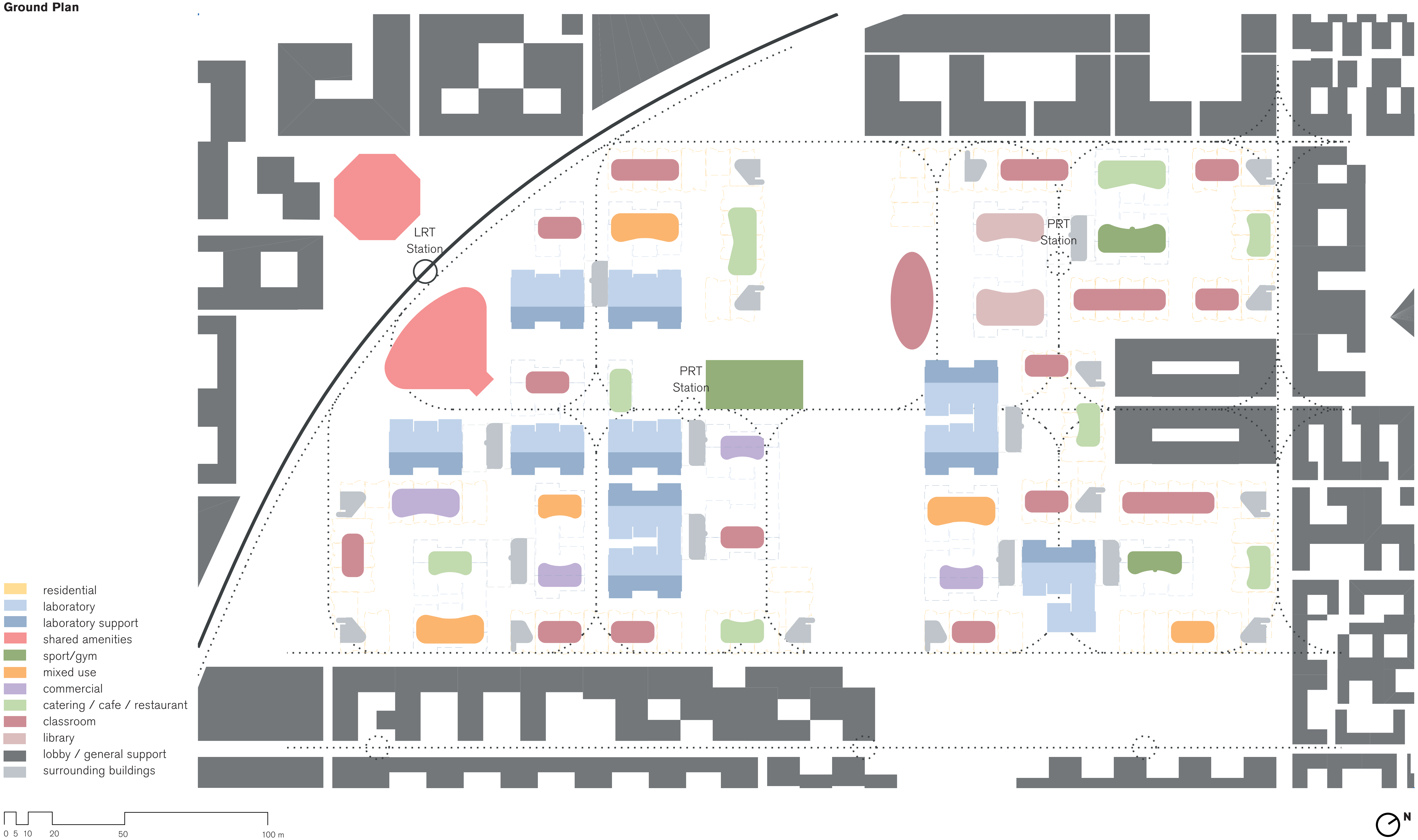
Summer Conditioned Circulation

- Summer conditioned circulation is improved through aligning circulation with the campus grid and between laboratory support

- Connections between laboratories are improved, however some residential buildings may be isolated



Ground Plan


LRT
Station
PRT
Station
PRT
Station
residential
laboratory
laboratory support
shared amenities
sport/gym
mixed use
commercial
catering / cafe / restaurant
classroom
library
lobby / general support
surrounding buildings
0 5 10 20 50 100 m
N

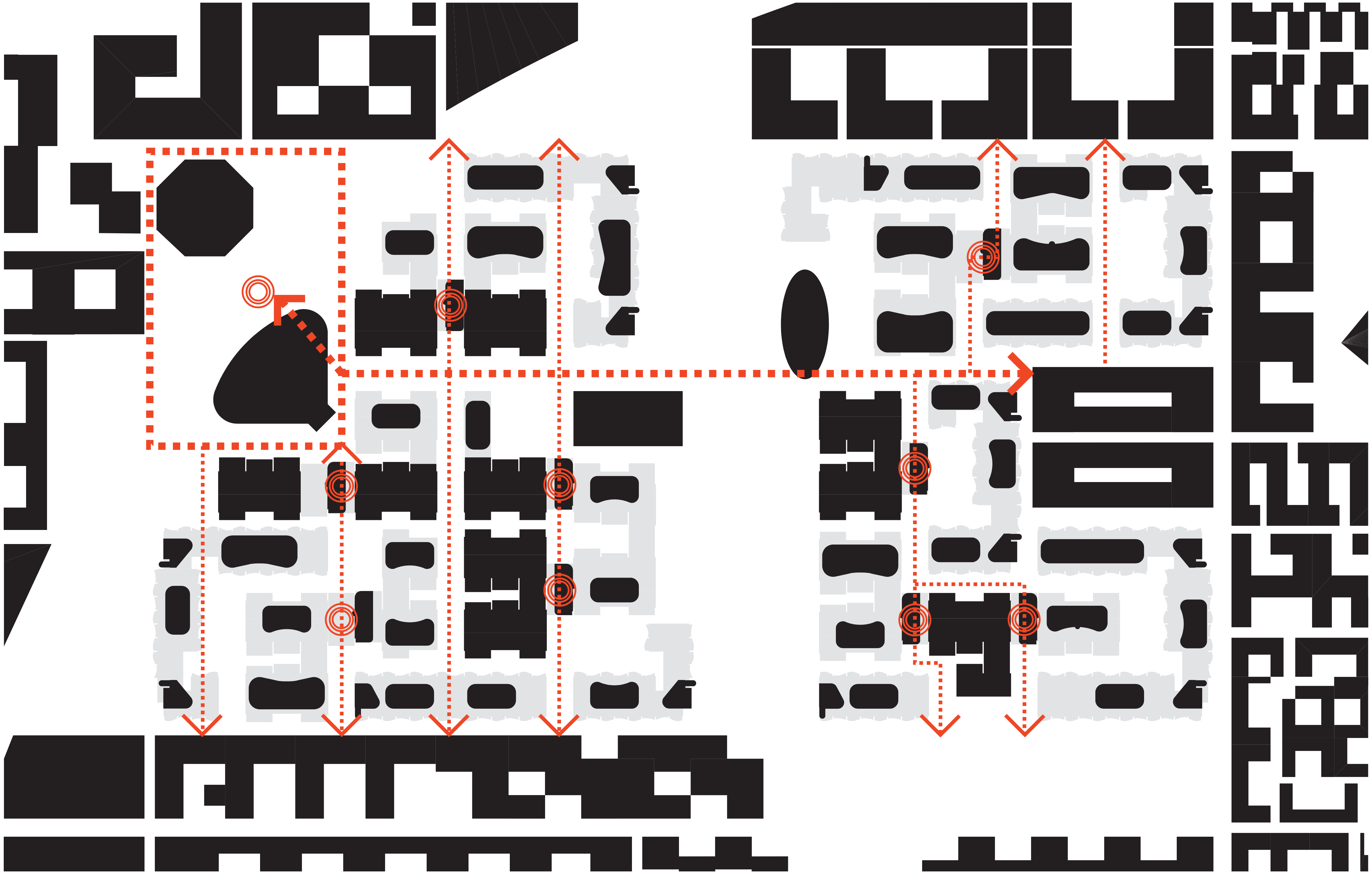
Ground Plan Diagram

- Connectivity between key nodes are improved through alignment to the campus gird

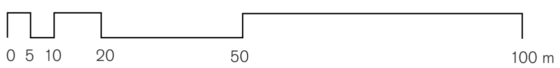
- A main avenue links phase 1A with the LRT station and creates a primary route across the linear park for the future university

- Minor streets are formed perpendicular to the avenue, aligned with the nodal connections on the campus grid

- Some laboratories extend down to the re-enforce the interaction at street level defining functional quaters and districts while allowing greater permeability to the surrounding city



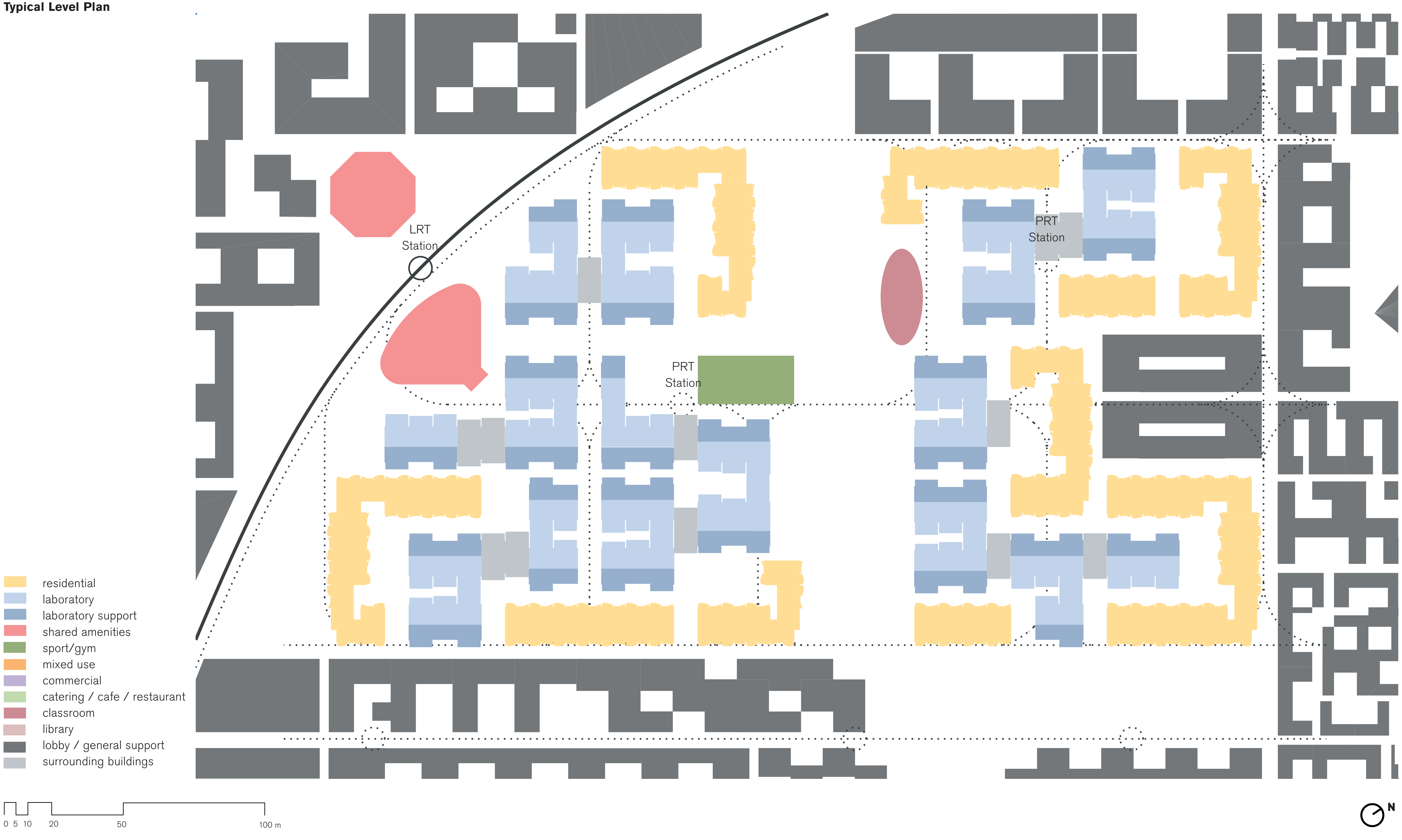
node
major avenue
minor street



University Masterplan

Master Plan Strategy - Option 3: Streets

Typical Level Plan



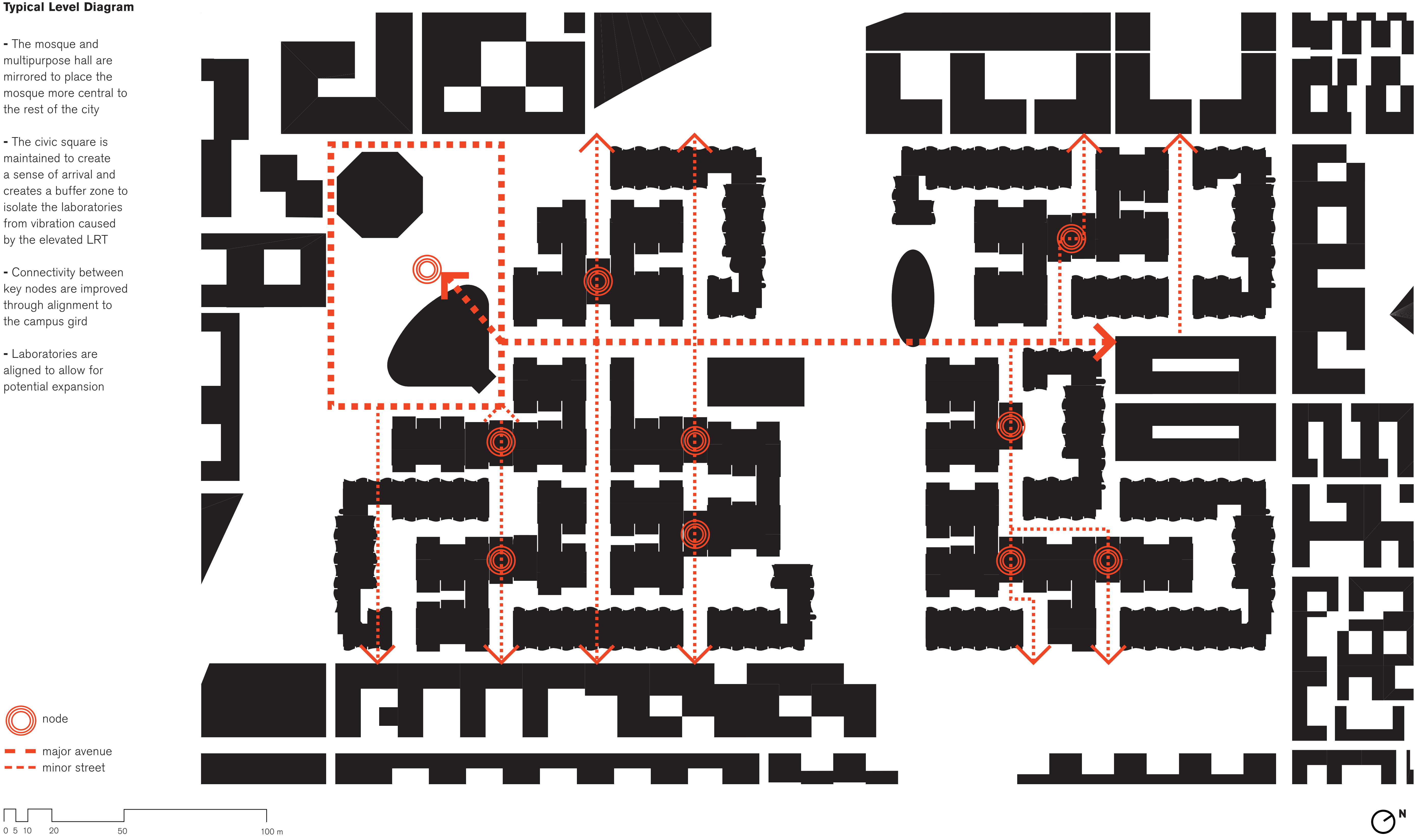
Typical Level Diagram

- The mosque and multipurpose hall are mirrored to place the mosque more central to the rest of the city

- The civic square is maintained to create a sense of arrival and creates a buffer zone to isolate the laboratories from vibration caused by the elevated LRT

- Connectivity between key nodes are improved through alignment to the campus gird

- Laboratories are aligned to allow for potential expansion



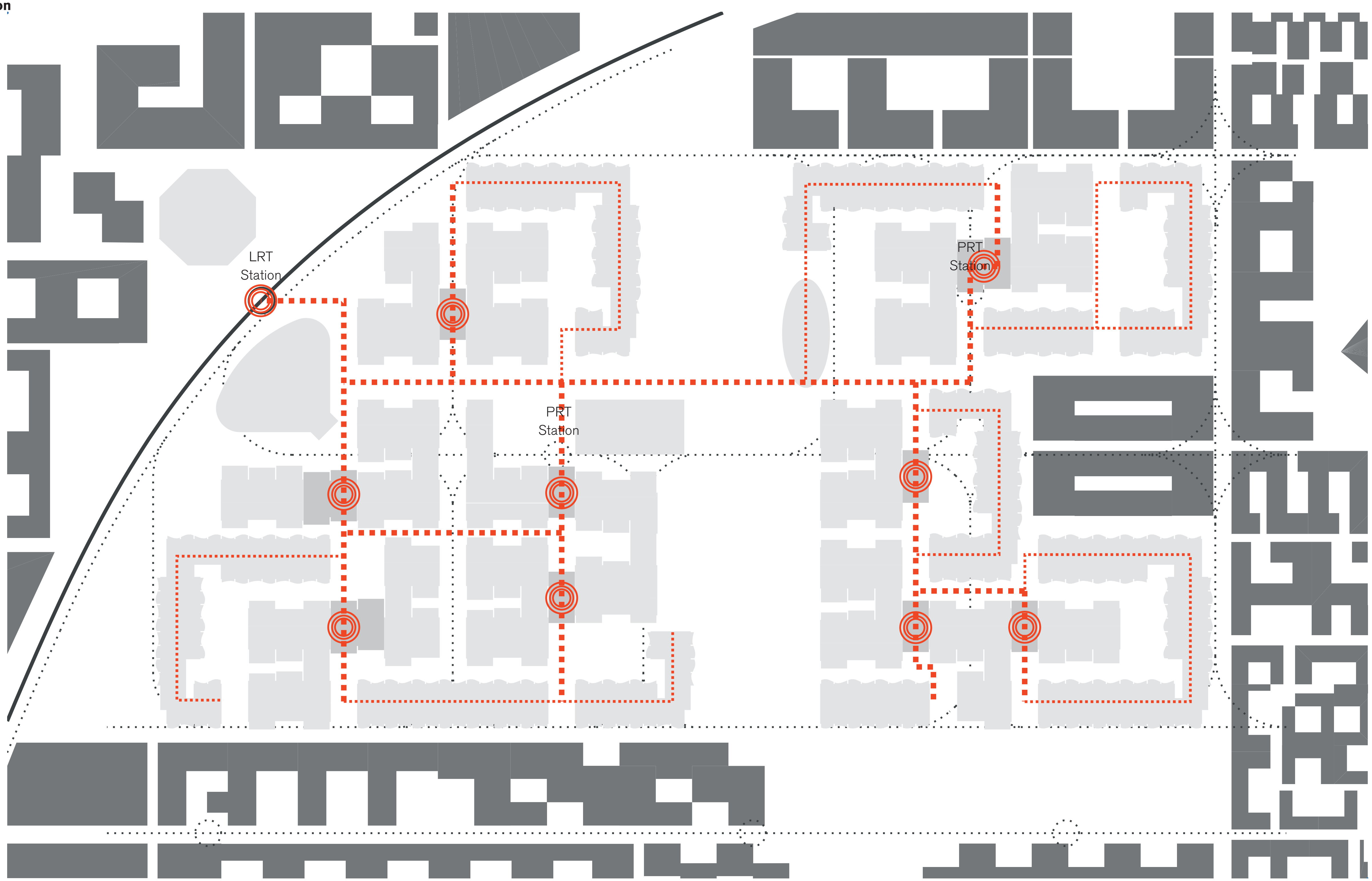
University Masterplan

Master Plan Strategy - Option 3: Streets

Summer Conditioned Circulation

- Summer conditioned circulation is improved through aligning circulation with the campus grid and between laboratory support

- Connections within laboratories and between residential buildings are improved



node

major circulation route

minor residential connection

Master Plan Strategy - Option 3: Streets

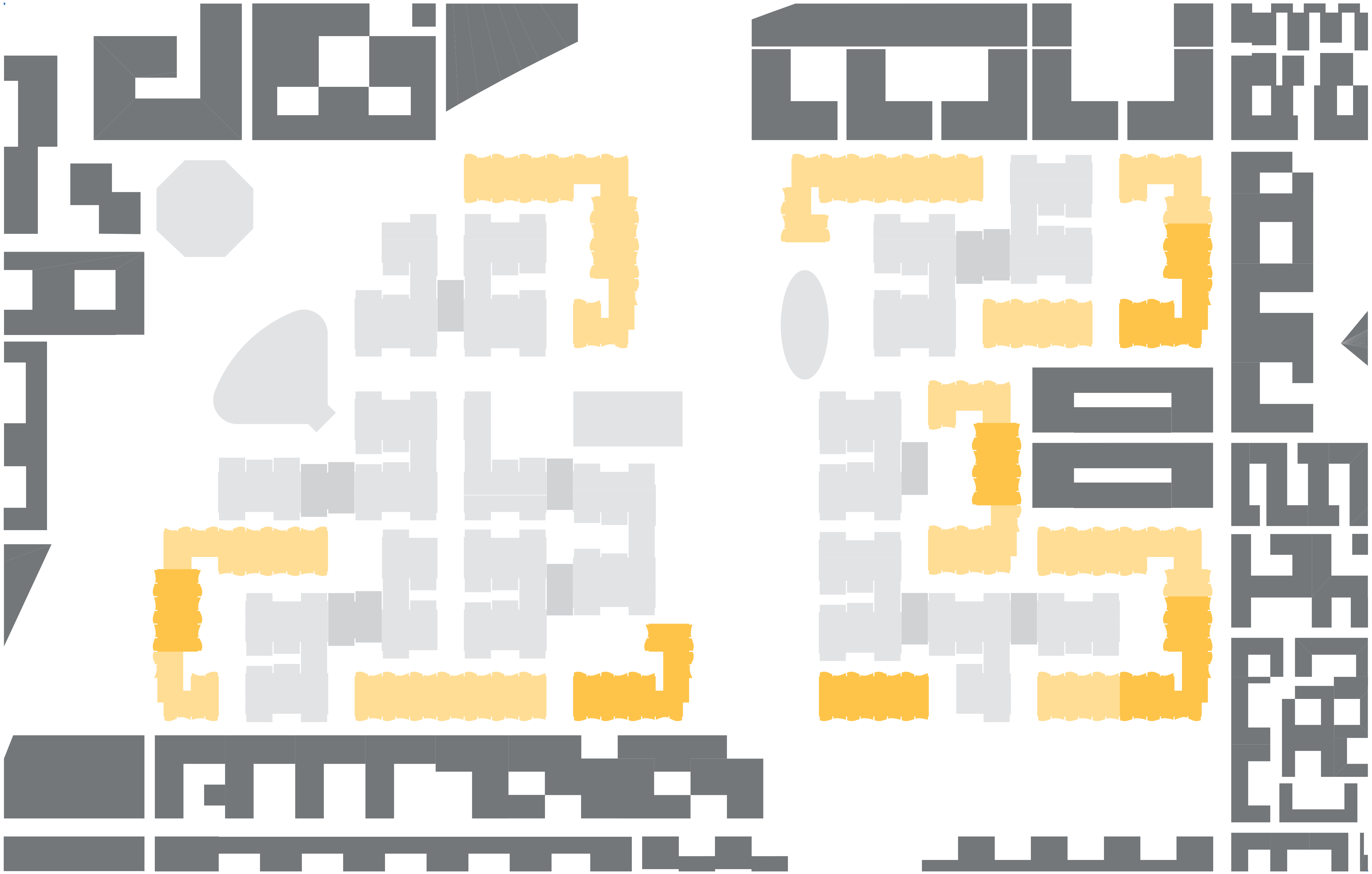
Male / Female Segregation

- Potential segregation options of female from male residential is shown

- Locations are chosen to minimise proximity to laboratories, overlooking and security

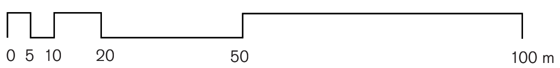
- Locations are remote, often adjacent to courtyards and may be entire buildings or partial floors

- Summer conditioned circulation access would be separated from the main walkway system or integrated with increased security



male residential

female residential



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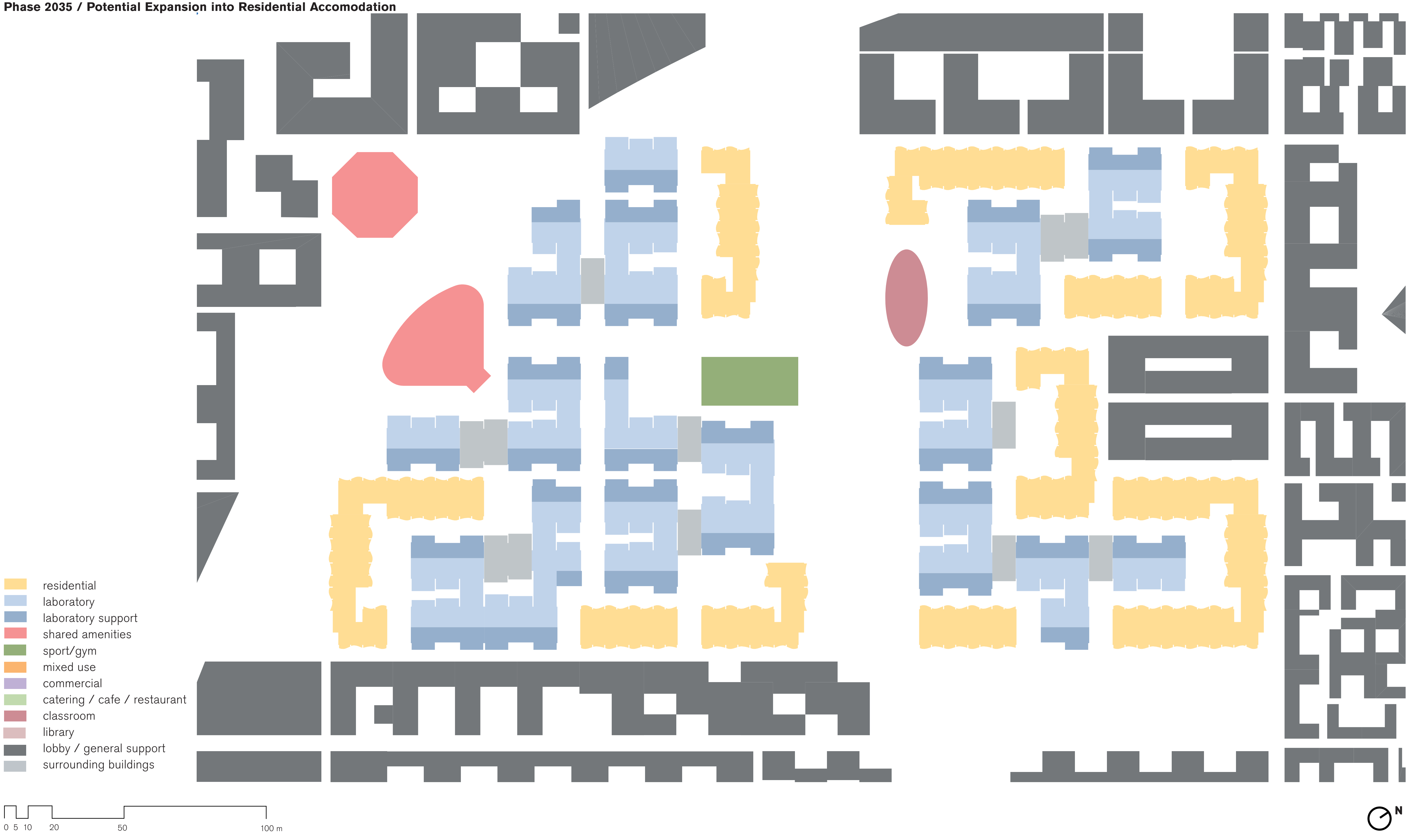
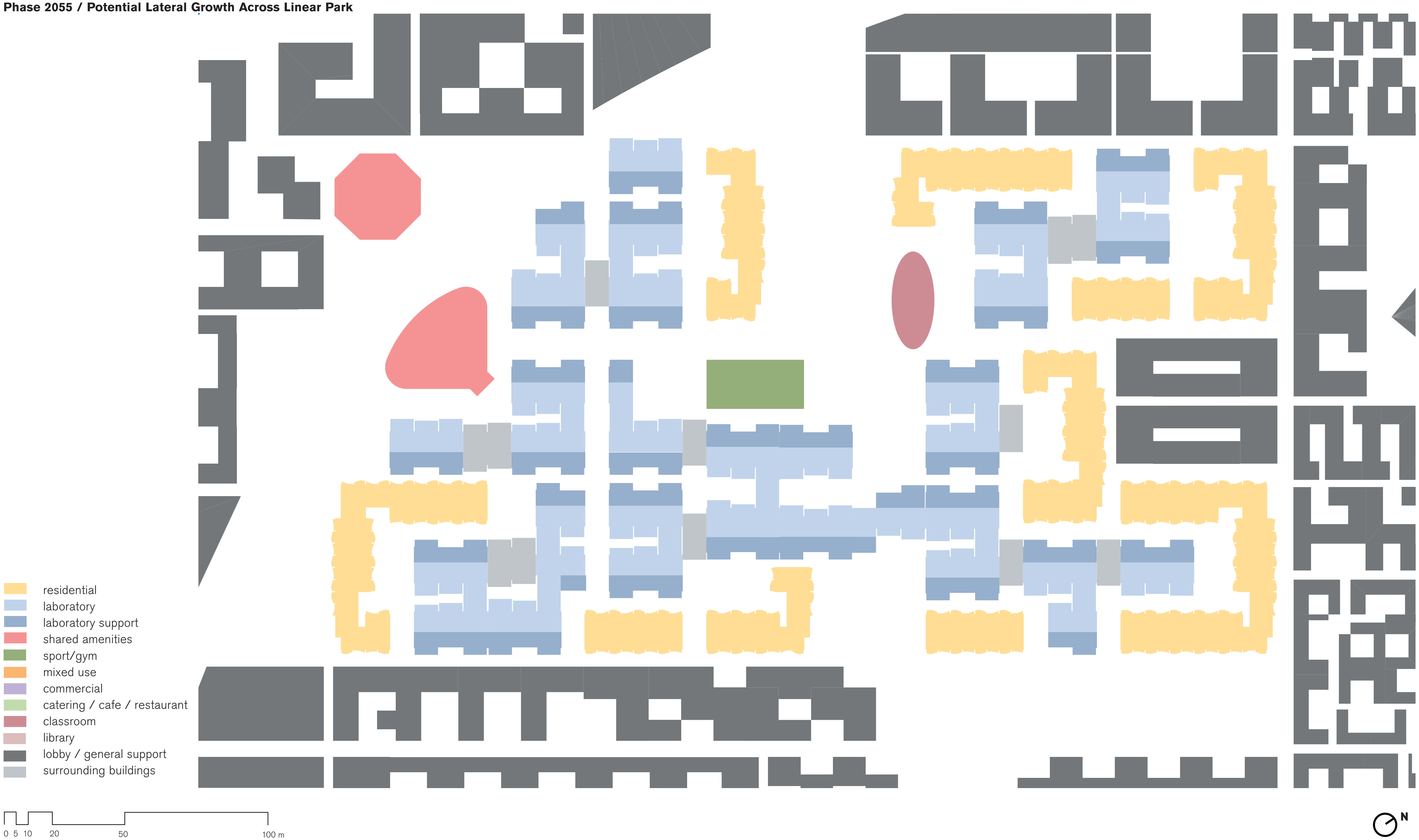
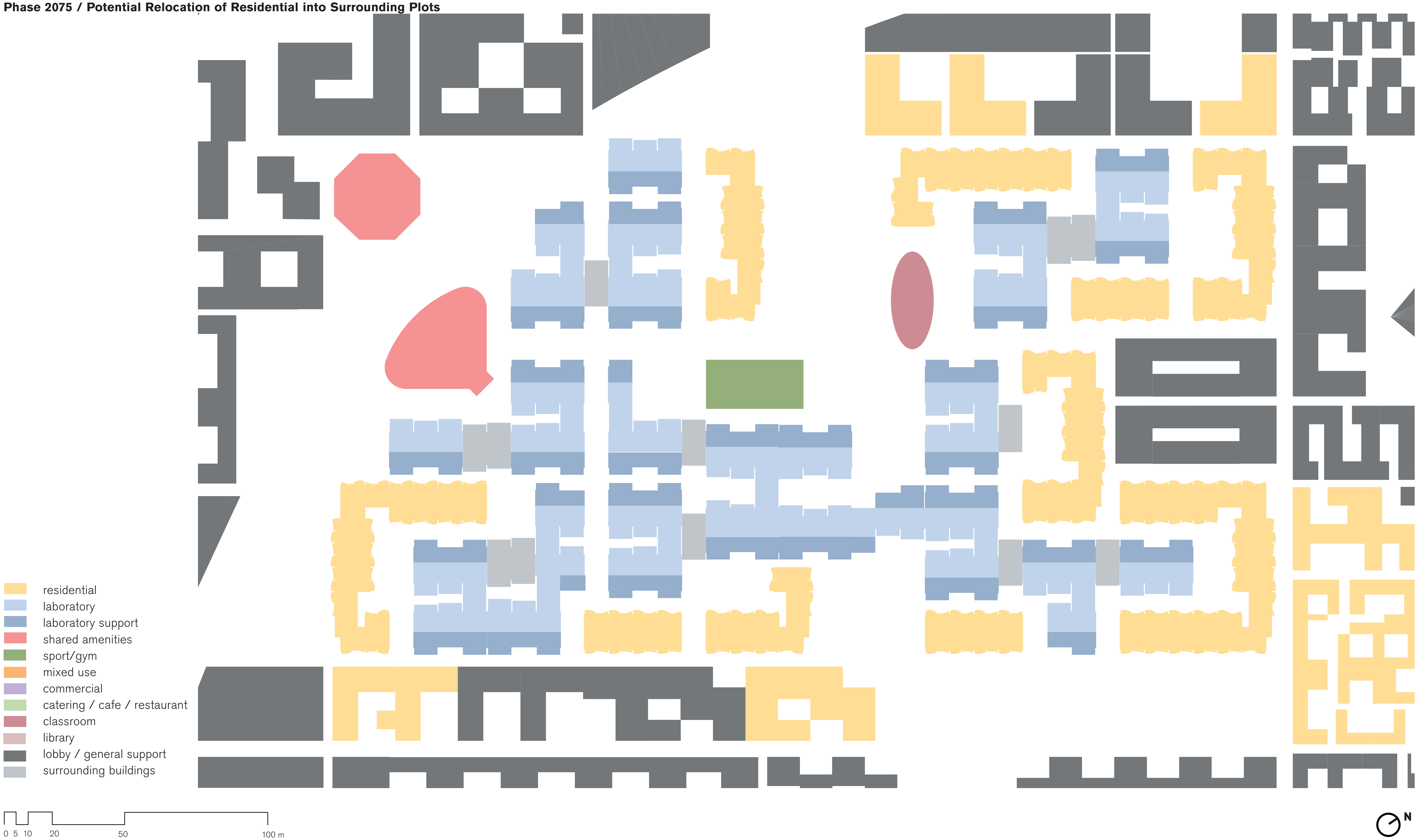
Phase 2035 / Potential Expansion into Residential Accomodation



Phase 2055 / Potential Lateral Growth Across Linear Park



Phase 2075 / Potential Relocation of Residential into Surrounding Plots

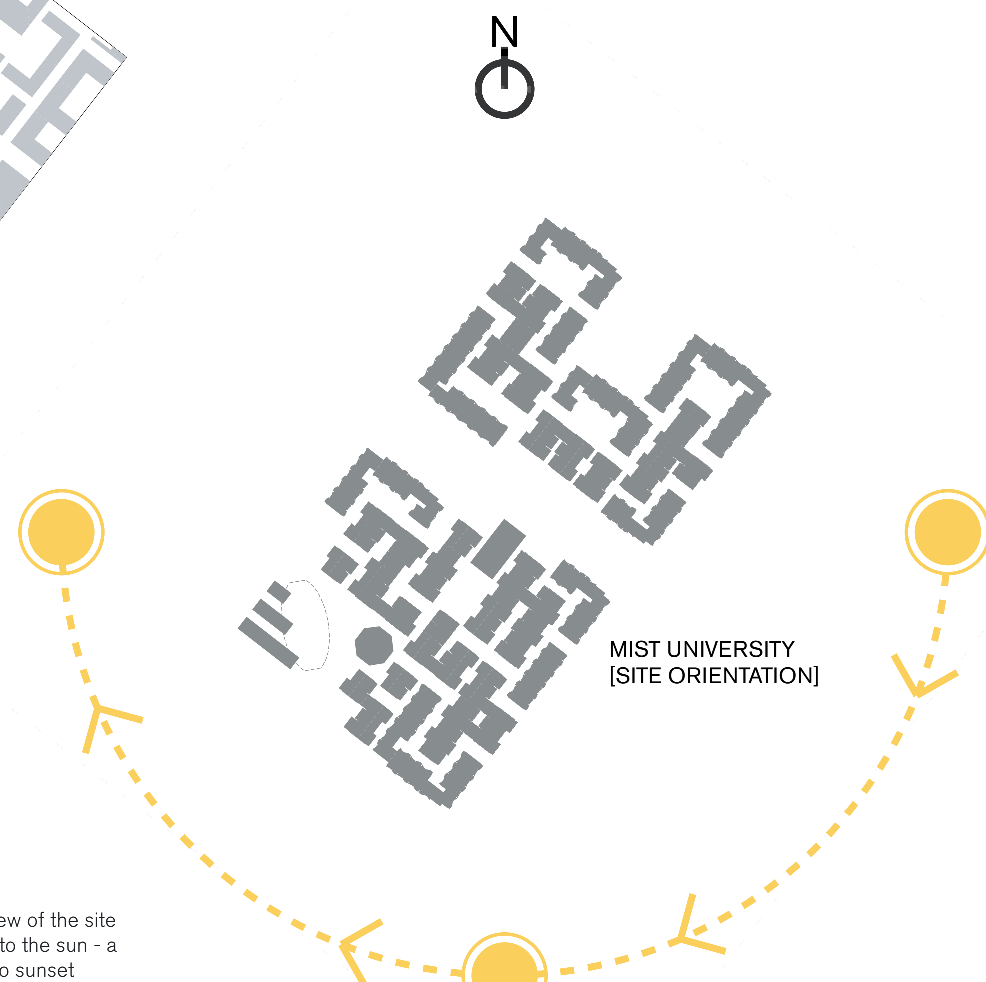


University Masterplan

Pedestrian Walkway and Circulation

General Influence Information

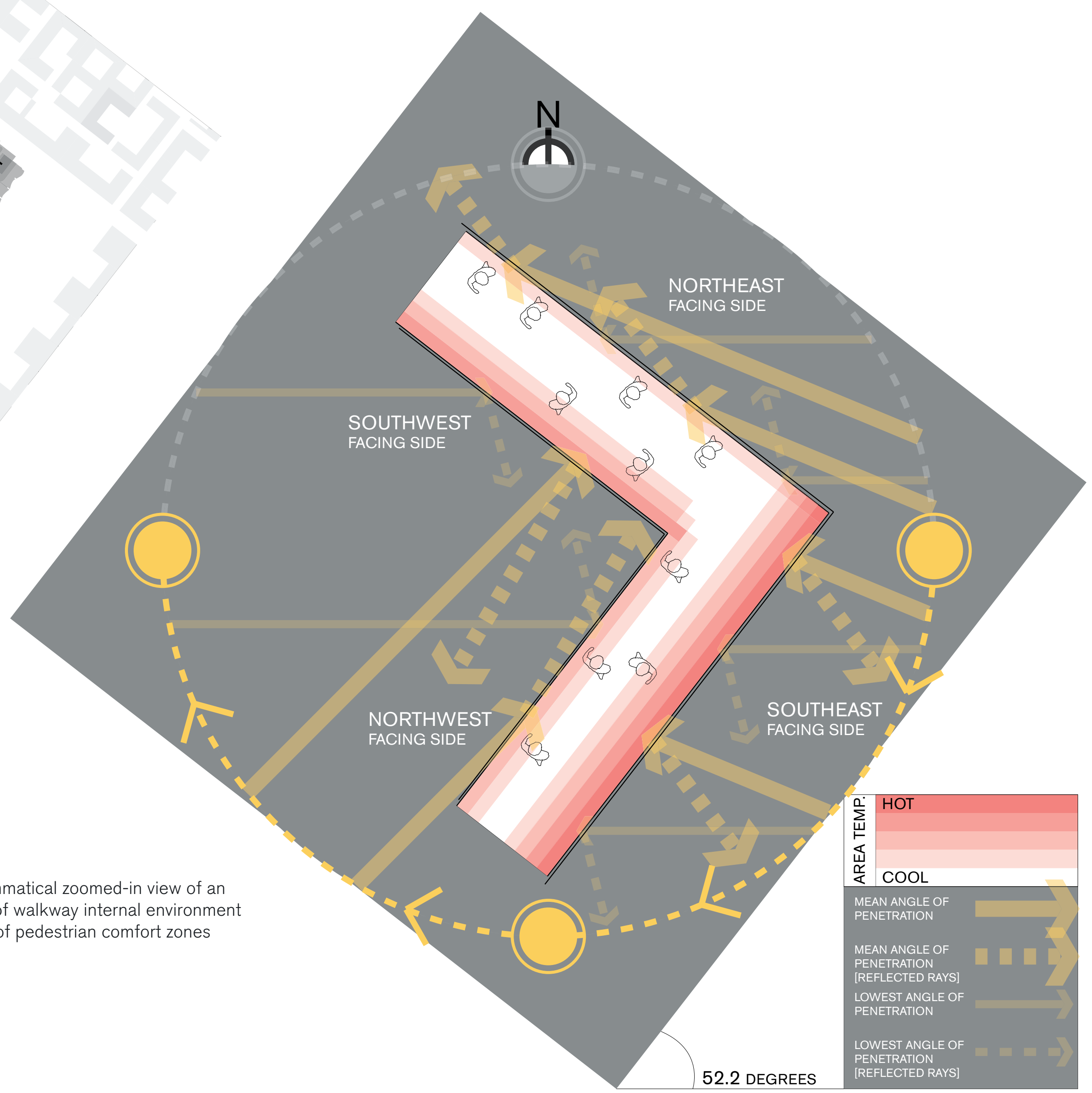
External walkway circulation routes and social centres - social activity generation



A diagrammatical overview of the site in its natural orientation to the sun - a general look at sunrise to sunset

Internal Environment

The natural sunpath's impact on walkway internal environments in terms of heat generation and user comfort

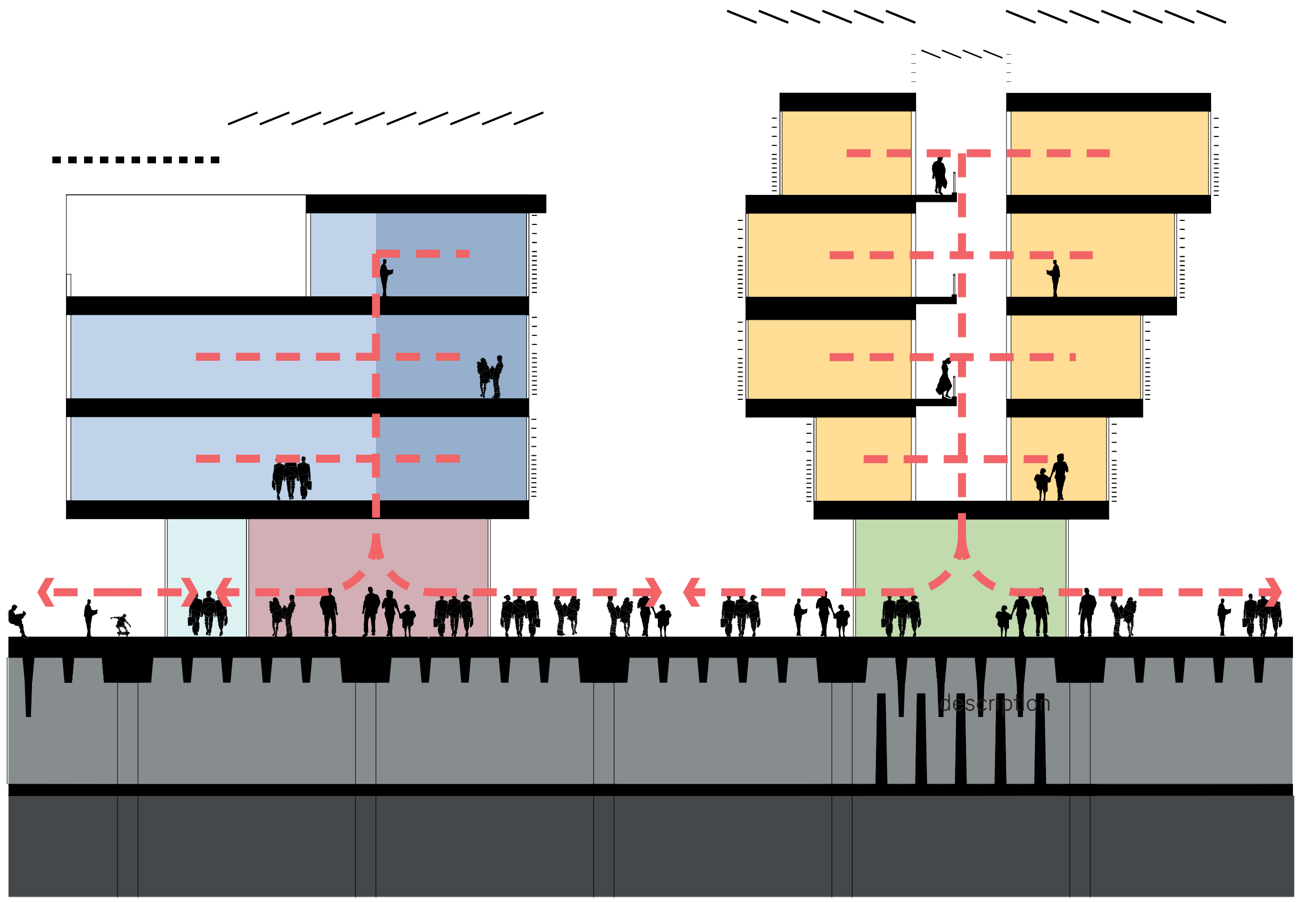


A diagrammatical zoomed-in view of an example of walkway internal environment - a study of pedestrian comfort zones

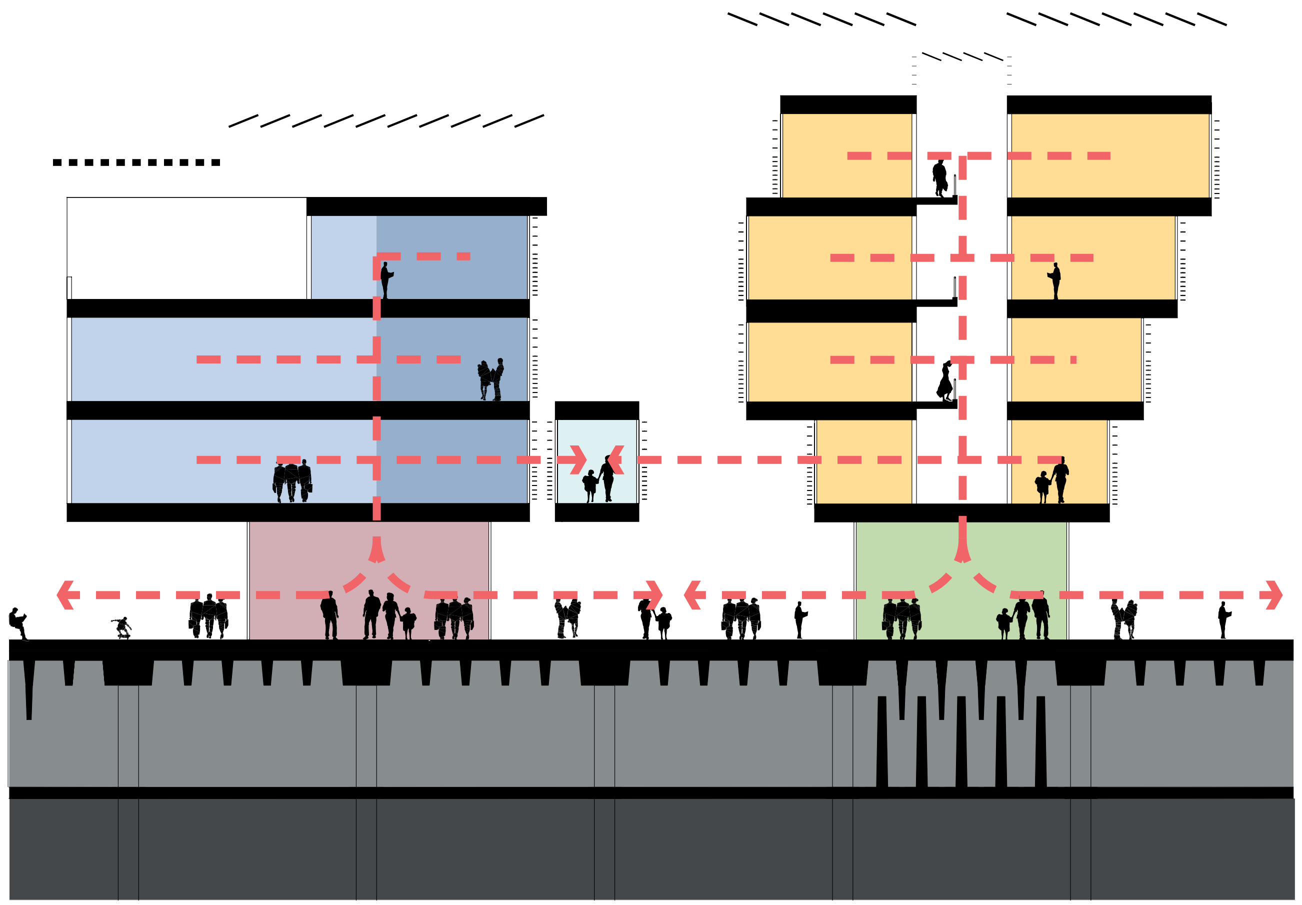
University Masterplan

Pedestrian Walkway and Circulation

Social Activity and Interaction Levels



Configuration 1



Configuration 2

Pros

- due to the main conditioned circulation routes being minimal in quantity, the pedestrian masses from the buildings above are forced to utilise the ground level to circulate within the site, this injects the whole circulating population down into the same ground level which creates maximised activity and interaction on site at all times
- the minimal amount of conditioned walkways means that the energy requirement of supporting the comfortable walkway internal environment is kept to a minimum, thus being very sustainable

Cons

- the pedestrian traffic within individual circulation routes of each building is bottlenecked and increases overall travel times within the site

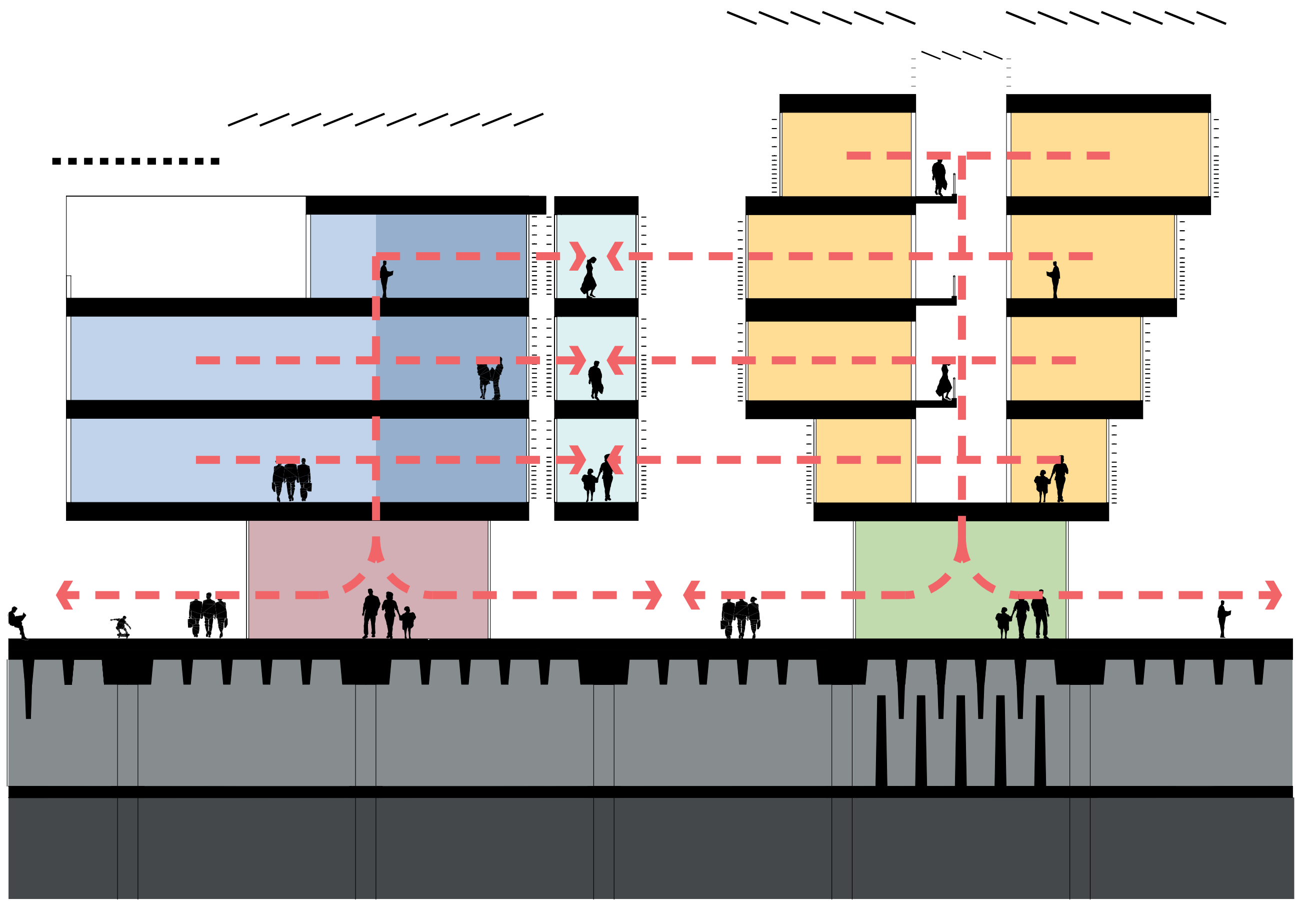
Pros

- the inclusion of an overhead walkway allows for greater shaded real estate options for the ground level allowing for an increase in area of comfort zones (useable area)
- general circulation convenience on site is increased slightly overall
- more interesting and more varied views through the space are created which allows more "scenic" routes as options for pedestrians

Cons

- introducing raised walkways diverts the circulating population away from the intended active ground level

Social Activity and Interaction Levels



Configuration 3

Pros

- circulation convenience and options are maximised allowing for efficient pedestrian travel times
- the raised walkways create better visual connections across the site for those who choose to circulate at higher levels

Cons

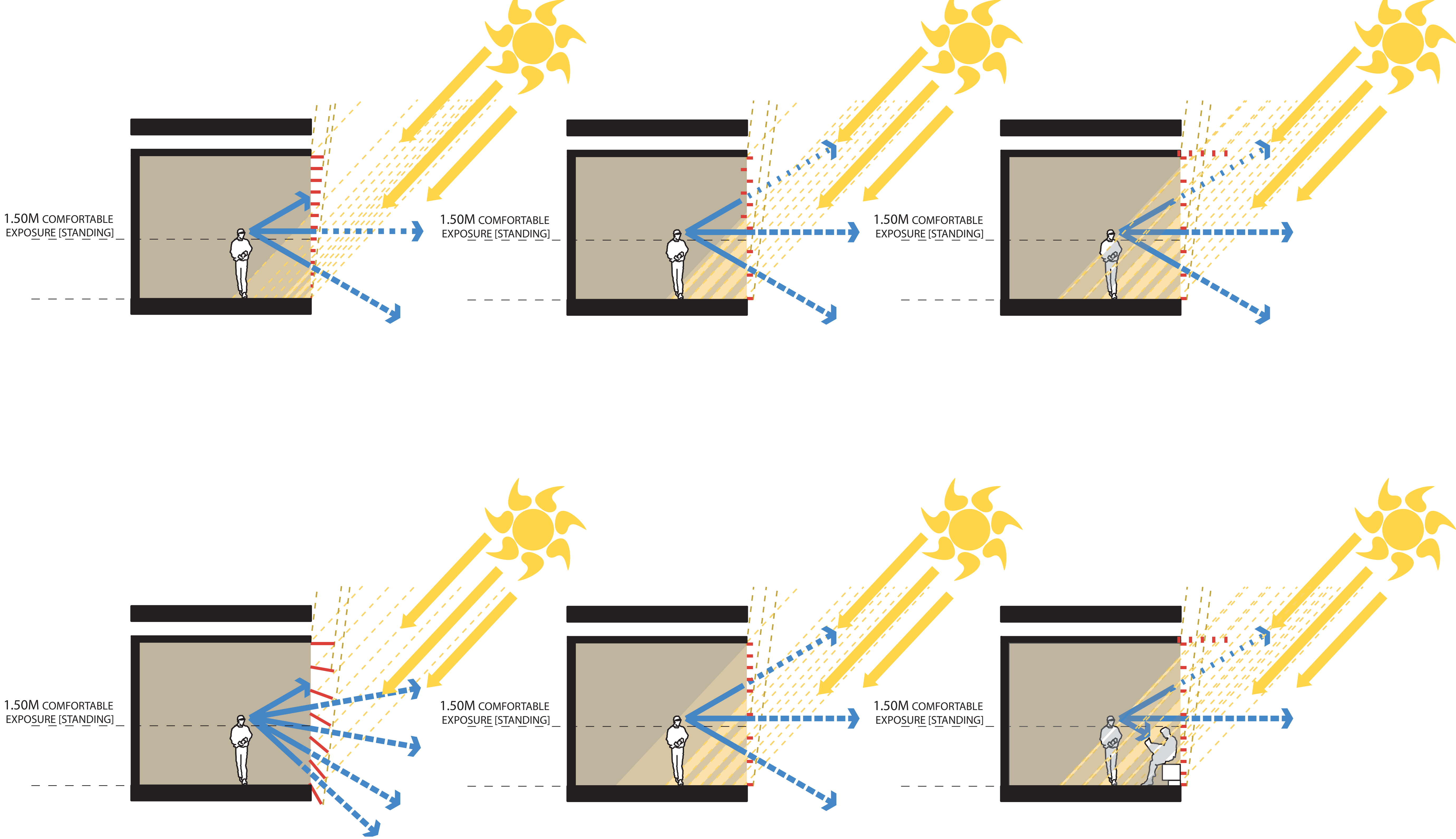
- increased density of walkways directly relates to the amount of energy needed to support the conditioned internal environment, thus not as sustainable as the other configurations
- maximising raised walkway circulation demotes social gathering/activity/interaction on the ground level which works against the design proposal concept

Comments

From Configuration 1 to Configuration 3, a clear pattern is shown where the increasing amounts of raised walkways are inversely related to the amount of pedestrian and social activity that occurs at the ground level

The intentions of the design proposal insist that there should be increased pedestrian and social activity on the ground level, which promotes a lively, attractive, almost 24hour ground level zone for which social interaction, intellectual convergence and community building can flourish and generate greater social activity

Shading System Studies 1

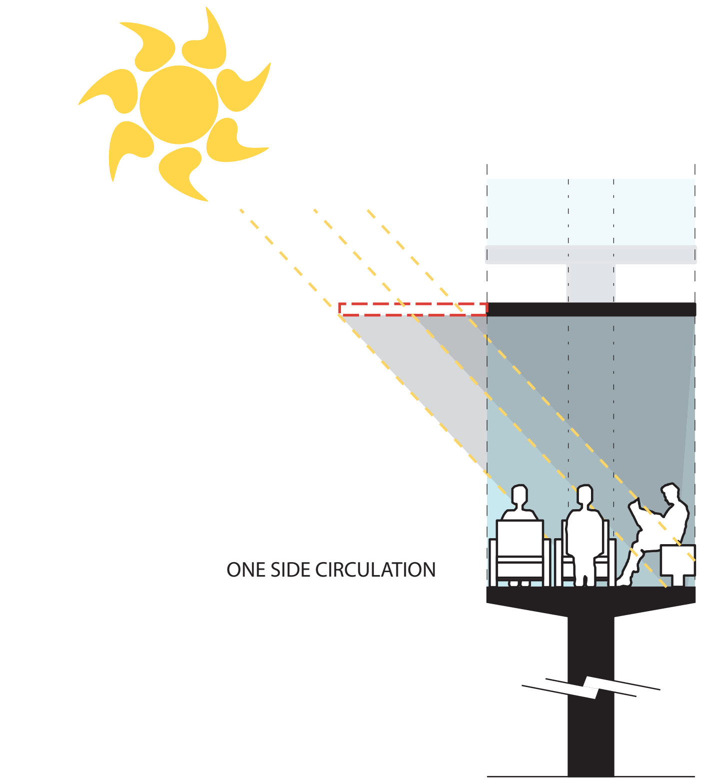


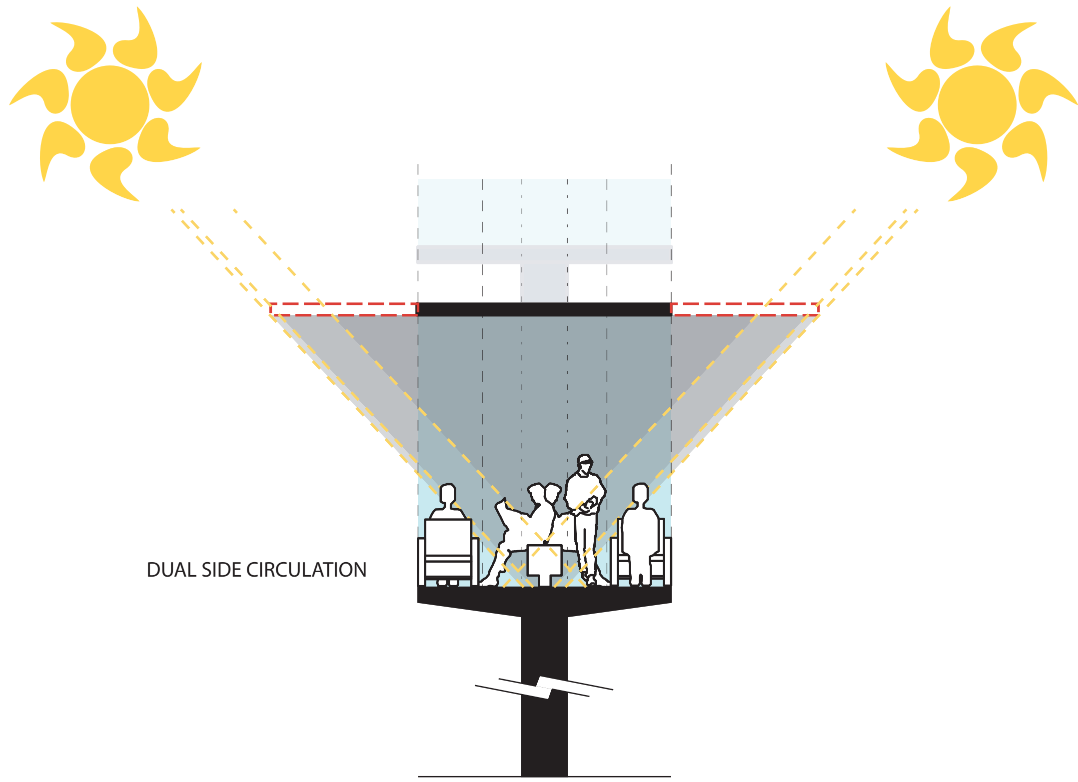
Shading System Studies 2

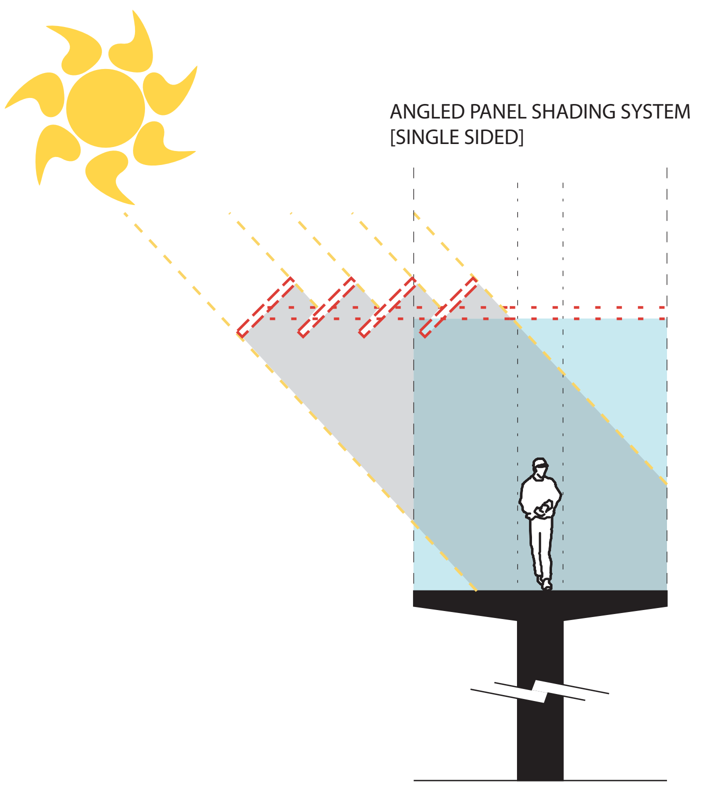
Circulation options
- as proposed, the walkways may contain seating areas which provide pedestrians places where they can rest, relax, enjoy the view and socialize
- the seating areas are ideally placed further away from the more sun exposed areas of the walkways
- seating either to one side or somewhere in the middle of the space allows for varied circulation routes; single sided circulation with 2-way pedestrian traffic lanes, and double sided circulation which can house 1 or 2 way traffic on each side

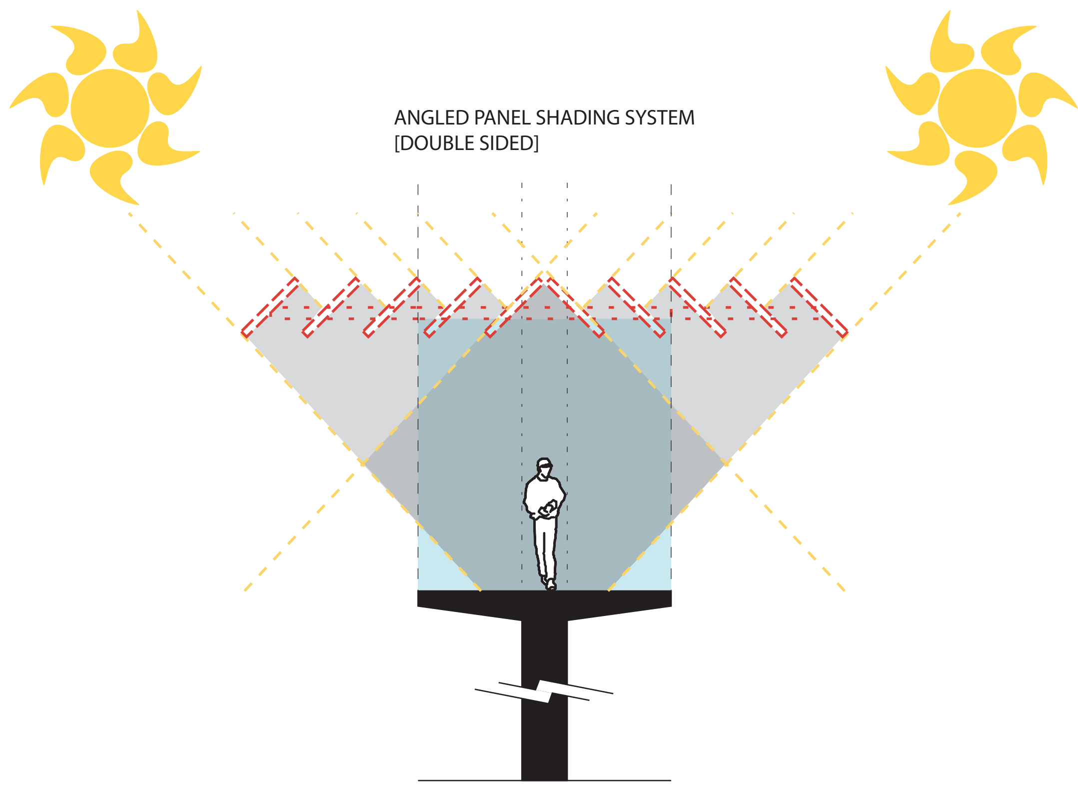
Angular roof panels
- the integration of angled roof panels means that whilst shading the walkway occupants, the in-direct light from the sky can provide lighting for the internal space

Winter and summer sun angles
- as the summer sun angle (87 degrees) is vertical, the winter sun angle (43 degrees) has been utilised most in the studies for shading systems as this angle has the more horizontal penetration into the walkway spaces



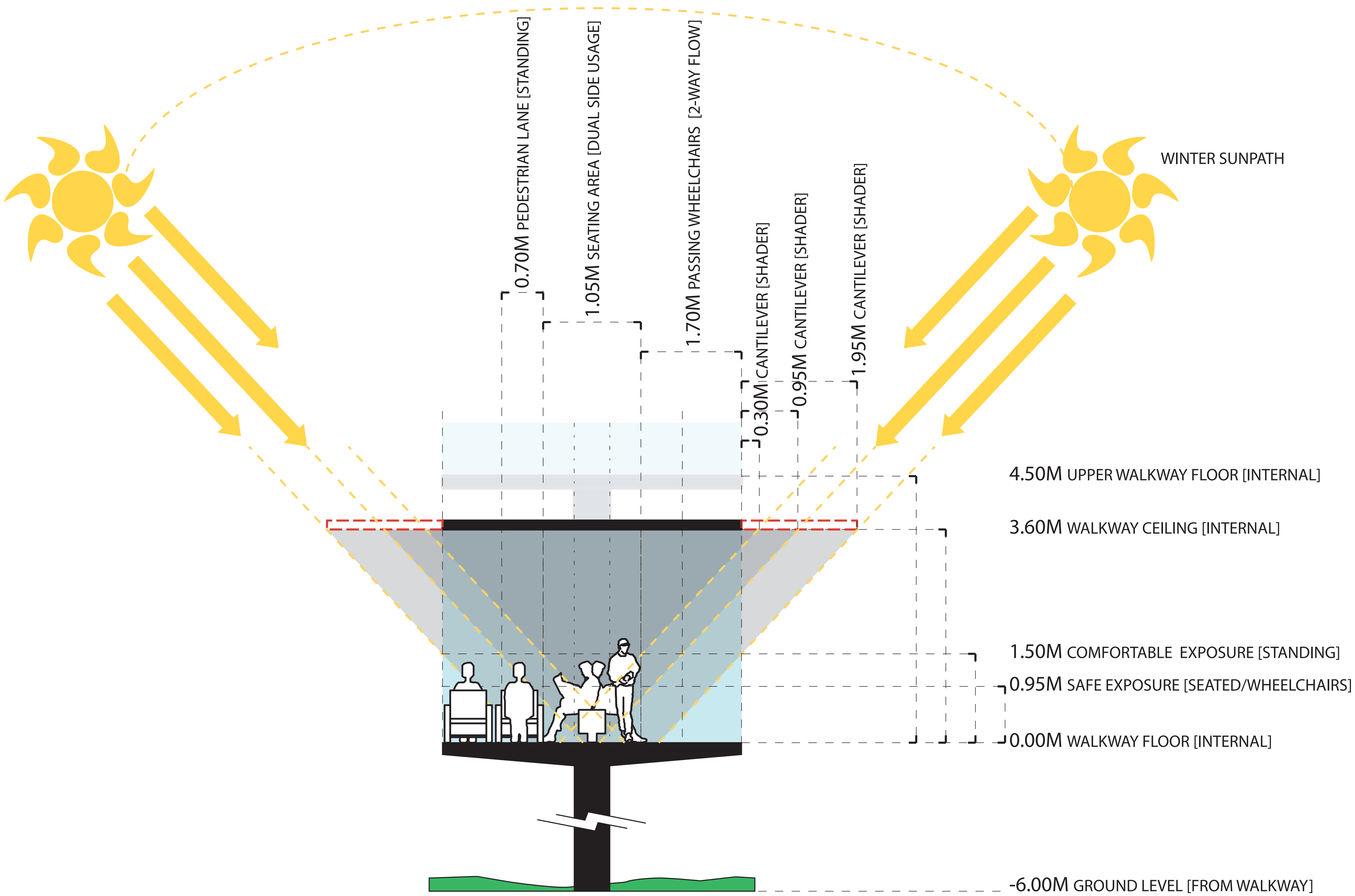






Shading System Studies 3

Shading impact on internal usage
- according to how the shading functions and the area that it provides, the internal make-up of the walkways need to be configured accordingly so that the maximised space is entirely a comfort zone for pedestrians
- also, when considering different circulation paths and internal features and communing spaces, the shading needs to adequately protect the users of the space no matter the nature of proposed activity, i.e, users who are seated or pedestrians using wheelchairs etc create a lowered height range for internal comfort zone
- the comfort level for pedestrians standing, and either sitting or in wheelchairs etc, are 1.50m and 0.95m respectively

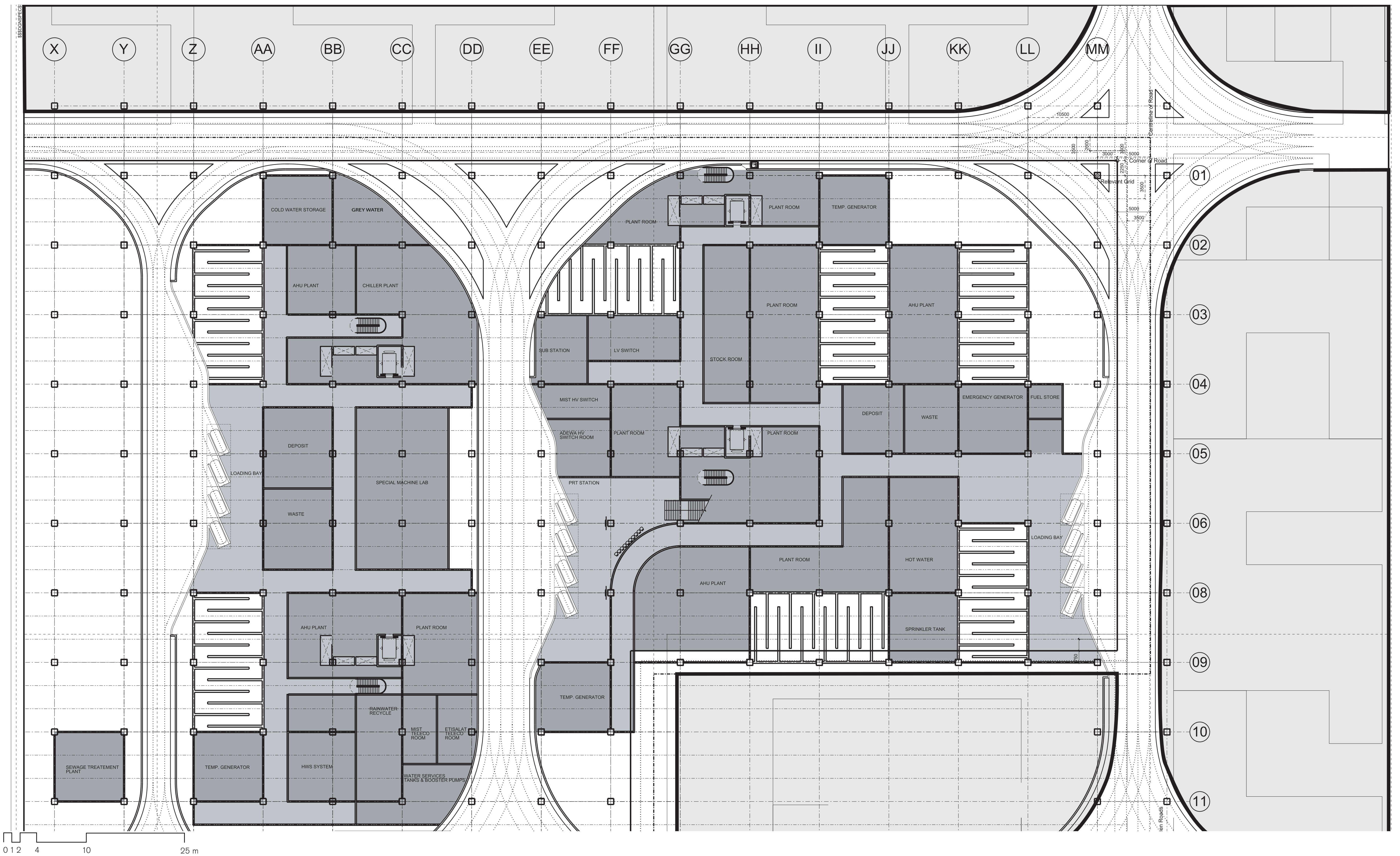


10

Illustrative Masterplan

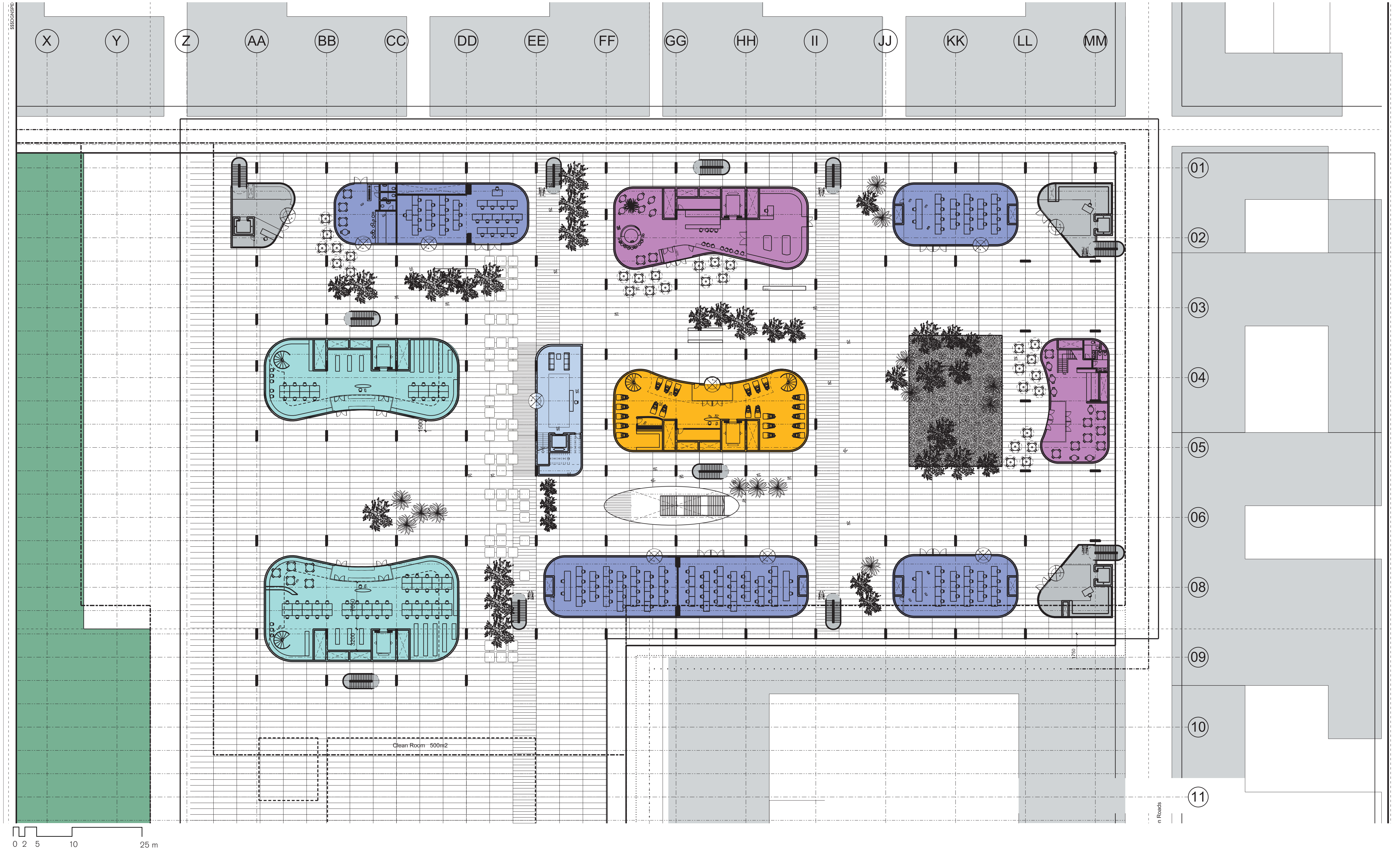
General Arrangement Drawings

PRT Level Plan



General Arrangement Drawings

Ground Floor Plan

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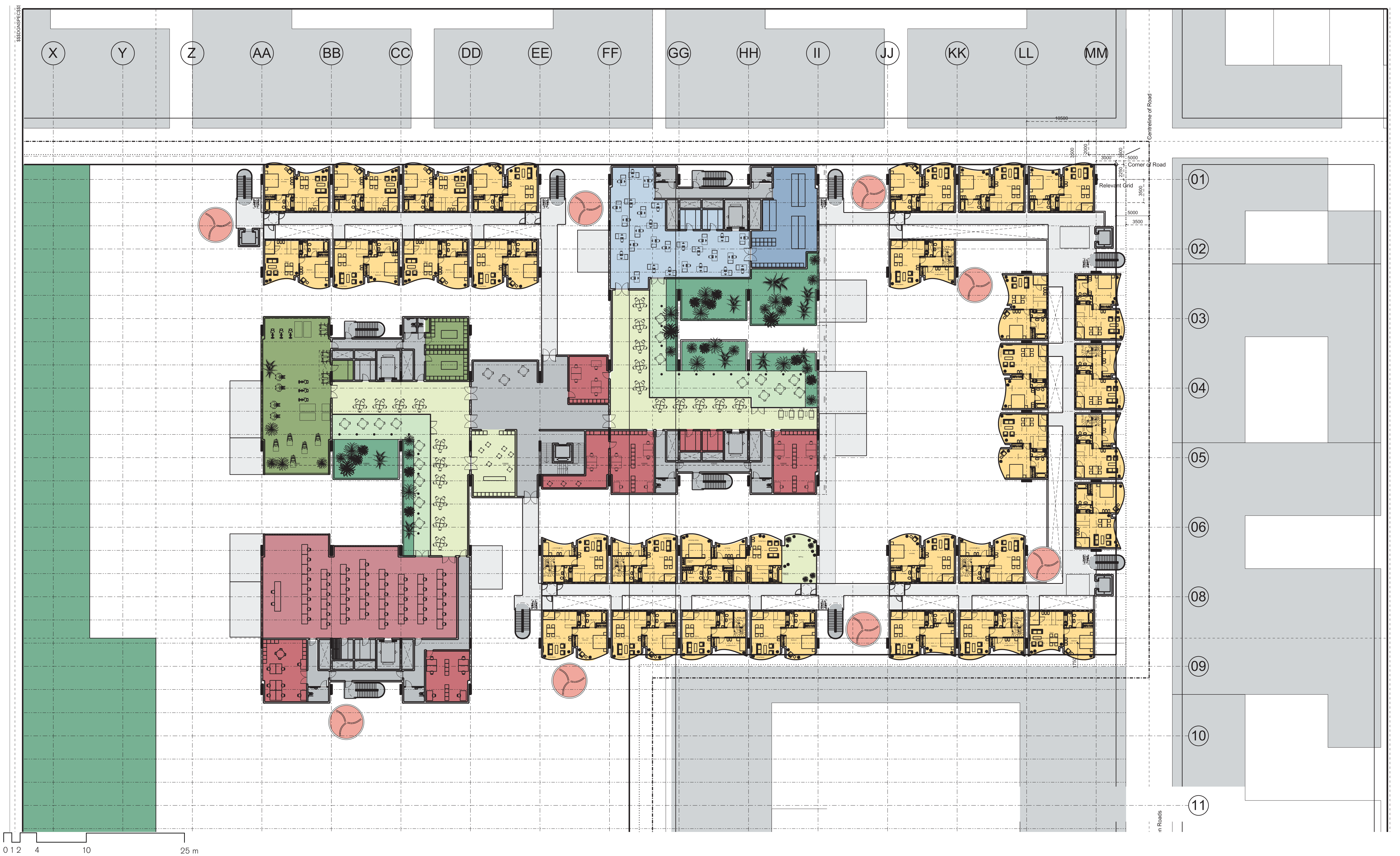
Centreline of Road
Corner of Road
Relevant Grid
0 1 2 4 10 25 m

General Arrangement Drawings

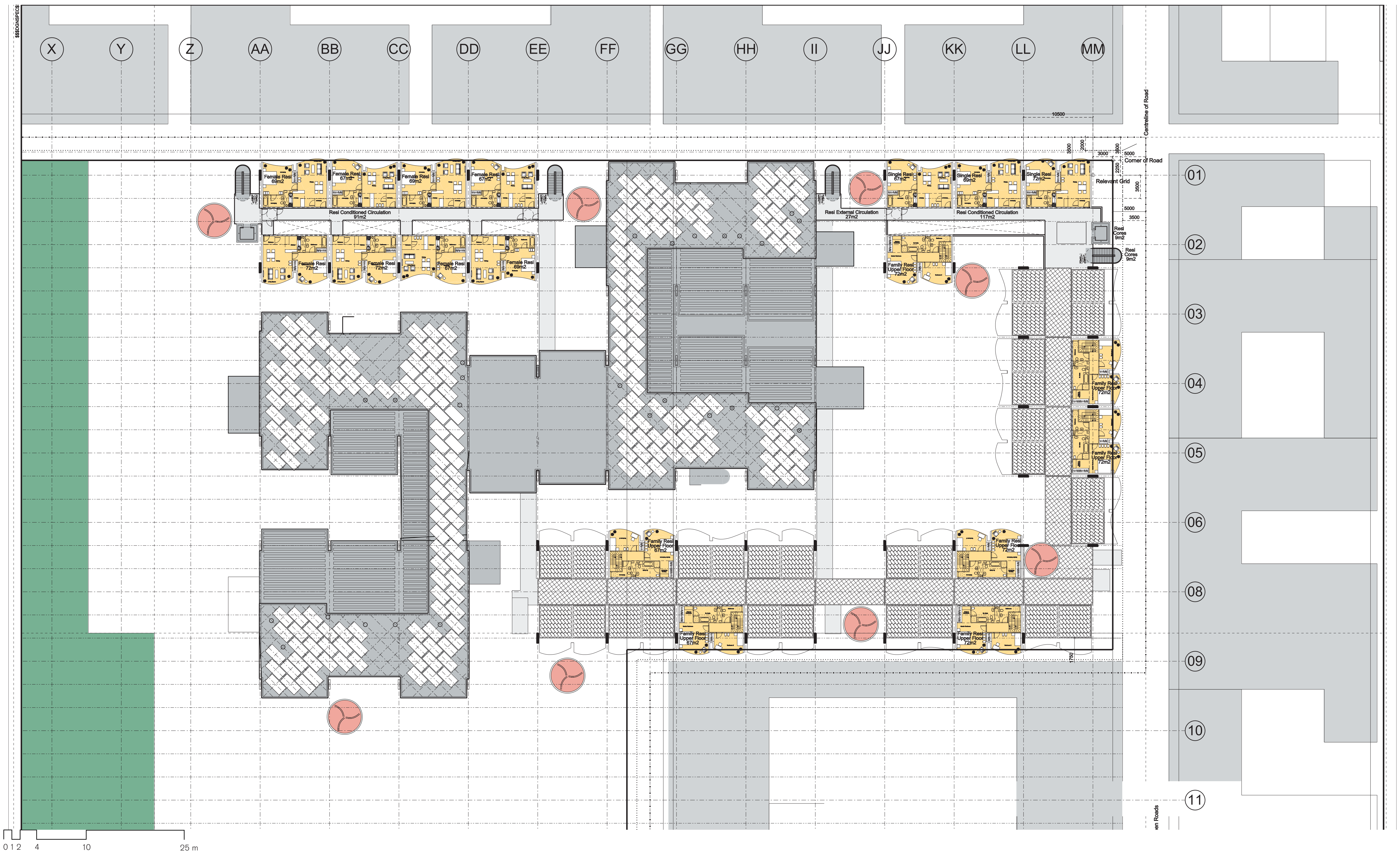
Level 02

General Arrangement Drawings

Level 03



Level 04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06
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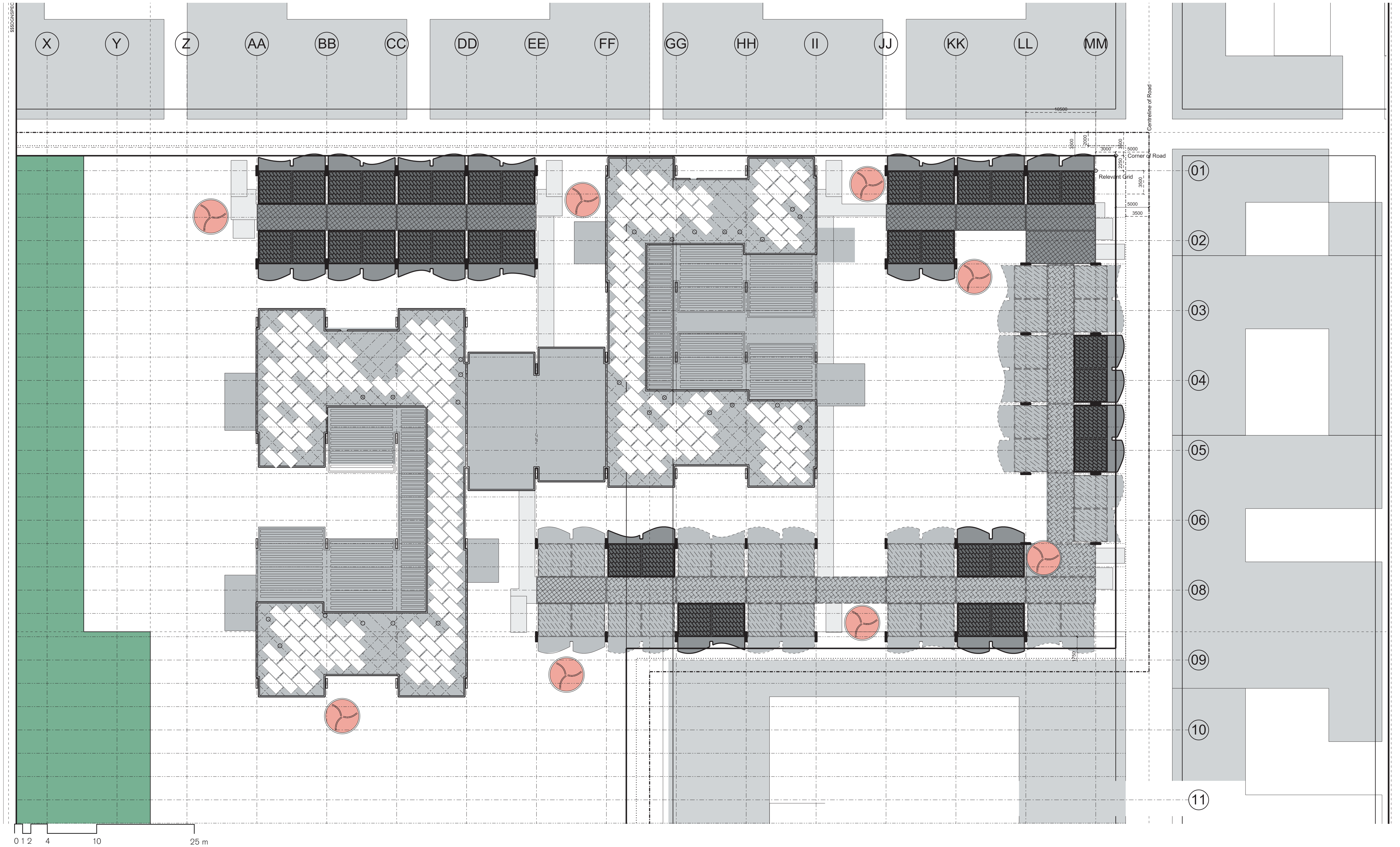
11
Centreline of Road
Corner of Road
Relevant Grid
Resi Conditioned Circulation
Resi External Circulation
0 1 2
4
10
25 m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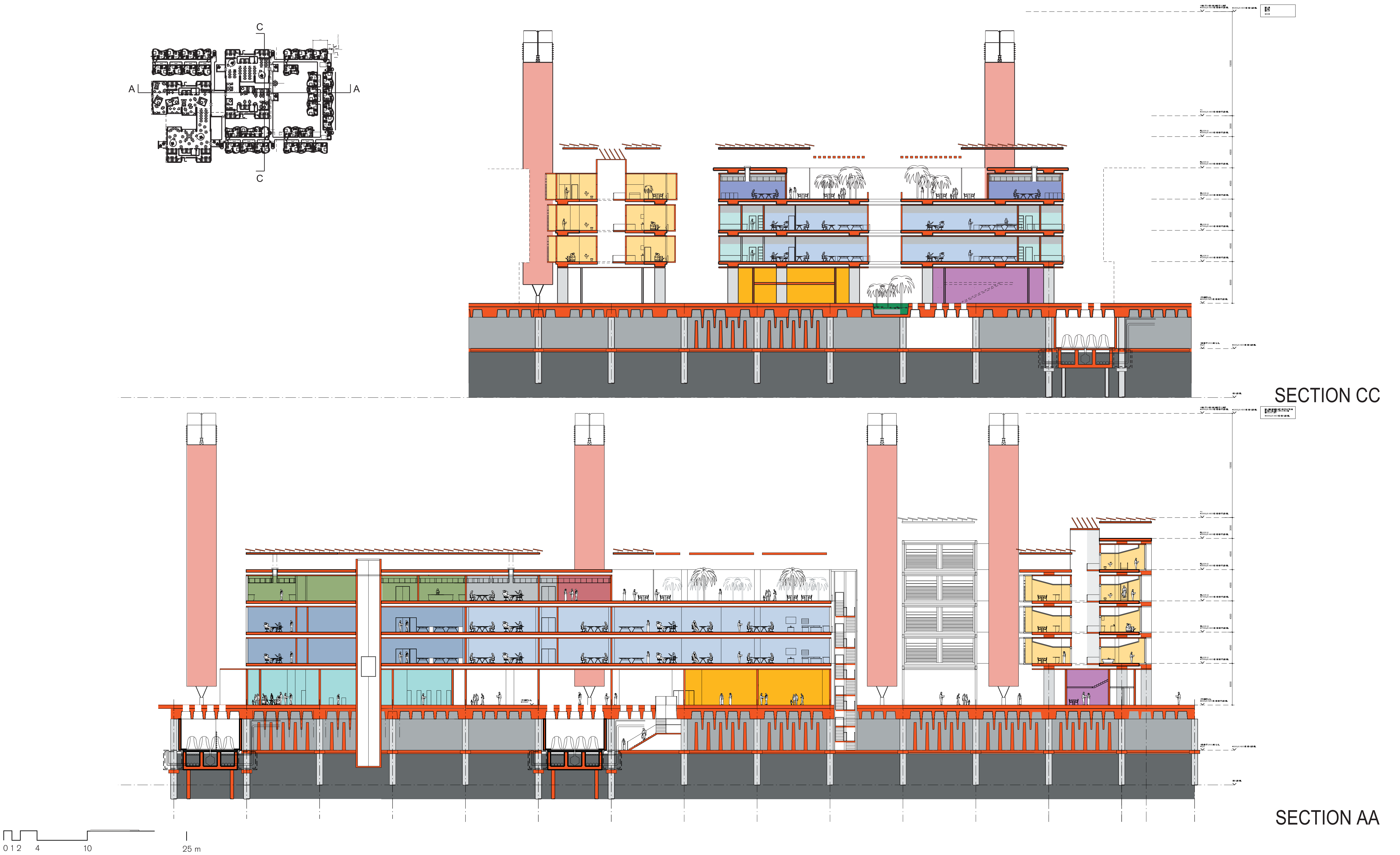
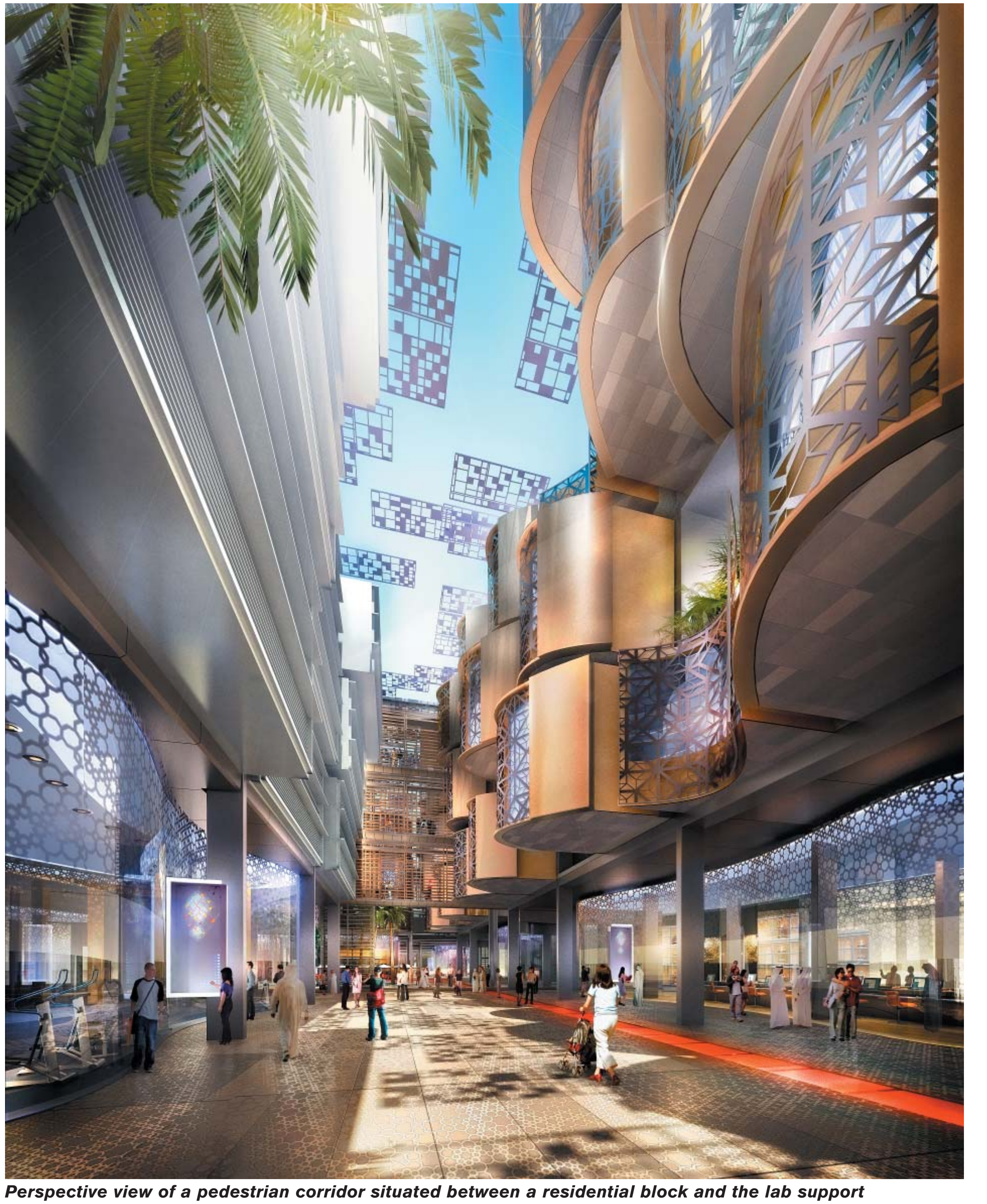
Centreline of Road
Corner of Road
Relevant Grid
0 1 2
4
10
25 m

General Arrangement Drawings

Sections A-A C-C



Illustrative Ground Floor Plan-Phase 1A

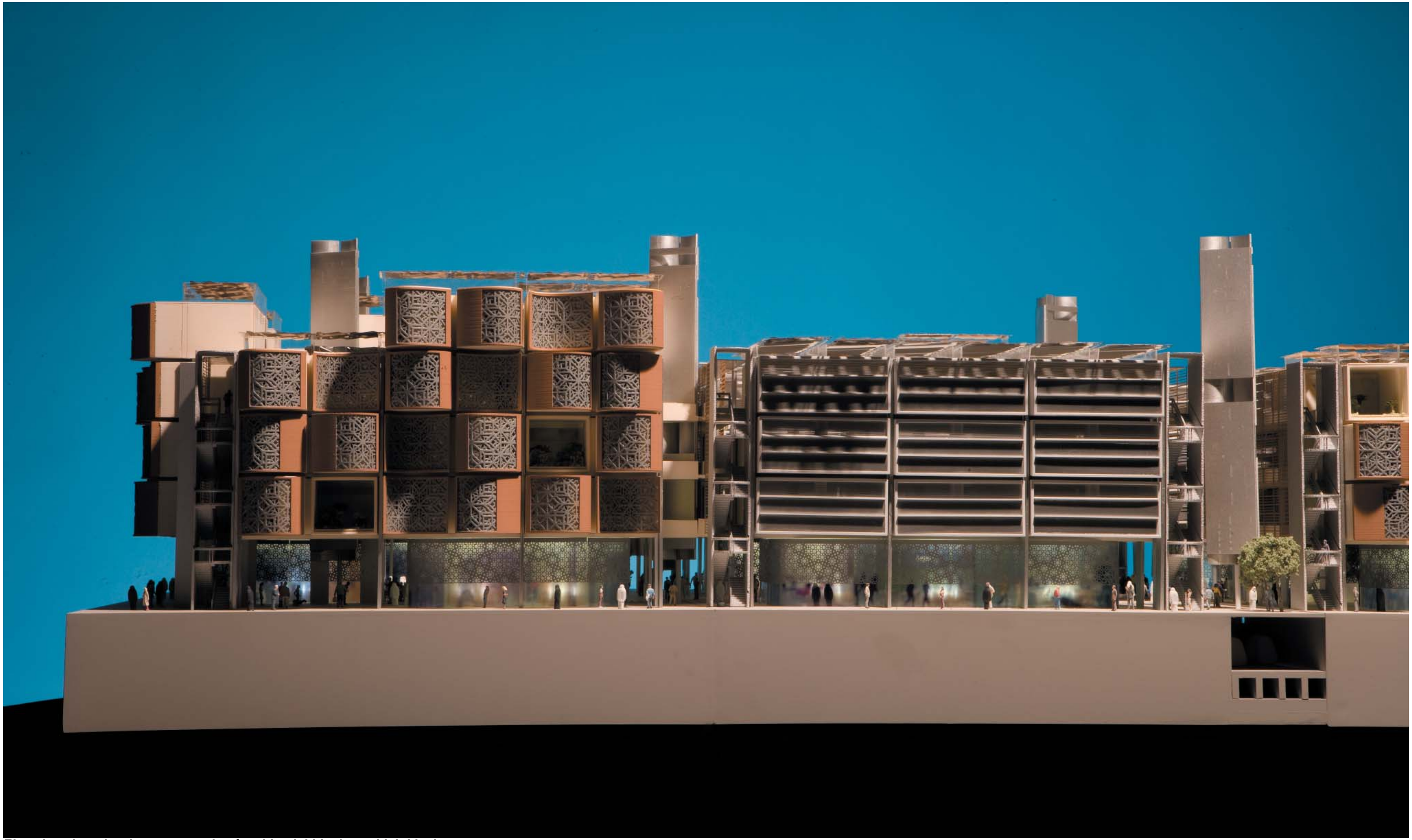


Perspective view of a pedestrian corridor situated between a residential block and the lab support

Perspective view of a pedestrian corridor situated between two lab support blocks

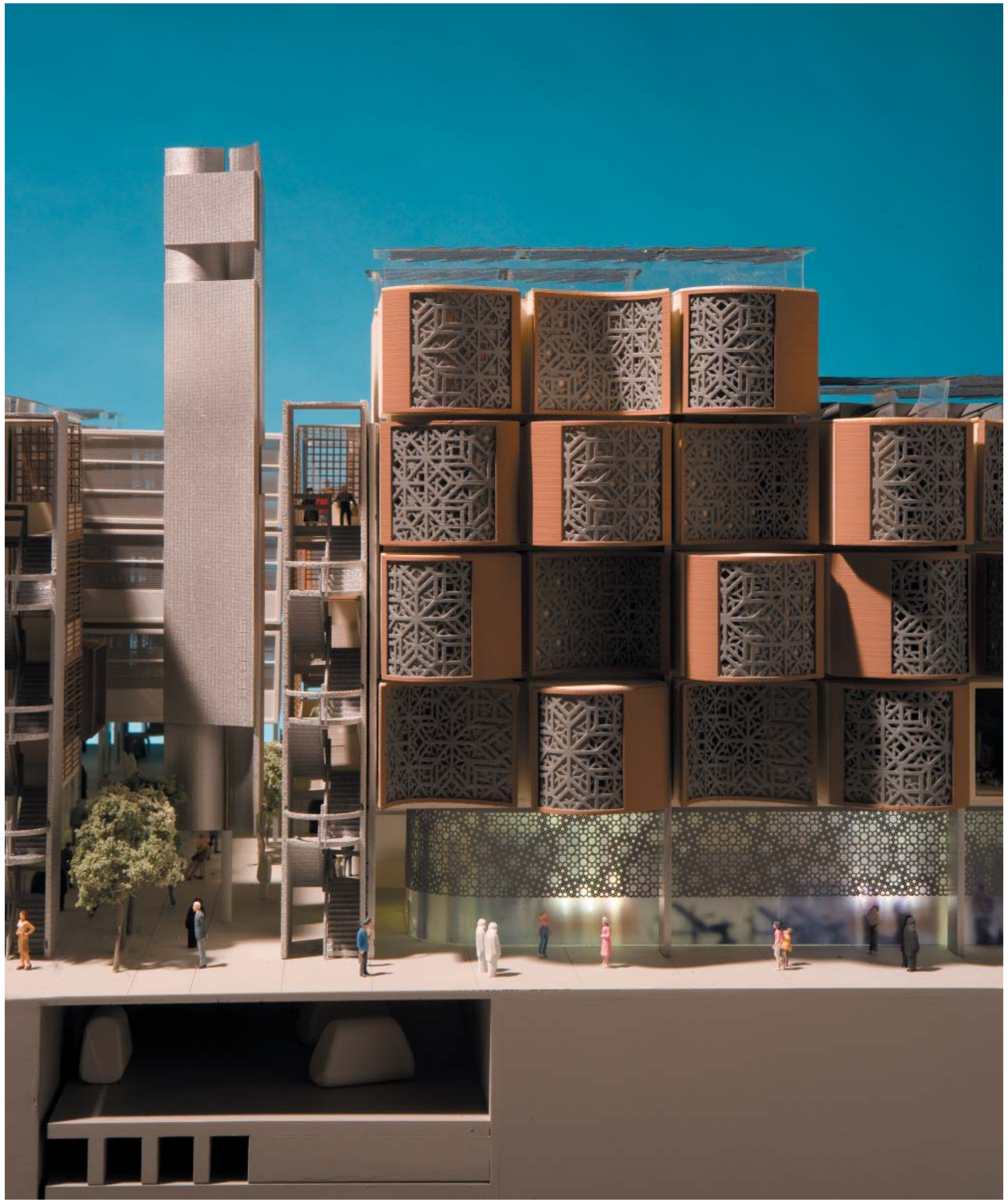
Perspective view of a public square surrounded by residential blocks

Perspective view looking down to a pedestrian corridor situated between a residential block and the lab support

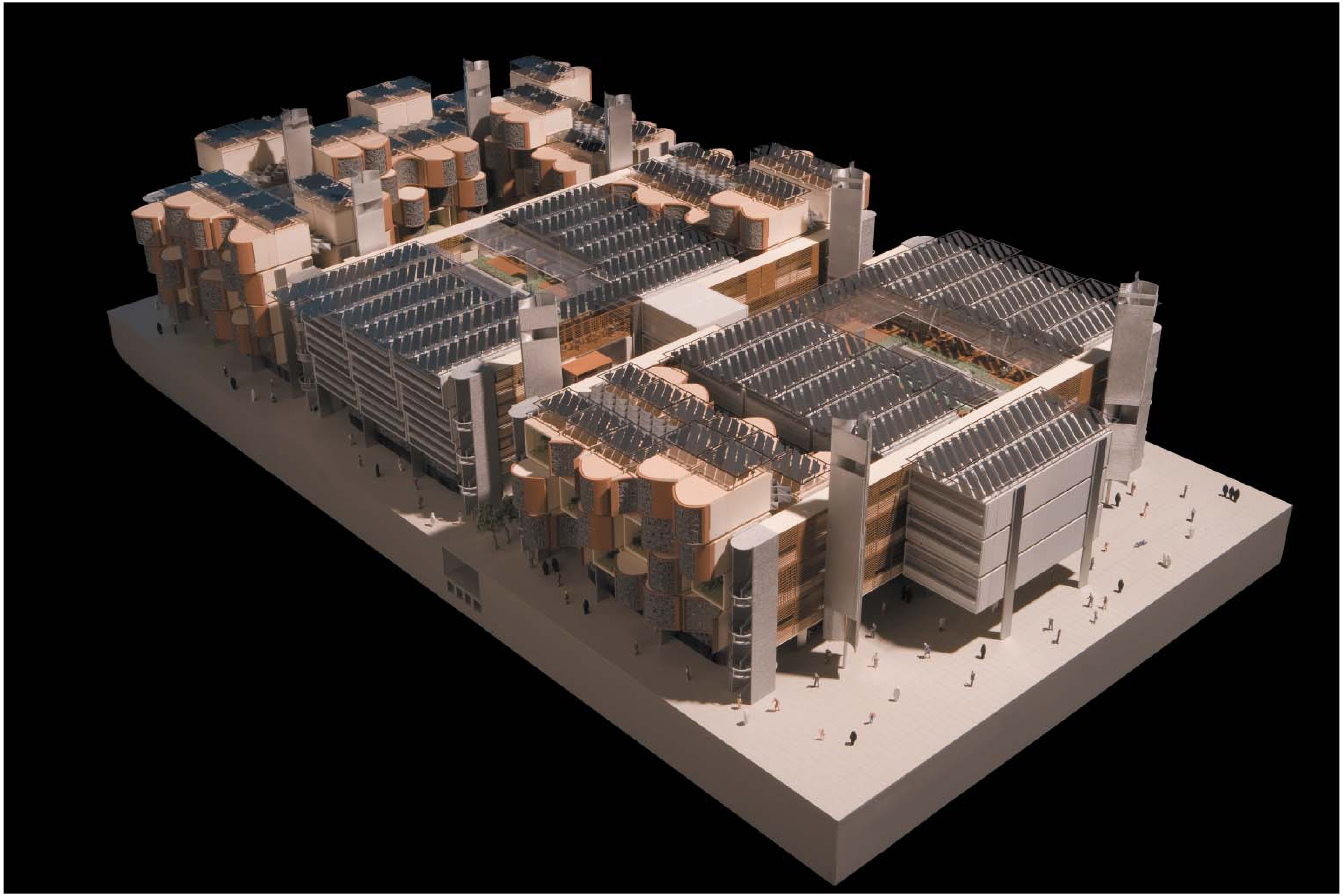


Elevation view showing an example of residential blocks and lab blocks

Close-up bird's-eye view of a public square surrounded by residential blocks and a lab block



Elevation view showing an example of how a residential block relates to the PRT system below



Bird's-eye view of the overall Phase 1A proposal

Phasing

Plot Area 62,077 sq.m not including Green Finger.

Phase 1a	2009	16,540 sq.m.
Phase 1b	2011	56,663 sq.m.
Phase 2	2014	95,168 sq.m.
Phase 3	2015	102,000 sq.m.

Accommodation

2015
39,550 sq.m.
Flexible Research Laboratory Space
Dedicated Clean Room Facility
46,080 sq.m.
Post Graduate Residential Accommodation
Family Residential Accommodation
Segregated Female Residential Accommodation
Multi-Purpose Hall
Mosque
Learning Resource Centre

The five programmes offered by M.I.S.T by September 2009:

Engineering Systems and Management
Information Technology
Materials Science and Engineering
Mechanical Engineering
Water and Environment

M.I.S.T. Cooperative Partner

Massachusetts Institute of Technology, Cambridge, MA, USA

Masdar Research Network

Imperial College London, UK
RWTH, Aachen Germany
University of Waterloo, Canada
Tokyo Institute of Technology, Japan
Columbia University, USA
German Aerospace Centre – DLR, Germany
CIEMAT – Research Centre for Energy, Environment and Technology, Spain

Consultant Drawings

11

Solar Heat Haze

Microclimate modelling suggests:

3.5°K average heat island impact from solar thermal array at roof level, with localised peaks of up to 9°K.

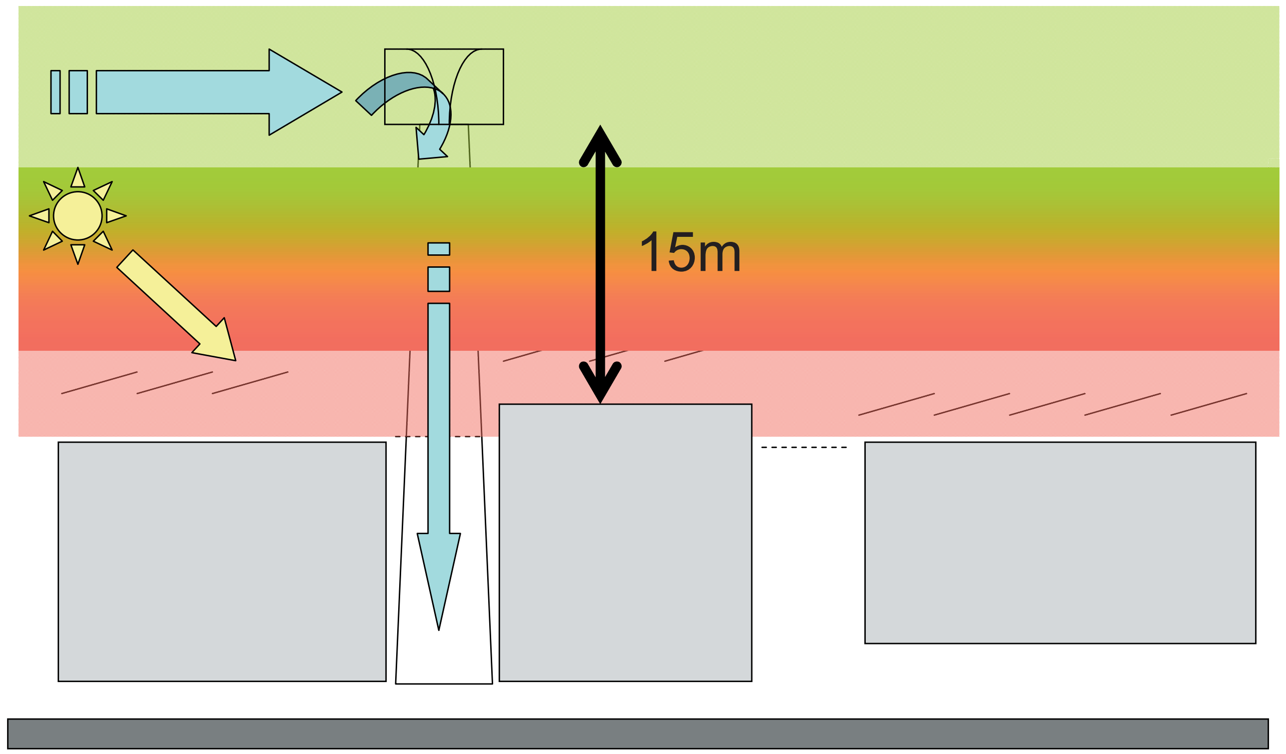
This is AVERAGED over a 3m high zone above roof level. Local air temperatures may well exceed 65°C, with surface temperatures of PVs of up to 125°C

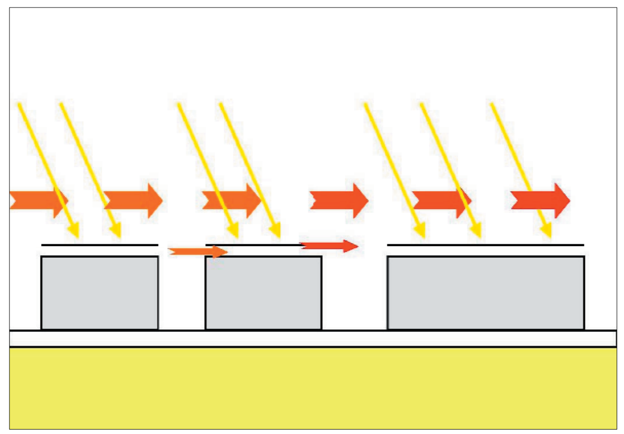
Using roof space during mid-day peak is therefore not viable, however from sunset to sunrise the space could be comfortably occupied.

Temperatures begin to drop back to ambient above 15m above mean roof level.

TO MINIMISE AHU sensible cooling we need to utilise:

1. Night cooled reservoir
2. High level air stream





Wind Towers – SUPPLY - PDEC & Wind Capture

Air supplied to ground level after night cooled reservoir is depleted needs to be taken from above the solar heat haze.

This suggests that intake should be is 3 storeys above roof level

Wind capture devices can direct winds to ground level to be fed through sub-podium labyrinth

Evaporative cooling spray can be used to create a ‘passive downdraught effect’ that can reduce ambient air temperatures by up to 8°C

Wind Towers – EXTRACT - Stack and Wind Assisted

Extract can be driven by thermal buoyancy:

- Greater air temperature at ground level than at top of tower – UNLIKELY DURING DAYTIME
- Upwards momentum from solar heat haze at roof level AND Solar assisted stack
- Atmospheric pressure difference due to height
- Wind driven

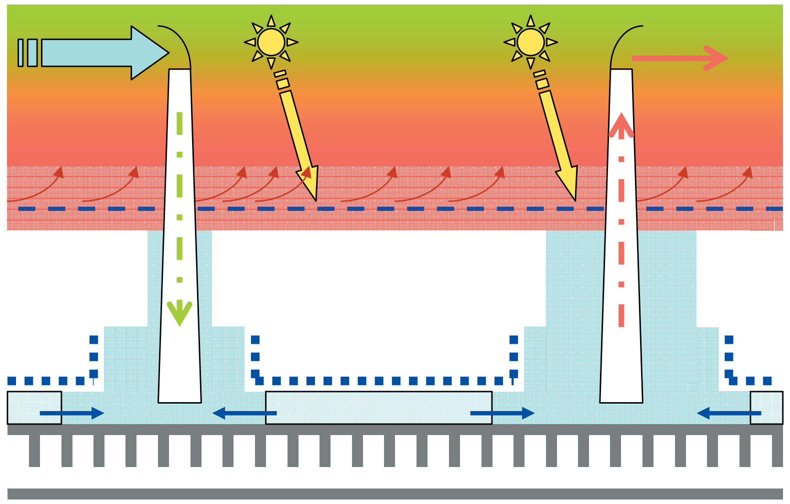
External Comfort – Streets

To achieve comfortable environment at street level the transsolar studies prioritise the following strategies:

DAYTIME

Separation of air mass from heat haze at roof level

Limit ambient air infiltration – use windtowers in streets

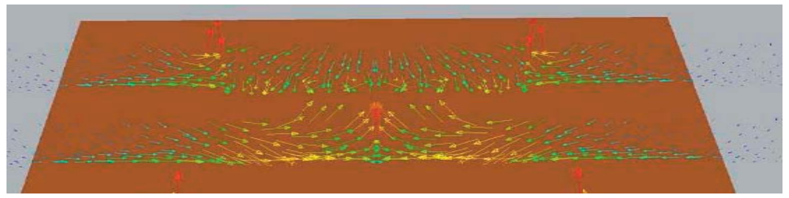


NIGHTIME

Connect air mass to sky as much as possible – remove covers to streets

Maximise air infiltration – using buoyancy effect and windtowers to create air movement

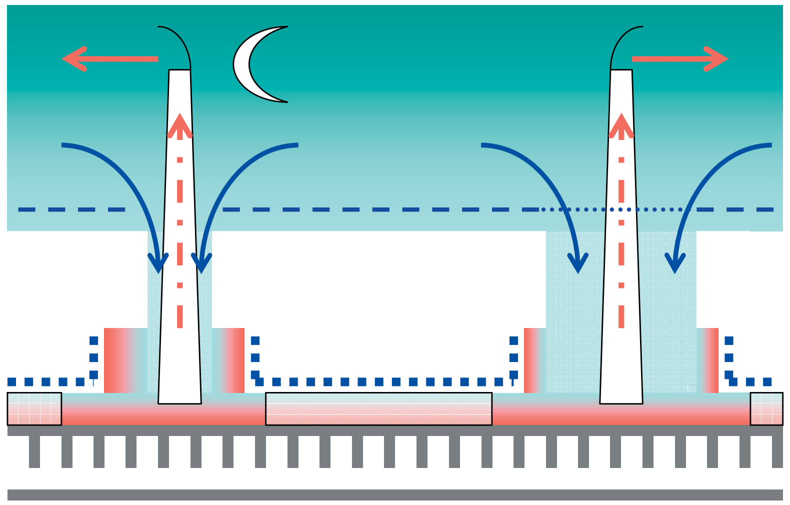
Narrow streets



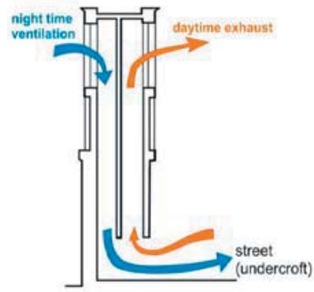
Provision of solar shading at roof level, not at façade to limit radiant temperatures of facades

Expose façade surfaces to night sky wherever possible

Aim for complete direct solar control



Night-purge exposed thermal mass



Exploit thermal mass of exposed façades to release coolth and store heat for subsequent night purge

Exploit free cooling from conduction at ground level

MIST Thursday, 17 January 2008

phaconsult

Solar Control

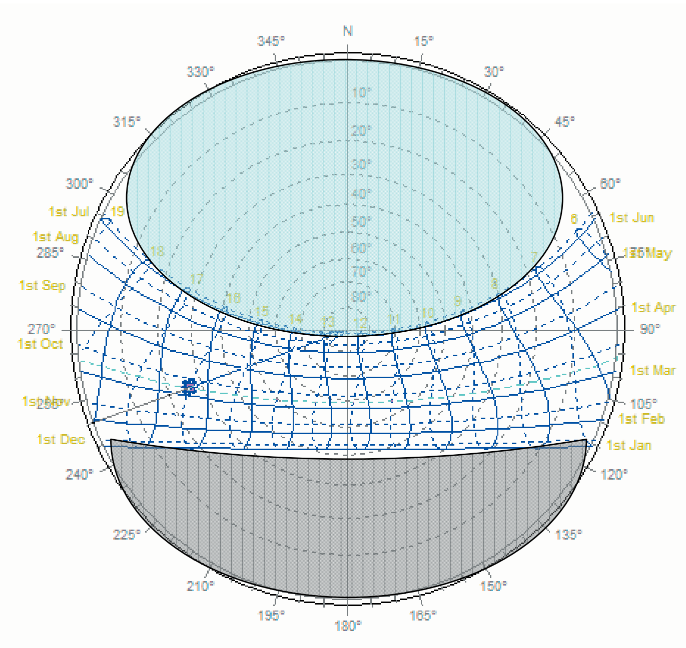
Tracking shades are not viable in this climate – failure of moving parts in motorised systems is inevitable.

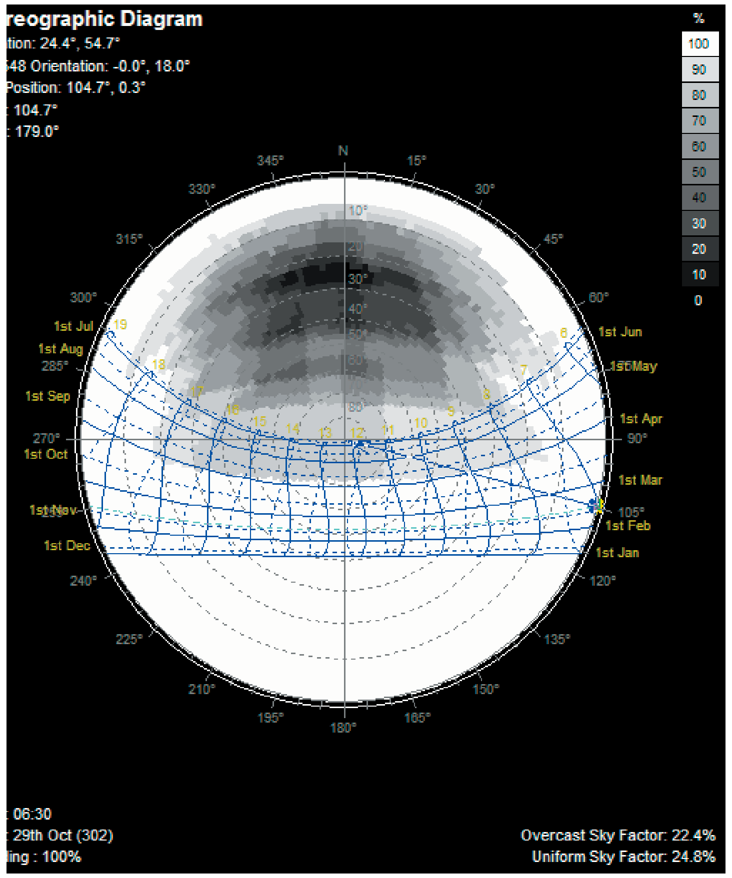
Since cooling is required throughout the year, an annual shading mask is necessary if 100% shading is to be achieved.

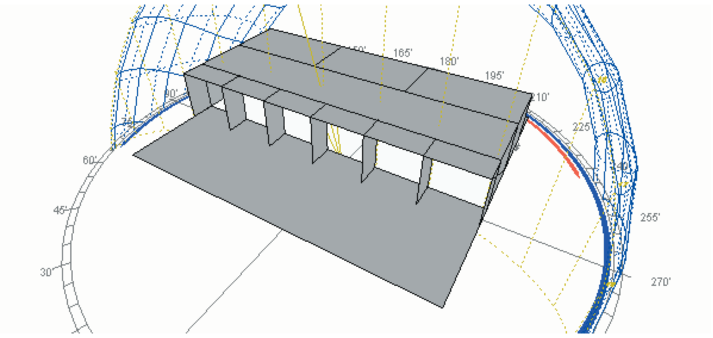
Two approaches are possible –

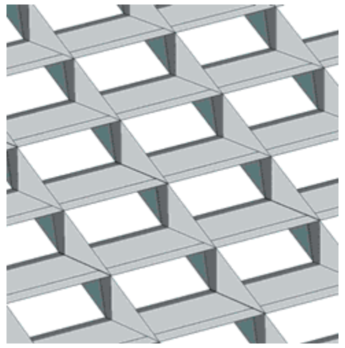
- Lanterns
- Egg-crates

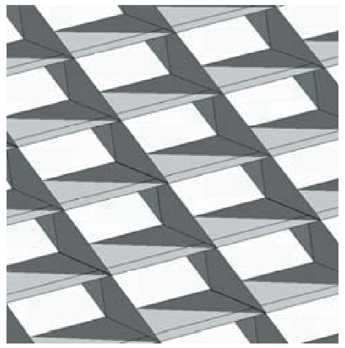
The amount of daylight penetration is maximised using egg-crate strategies, despite only the northern hemisphere of the sky being seen – this is still only 25%!

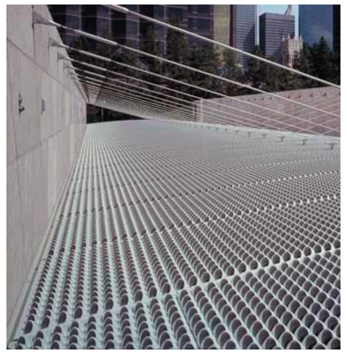










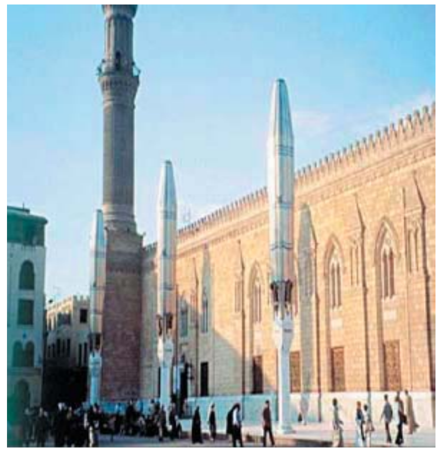


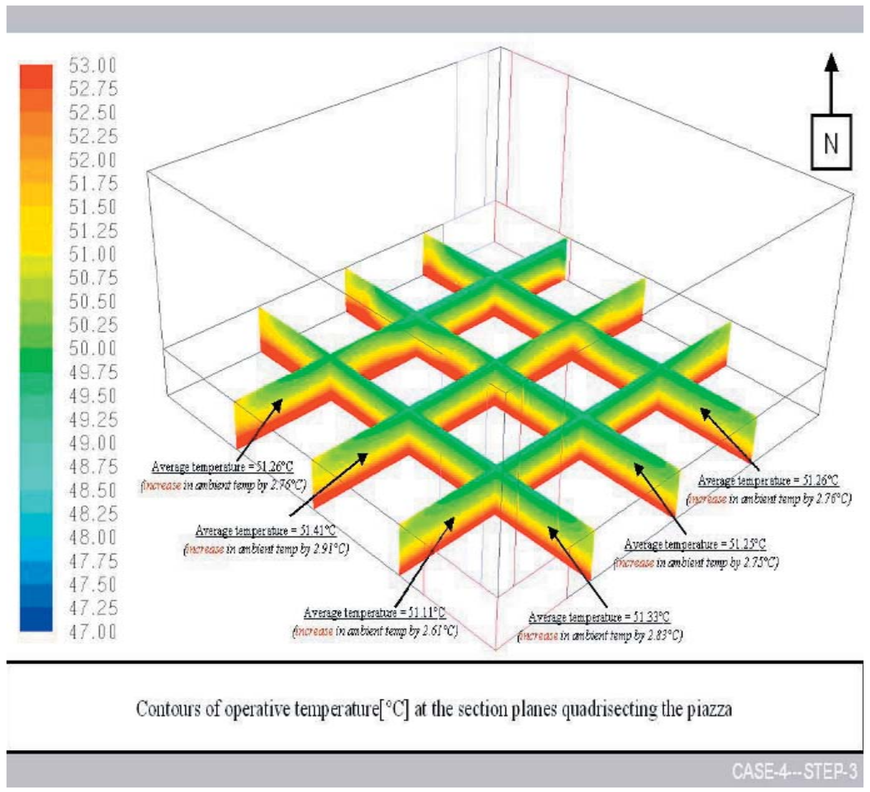
Solar Control Courtyards

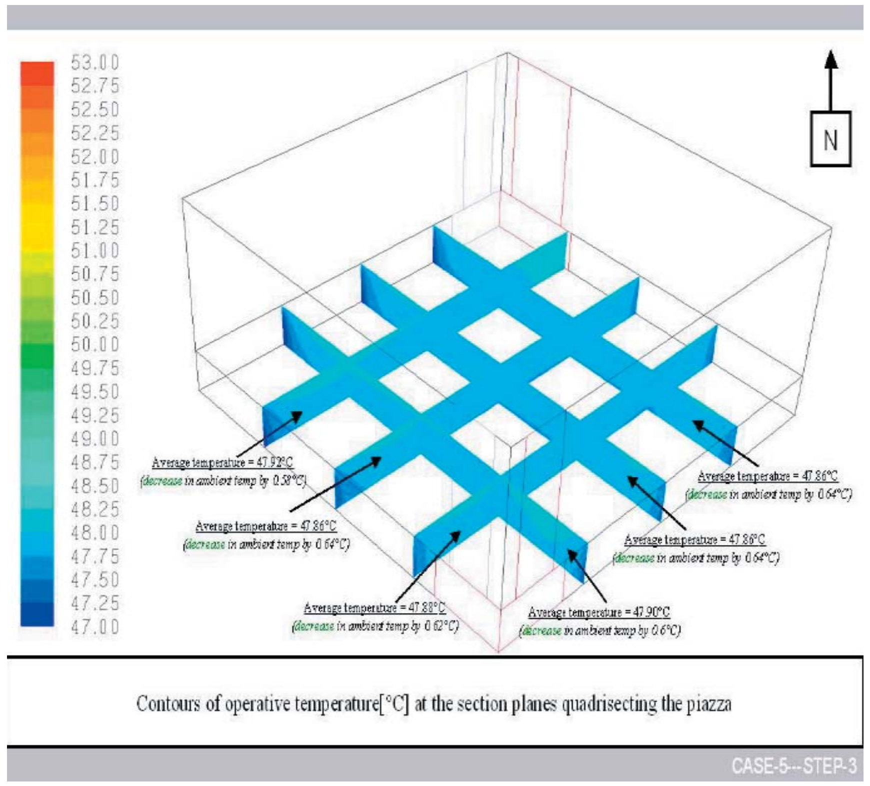
For courtyards total exclusion of direct solar gains may not be desirable:

Solar gains during winter are pleasant for much of the day

Overhead shading limits reflected daylight opportunities





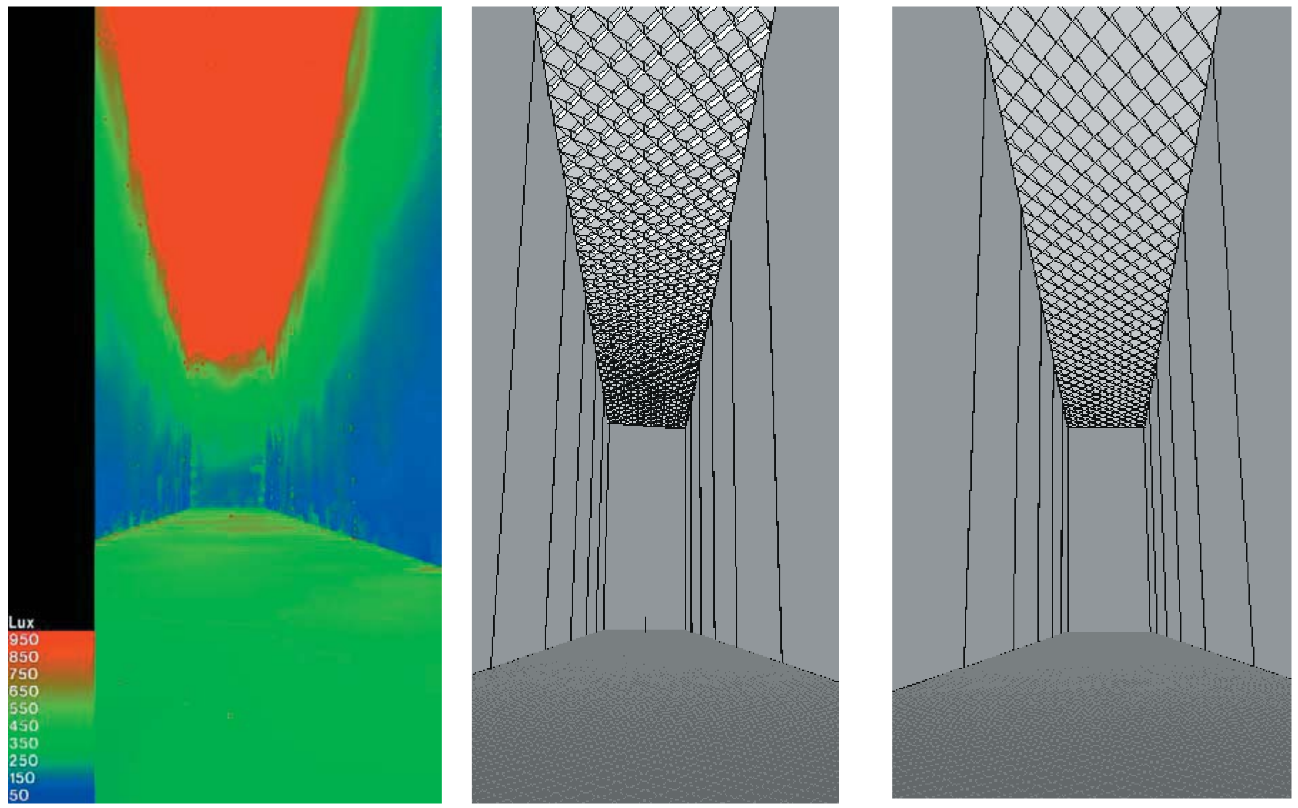


Solar Control - Atrium

Under sunny sky conditions Radiance simulations show that it is possible to achieve 500lux at floor level for an enclosed volume with h:w of 3:1

For residential atria, the orientation of the street affects the experience – travelling northwest or northeast it is possible to see some of the sky, walking southeast or southwest the sky will be obscured.

Locally shading may be replaced with solar control glazing to provide direct sunlight to animate the interior, this should be limited to minimise impact on cooling loads



Daylight

Transsolar modelling assumes '**PERFECT**' solar shading.

Complete solar shading is a prerequisite for meeting the cooling loads permissible.

However, a perfect shade is not possible – to shield all surfaces from direct solar gain necessitates obstruction to >70% of sky.

Their results therefore over estimate performance by a factor of 3.

In addition, Transsolar assumes 3m floor to floor of 3m versus MIST of 4.5m

Therefore performance observed at 'Minus 2' from roof at MIST will be equivalent to that of 'Minus 3' in Transsolar model

Average daylight factors are calculated over a floor depth that is substantially shallower than at MIST, again this means MIST will perform less well

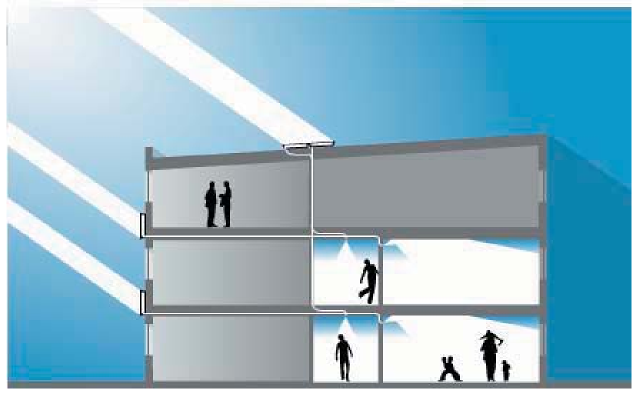
DAYLIGHT THROUGH WINDOWS CAN ONLY PROVIDE USEFUL DAYLIGHT TO THE TOP FLOOR AND ROOMS FACING THE SQUARE

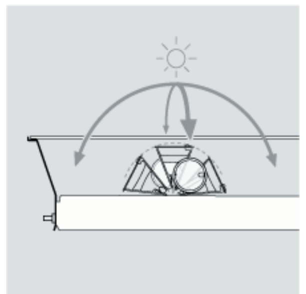
Taking sunlight directly from roof level and piping it to the interior is a viable technique

Sunlight has a significantly lower heat intensity for a given unit of illumination, so long as you can avoid excess illumination.

Savings can therefore be achieved in both electrical and cooling loads.

Parans have developed a solar tracking fibre optic system that can be roof mounted.





Energy Consumption Targets

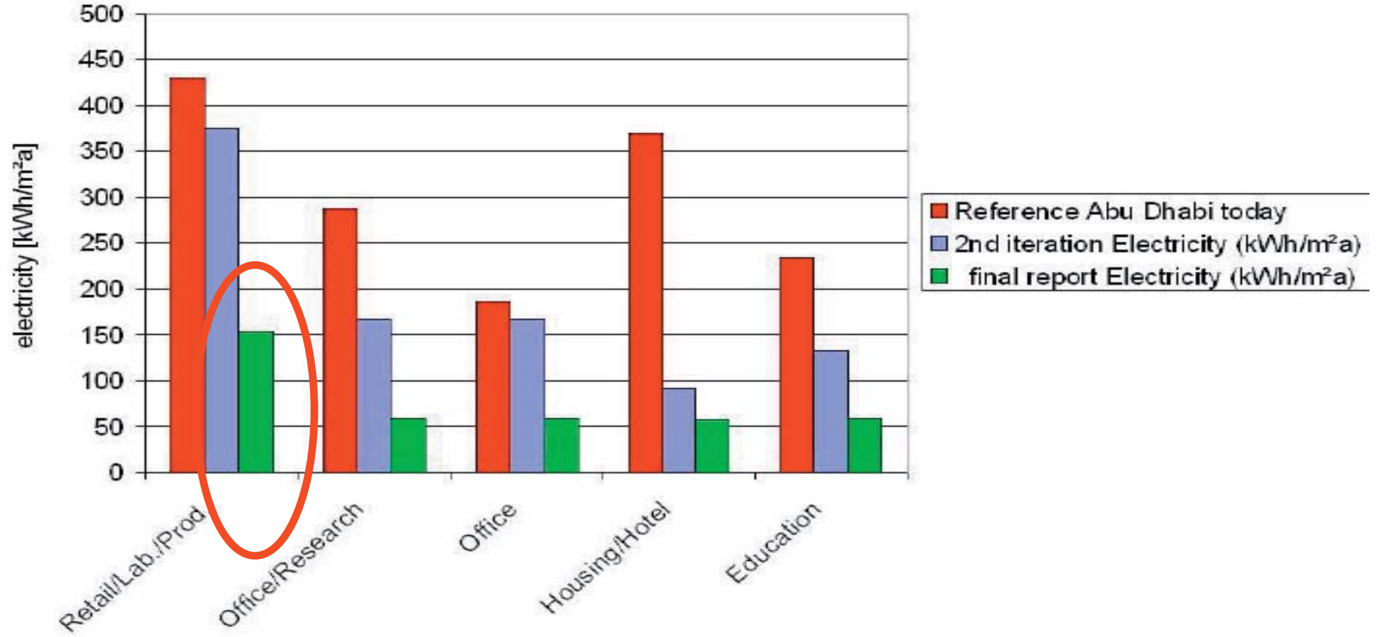
The energy consumed by labs within the masterplan model allows for 3 times the electrical consumption compared to all other uses.

A LAB SITE IS NOT EXPECTED TO BE CARBON NEUTRAL

Efficiencies from other uses are used to offset greater energy consumption per m²

TO BE CARBON NEUTRAL AT MIST WILL REQUIRE SUPPLEMENTARY RENEWABLE ENERGY INSTALLATIONS TO BE CONSTRUCTED

To assess the extent of renewable energy required the critical data to obtain is likely equipment and process loads from MIST faculty.



DEMAND		Heat [MWh_th]			Electricity [MWh_e]			
		total	day	night	total	day	night	Peak
Building non-space energy demand		25,000	12,500	12,500	158,000	92,019	65,981	29.8 MW_p
building sensible demand	278,000 MWh_cool	139,000	90,016	48,984	60,638	39,269	21,369	98.3 MW_p
building latent energy demand	234,000 MWh_cool	260,000	127,920	132,080	4,680	2,303	2,377	113.0 MW_p
distribution					3,160	1,580	1,580	
desalination	9,600 m3/day				14,016	7,008	7,008	
on site traffic, PRT					50,000	37,500	12,500	
street lighting					4,900	0	4,900	
waste treatment					2,950	1,475	1,475	
water distribution					6,600	3,300	3,300	0.8 MW_p
Total		**424,000**	*230,436*	*193,564*	**304,944**	*184,454*	*120,490*	
SUPPLY	**Peak**							**Area**
Wind turbines	4.5 MW_e				6,443	3,544	2,899	0 ha
Small square PV	57.2 MW_e				93,680	93,680	0	47.8 ha
Building PV	82.9 MW_e				132,032	132,032	0	51.7 ha
Outside parkings PV	5.5 MW_e				9,065	9,065	0	5.2 ha
Courtyard PV-shading	13.3 MW_e				21,000	21,000	0	24.1 ha
PV/T systems for DHW		28,125	12,500	15,625				*4.7 ha*
Waste treatment plant	2.74 MW_e	29,108	14,554	14,554	21,920	10,960	10,960	
CSP	2.7 MW_e	49,171	24,960	24,211	20,803	10,560	10,243	15 ha
ETC needed		365,686	187,813	177,873				48.8 ha
Heat Store from Waste								
Extra PV if all building area used	6.4 MW_e*				10,536 MWh_e			6.0 ha
Total		**472,090**			**304,944**	*280,841*	*24,103*	

*Assuming a mix of crystalline and thin-film (174 kWh/m²). It is not included in the energy totals.

From Masterplan to Building Plot

We need to question the assumptions made in the TRNYSYS modelling.

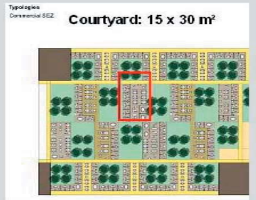
COP (electric) of district cooling is assumed to be 2.3 by ETA and 4.3 by WSP

COP (electric) of Liquid Dessicant system is assumed to be 27 by ETA and 50 by WSP

AHU electricity consumption, for offices is 0.3 kWh/1000m³ which equates to 1.4 W/m² but is listed as 0.7

Lighting allowances assume daylight autonomy for a significant portion of building – initial analysis suggests that this is only possible at top floor and onto square

Air infiltration levels are significantly more stringent than those achieved by best practice in Europe
(need to be less than 3m³/m²/h @ 50Pa)

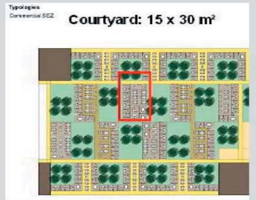


peak loads (to gross footprint):
- sensible - 42.3 W/m²
- latent - 31 W/m²
- AHU - 1.3 W/m²
- equipment - 5.3 W/m²
- art. lighting - 9 W/m²

annual demands (to gross footprint)
- sensible - 94.8 kWh/m²/a
- latent - 50.5 kWh/m²/a
- electrical - 49.1 kWh/m²/a

Office floors in 2. to 5. story; 3 m clearance;
25 % of total area as top floor area with roof

working hours -	8°° to 19°°; 6 days per week
operation of AHU -	24 h / 7 d; based on working area; working: 1.5 acr; non-working: 0.75 acr
artificial lighting -	operation controlled depending on outdoor illuminance; 10 W/m² based on net floor area
facade -	30% glass; neutral solar control glass 50/25; 20 % frame ratio; operable, exterior shading device; shading coefficient 0.3
facade -	opaque facade ratio of 70 %; 5 cm thermal insulation (outer surface)
roof -	20 cm thermal insulation (outer surface)
exposed ceiling -	as thermal mass
infiltration -	0.15 acr during working hours; 0.05 acr in non working hours
design temperature -	24°C / 65 % r. hum. daytime; 28°C in non working hours
density -	20 m² per occupant
internal heat gains - (office equipment)	5.3 W/m² during working hours; 2.65 W/m² in non working hours
el. demand of AHU -	0.6 kWh/1,000 m³
sens. heat recovery -	80 %



peak loads (to gross footprint):
- sensible - 51 W/m²
- latent - 74.2 W/m²
- AHU - 3.7 W/m²
- equipment - 10.6 W/m²
- art. lighting - 8 W/m²

annual demands (to gross footprint)
- sensible - 127.5 kWh/m²/a
- latent - 107.3 kWh/m²/a
- electrical - 99 kWh/m²/a

Lab floors in 2. to 5. story; 3 m clearance;
50 % office / 50 % laboratory

working hours -	8°° to 19°°; 6 days per week
operation of AHU -	24 h, 7 d; working: 6 acr in lab area; 3 acr in office area; non-working: 3 acr;
artificial lighting -	operation controlled depending on outdoor illuminance; 10 W/m² based on net floor area
facade -	30% glass; neutral solar control glass 50/25; 20 % frame ratio; operable, exterior shading device; shading coefficient 0.3
facade -	opaque facade ratio of 70 %; 5 cm thermal insulated (outer surface)
exposed ceiling	
infiltration -	0.15 acr during working hours; 0.05 acr in non working hours
design temperature -	24°C / 65 % r. hum. daytime; 28°C in non-working hours
density -	20 m² per occupant
internal heat gains - (office equipment)	10.6 W/m² during working hours; 5.3 W/m² in non working hours
el. demand of AHU -	0.6 kWh/1,000 m³
sens. heat recovery -	80 %

2. floor 3. floor
Courtyard: 11 x 11 m²

peak loads (to gross footprint):
- sensible - 32.3 W/m²
- latent - 35.4 W/m²
- AHU - 1.2 W/m²
- equipment - 2.8 W/m²
- art. lighting - 1 W/m²

annual demands (to gross footprint)
- sensible - 74.3 kWh/m²/a
- latent - 76.9 kWh/m²/a
- electrical - 22 kWh/m²/a
- dom. water heating 15.8 kWh/m²/a

Housing floors in 2. to 5. story; 3 m clearance;
25 % of total area as top floor area with roof

Reduced hours -	8°° to 18°°; 5 days per week
operation of AHU -	24 h, 7 days per week; 1 acr based on used floor area
artificial lighting -	operation controlled depending on outdoor illuminance; 1.25 W/m² based on used floor area
facade -	30% glass; neutral solar control glass 50/25; 20 % frame ratio; operable, exterior shading device; shading coefficient 0.2
facade -	opaque facade ratio of 70 %; 10 cm thermal insulated (outer surface)
roof -	20 cm thermal insulation (outer surface)
exposed ceiling	
infiltration -	0.2 acr during day time; 0.05 acr during night time
design temperature -	24°C / 65 % r. hum.; 26°C in reduced hours
density -	50 m² per resident
internal heat gains - (household equipment)	430 kWh/resident/a
el. demand of AHU -	0.5 kWh/1,000 m³
domestic water -	35 l/per/d; 65°C
sens. heat recovery -	80 %

Issue	Item	Units	Office Working TRNS	Office Working MIST	Office Non-Working TRNS	Office Non-Working MIST
Building Geometry	Floor to Floor Height	m	3.5	4.5	3.5	4.5
	Floor to Ceiling Height	m	3	3.9	3	3.9
	Volume (1 air change)	m³/m²	3	3.9	3	3.9
Storeys Occupied	Sub Podium	-01	No	No	No	No
	Ground	00	No	No	No	No
	First	01	No	No	No	No
	Second	02	Yes	Yes	Yes	Yes
	Third	03	Yes	Yes	Yes	Yes
	Fourth	04	Yes	Yes	Yes	Yes
	Fifth	05	Yes	Yes	Yes	Yes
	Sixth	06	No	No	No	No
Density	Occupants	m²/pers.	20	20	20	20
Working Hours	Range (from)	hrs	0800	0800	0800	0800
	Range (to)		1900	1900	1900	1900
	Days per week	#	6	6	6	6
Operation of AHU	Range (from)	hrs	0000	0000	0000	0000
	Range (to)		0000	0000	0000	0000
	Days per week	#	7	7	7	7
	Air Change Rate	ach	1.5	1.5	0.75	1.5
	Air Supply Rate	l/s/m²	1.25	1.625	0.625	1.625
	Fresh Air Delivery Rate	l/s/pers	12	12	12	12
	Fresh Air Supply Rate	l/s/m²	0.6	0.6	0.6	0.6
	Sensible Cooling	-	D-Ch	L-AbEl	D-Ch	L-AbEl
	Dehumidification	-	D-LqDes	L-LqDes	D-LqDes	L-LqDes
Artificial Lighting	Control		ZC-DD	ZC-DD-Occ	ZC-DD	ZC-DD-Occ
	Power Density	W/m²	7	7	7	7
Building Envelope	Glazing Ratio	%	30	30	30	30
	g-value (glass)	%	50	50	50	50
	shading	-	external	external	external	external
	g-value (shaded)	%	15	15	15	15
	Light Transmission	%	25	25	25	25
	Frame Ratio	%	20	20	20	20
	U-value (glass)	W/m²/K	1.2	1.2	1.2	1.2
	U-value (frame)	W/m²/K	1.2	1.2	1.2	1.2
	U-value (wall)	W/m²/K	0.25	0.25	0.25	0.25
	U-value (roof)	W/m²/K	0.12	0.12	0.12	0.12
	U-value (floor)	W/m²/K	0.35	0.35	0.35	0.35
Ceilings	Thermal Mass (admittance)	W/m²K	8	8	8	8
	Reflectance	%	80	80	80	80
	Clear Void	mm	-	-	-	-
Internal Walls	Thermal Mass (admittance)	W/m²K	6	6	6	6
	Reflectance	%	50	50	50	50
Floors	Thermal Mass (admittance)	W/m²K	3	3	3	3
	Reflectance	%	30	30	30	30
	Clear Void	mm	-	-	-	-
Infiltration	Overall Infiltration Rate Occupied	ach	0.15	0.15	0.05	0.05
		m³/m² @ 50 Pa				
	Overall Infiltration Rate Unoccupied	ach	0.05	0.05	0.05	0.05
		m³/m² @ 50 Pa				
Design Hygrothermal Conditions	High	°C	24	28	24	28
	Coincident RH	%	65	65	65	65
	Enthalpy	kJ/kg	55.1	67.8	55.1	67.8
Occupant Heat Gains	Occupants (sensible)	W/person	85	85	85	85
		W/m²	4.25	4.25	4.25	4.25
	Occupants (latent)	W/person	60	60	60	60
		W/m²	3	3	3	3
Equipment Heat Gains	Sensible	W/m²	3.1	3.1	1.55	1.55
Lighting	Sensible	W/m²	7	7	7	7
Electrical Demand of AHU	Transolar	kWh/1000m³/h	0.3	0.3	0.3	0.3
	Specific Fan Power	W/l/s	1.1	1.1	1.1	1.1
		W/m²	1.4	1.8	0.7	1.8
Sensible Heat Recovery		%	80	80	80	80
SCOP	E: District Cooling	$Q_{cool}:Q_{elec}$	4.3	4.3	4.3	4.3
	Local Condensing Chiller	$Q_{cool}:Q_{elec}$	3.0	3.0	3.0	3.0
	Abs and Lq-Des	$Q_{cool}:Q_{elec}$	50.0	50.0	50.0	50.0
	Local Abs	$Q_{therm-}:Q_{therm+}$	0.8	1.2	0.8	1.2
	Lq-Des	$Q_{therm-}:Q_{therm+}$	0.9	0.9	0.9	0.9
Peak Loads : Gross Footprint	Sensible (all heat loads)	W/m²	37	37	37	37
	TOTAL internal listed	W/m²	12.9	12.9	11.35	11.35
	Derived Peak Solar, Conduction, Infiltration,Air Cooling	W/m²	24.8	24.8	26.35	26.35
	Latent (dehumidification)	W/m²	31	31	31	31
	AHU	W/m²	0.7	0.7	0.7	0.7
	AHU from SFP	W/m²	1.4	1.8	0.7	1.8
	Equipment	W/m²	3.1	3.1	3.1	3.1
	Lighting	W/m²	6	6	6	6
	TOTAL Electric	W/m²	9.8	9.8	9.8	9.8
Annual Demands	Sensible (thermal)	kWh/m²	72.8	72.8	72.8	72.8
	Sensible (electric)	kWh/m²	16.8	16.8	16.8	16.8
	Latent	kWh/m²	50.5	50.5	50.5	50.5
	Electrical	kWh/m²	29.0	29.0	29.0	29.0
	TOTAL (from graphs)	kWh/m²	54.0	54.0	54.0	54.0
	TOTAL (from this data)	kWh/m²	45.8	45.8	45.8	45.8

MIST Thursday, 17 January 2008

phaconsult

Laboratory Benchmarks

Establishing plug load limits with MIST faculty will be essential in assessing cooling requirements.

For every Watt of electrical consumption by equipment an additional Watt of sensible cooling capacity is required

DOUBLE IMPACT……

Measured plug loads by LAB21 project in USA suggest 2 to 4 W/sqft is a reasonable 15minute averaged peak. This is used as a basis upon which to size HVAC cooling loads

This equates to 21.5 – 43.0 W/m².

Energy benchmarking for the masterplan has assumed 10.6

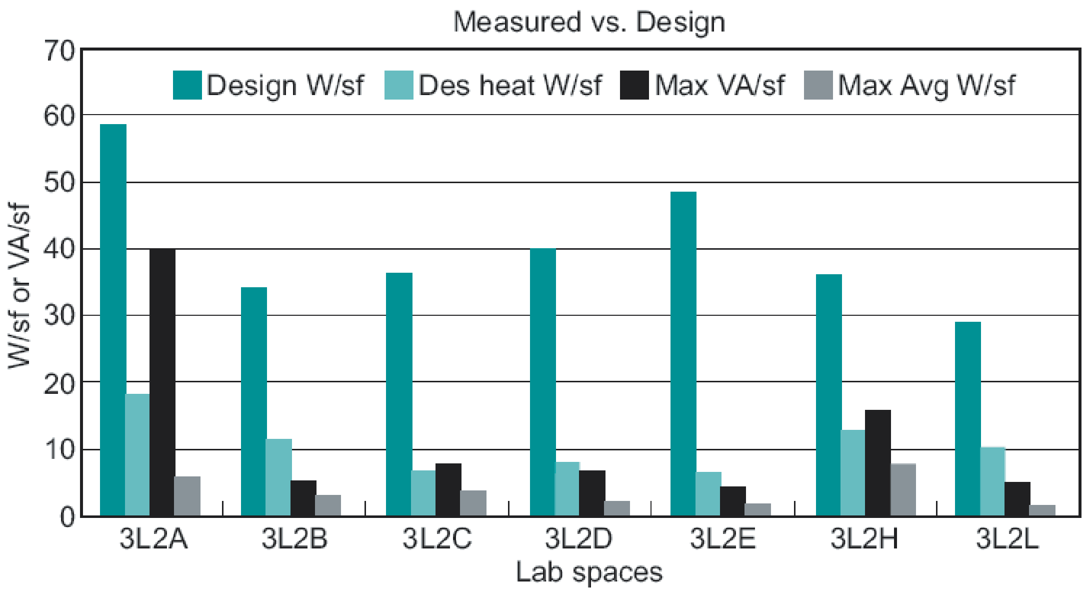


Figure 6. Comparison of design loads and measured plug loads in various laboratory spaces at the University of California, Davis. Measurements were taken over a 2-week period while labs were fully occupied. Des W/sf is the peak plug load assumption for electrical design. Des heat W/sf is the peak plug load assumption for HVAC design. Max VA/sf is the measured peak (instantaneous) apparent power. Max Avg W/sf is the maximum of the 15-minute averages.

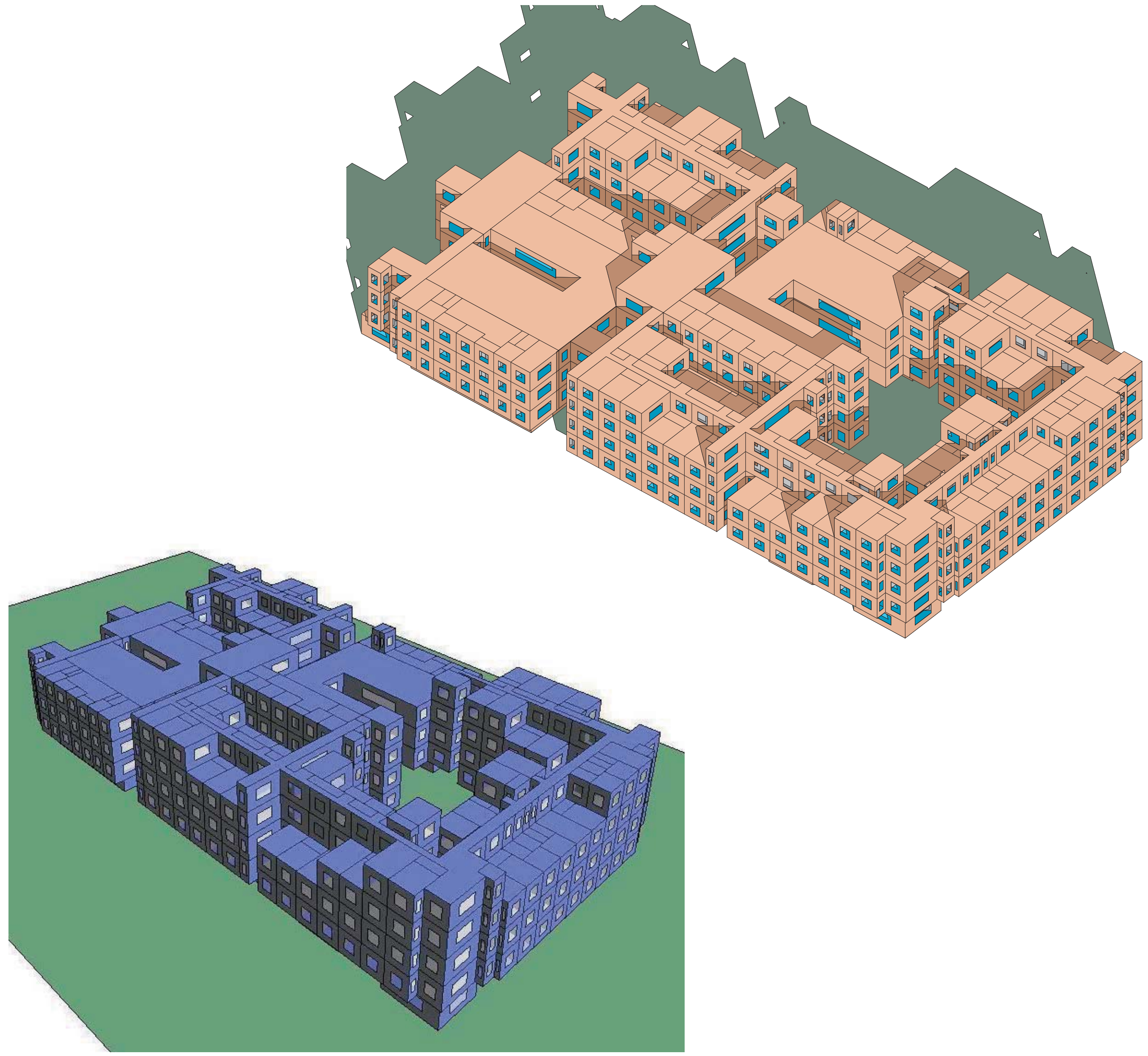
Energy Consumption Modelling

Modelling has begun in IES, taking the assumptions for building envelope, glazing etc from the Trans Solar TRNSYS model and testing on a real building.

Clarification will be required from MIST on the likely nature of process/equipment electrical and thermal loads as these will have a significant impact on the overall energy consumption of the building.

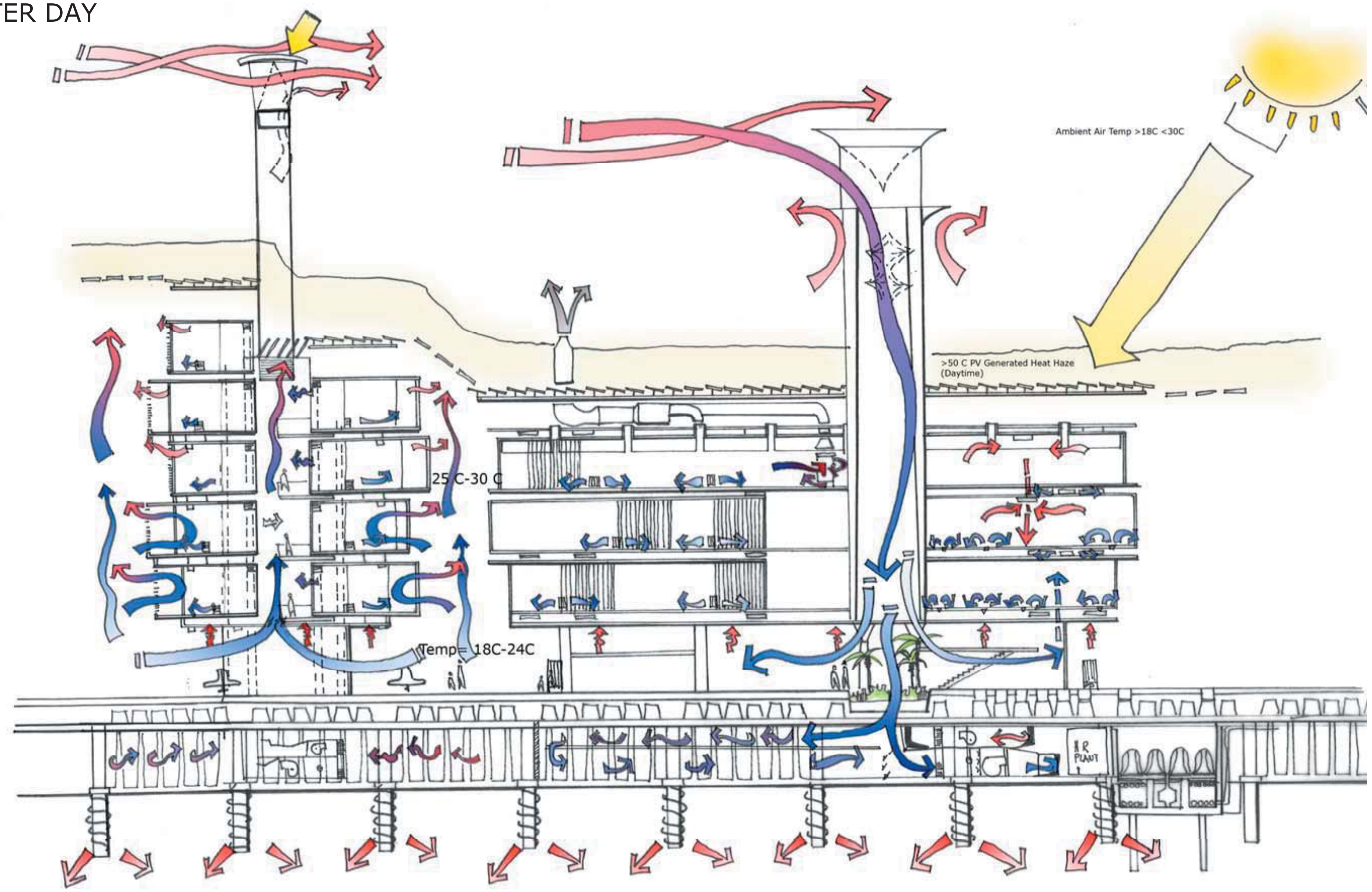
Existing benchmarks for engineering labs (lowest user of power in lab sector) suggests that peak loads are at least 3 times lower in the TRNSYS model than achieved in current best practice labs….

We are investigating using LAB21's Design Intent Tool to confirm design conditions.



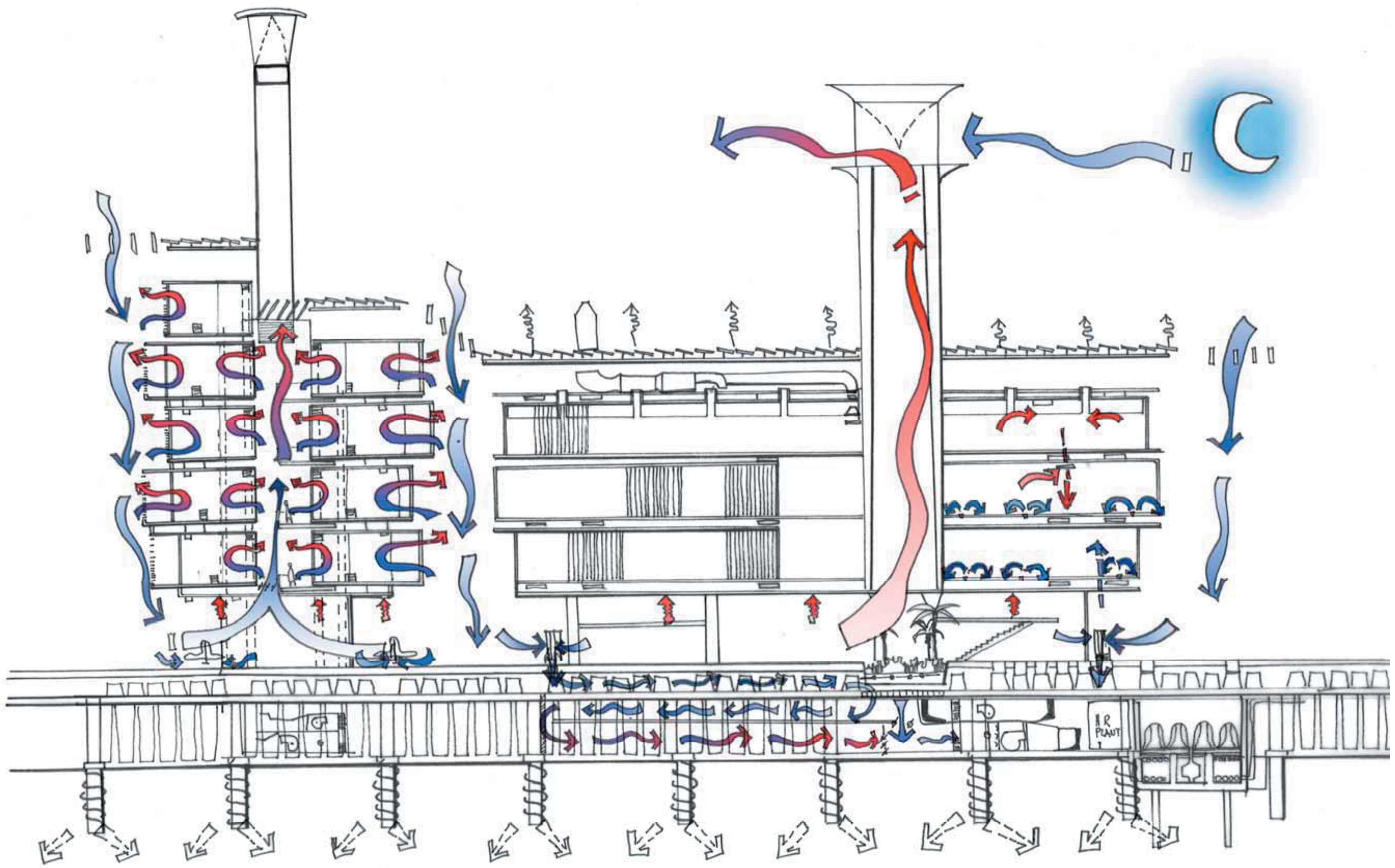
HVAC Strategy in Response to Site and Masterplan Analysis

WINTER DAY



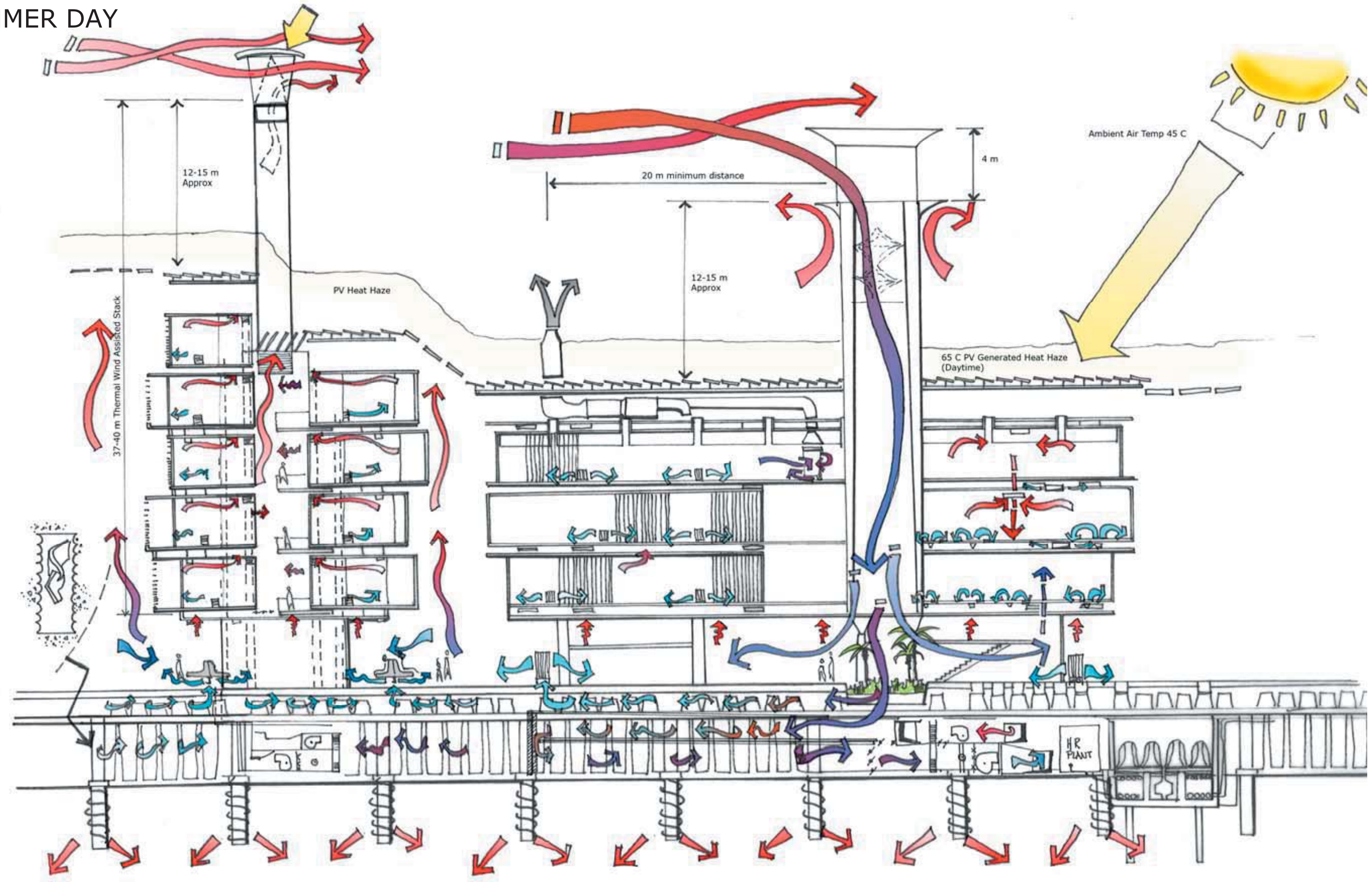
HVAC Strategy in Response to Site and Masterplan Analysis

WINTER NIGHT



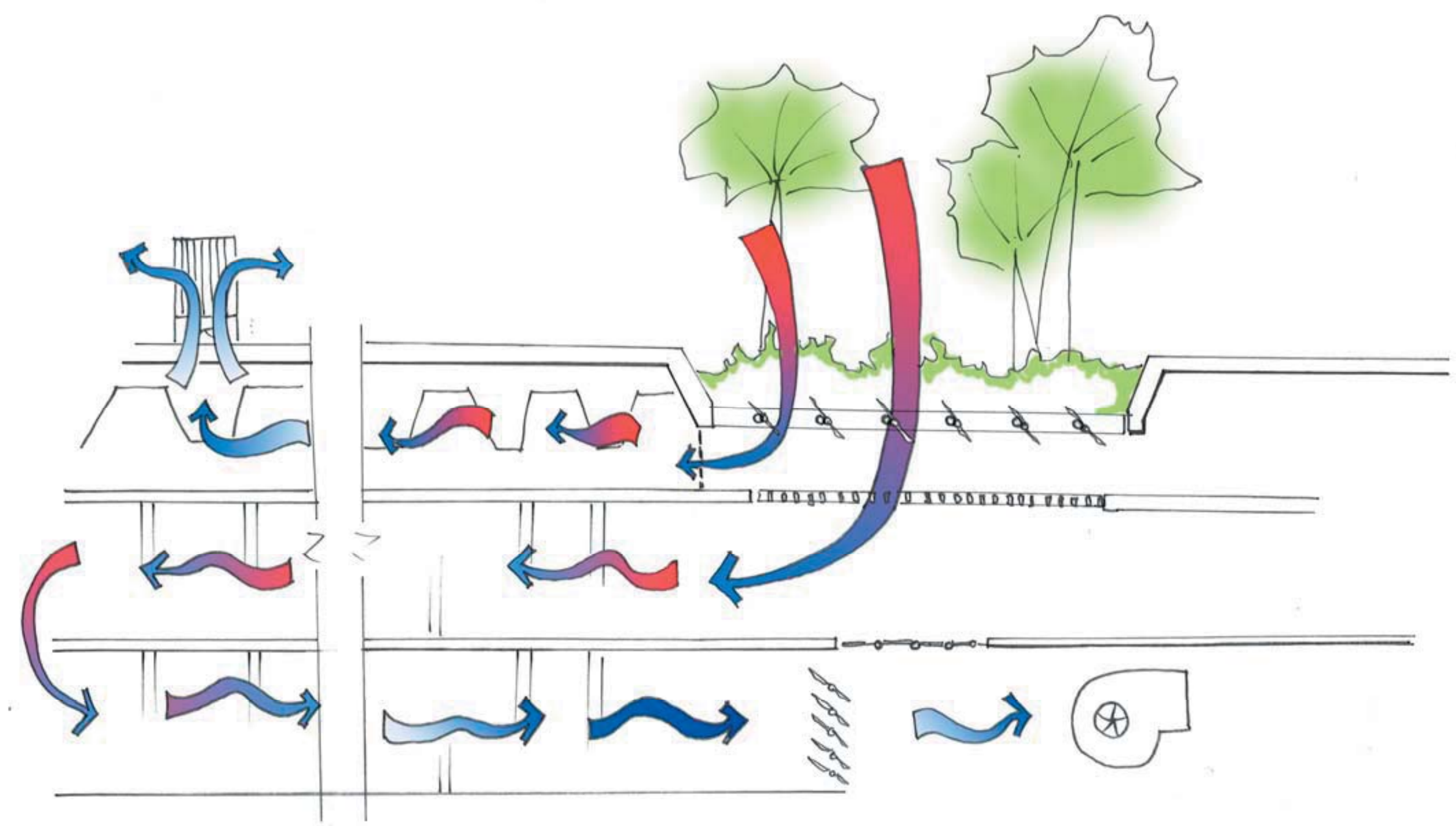
HVAC Strategy in Response to Site and Masterplan

SUMMER DAY



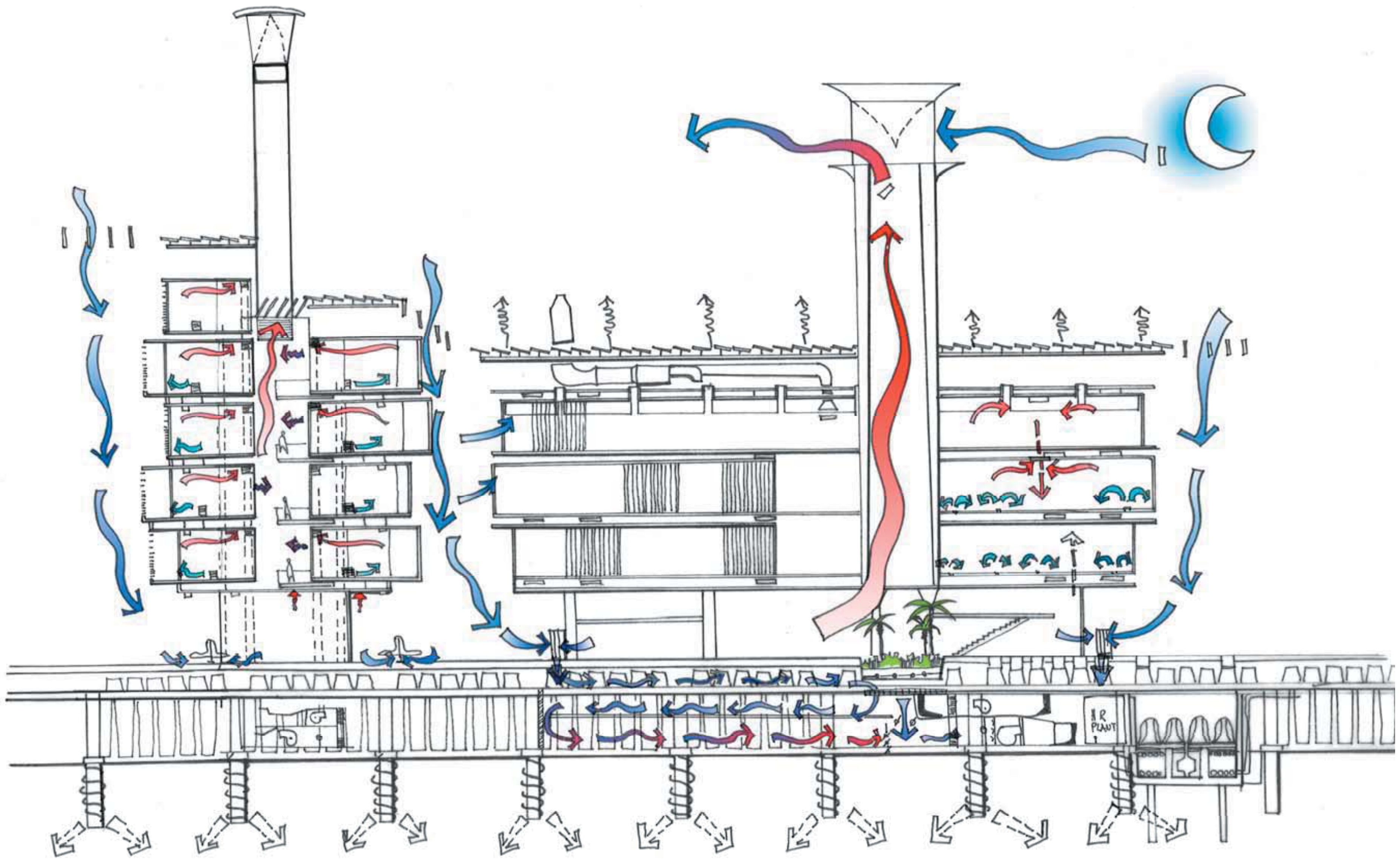
HVAC Strategy in Response to Site and Masterplan

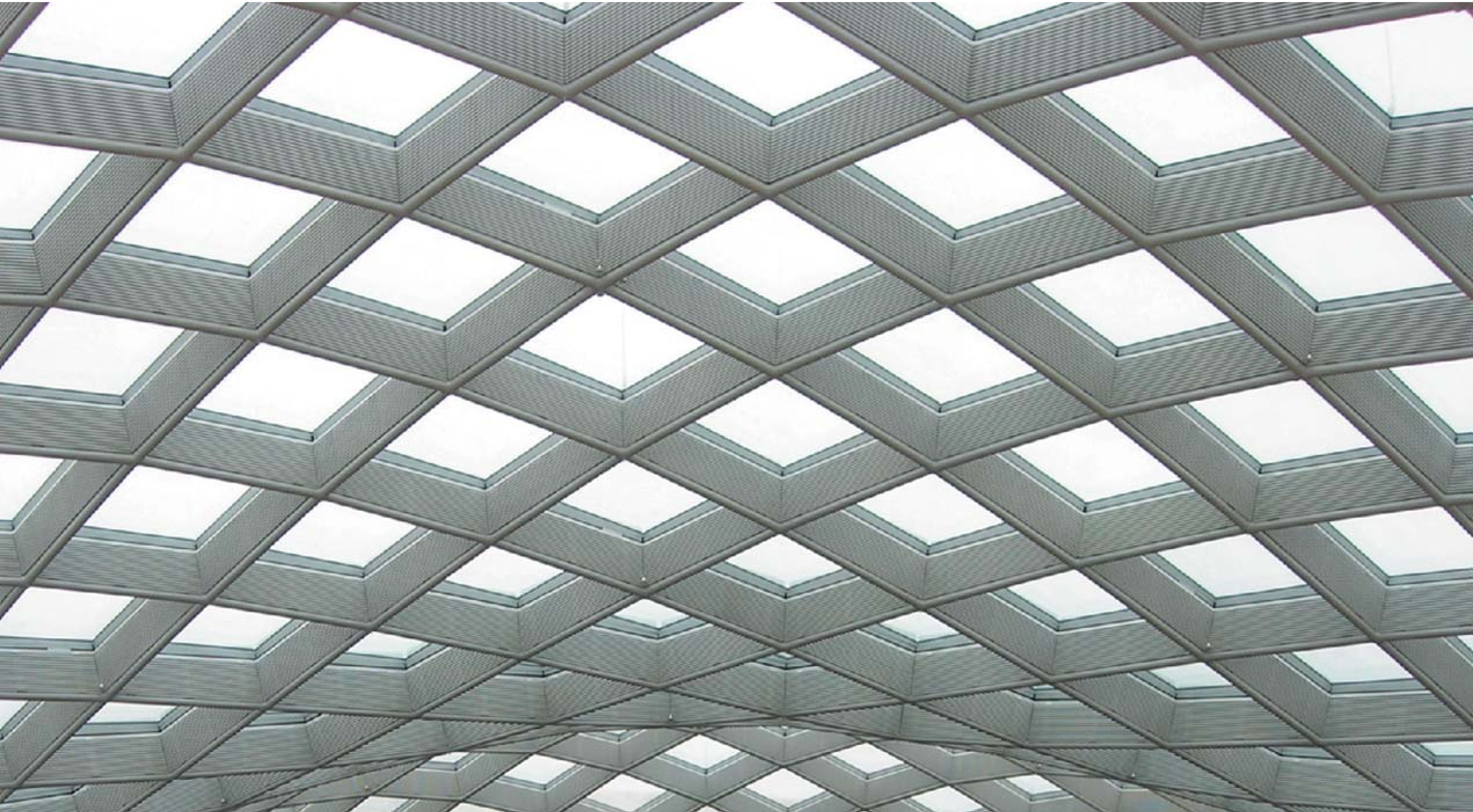
SUMMER DAY - DETAIL



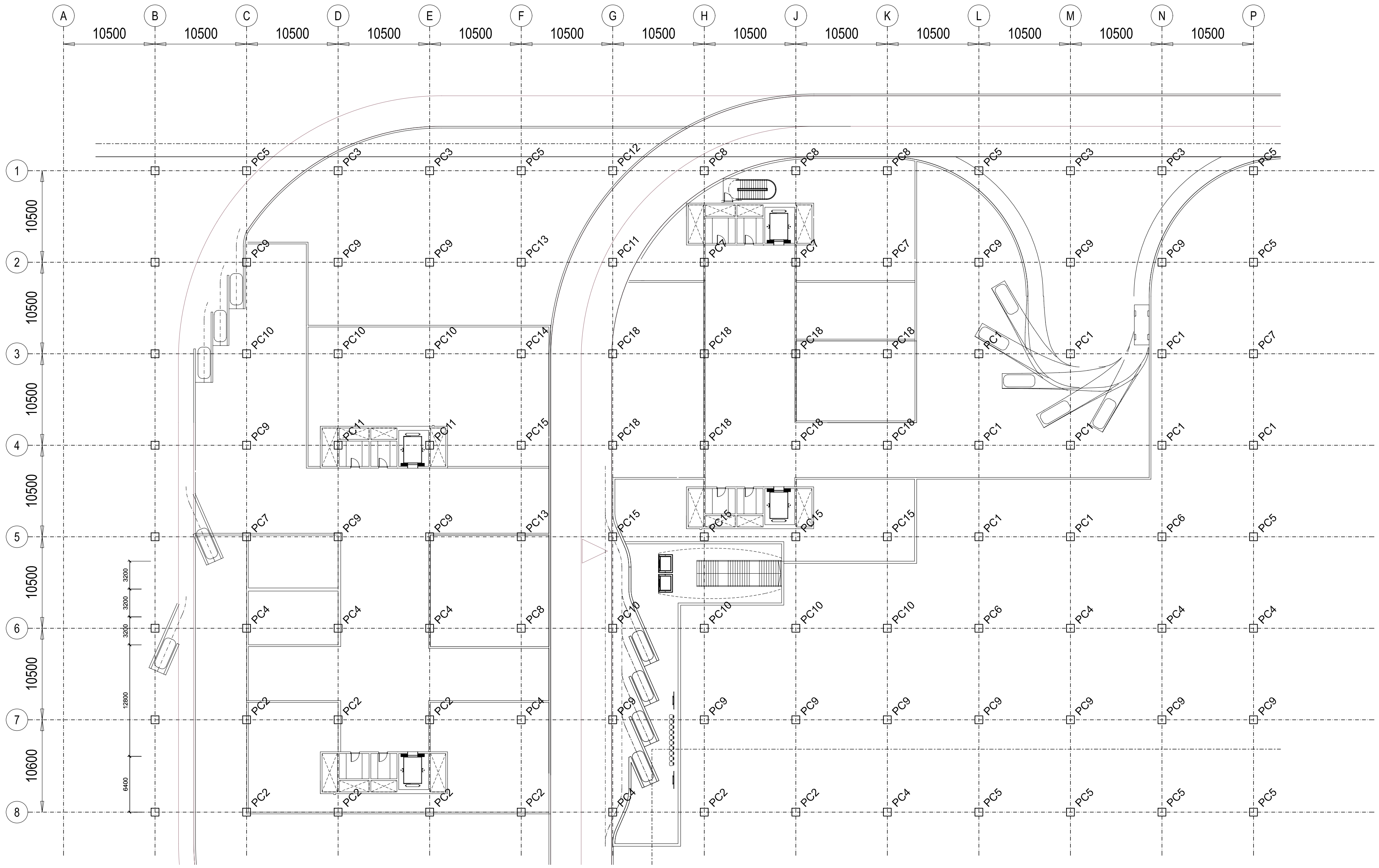
HVAC Strategy in Response to Site and Masterplan

SUMMER NIGHT





Pile General Arrangement



NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL STRUCTURAL SPECIFICATIONS AND DETAILS AND ALL OTHER RELEVANT CONSULTANTS DRAWINGS AND SPECIFICATIONS.
2. THE GRID SYSTEM USED IS BASED ON THE ARCHITECTURAL LAYOUTS. REFERENCE SHOULD BE MADE TO THE ARCHITECTS DRAWINGS FOR SETTING OUT OF THE GRID WITHIN THE SITE BOUNDARY.
3. PILED FOUNDATIONS HAVE BEEN BASED ON THE FOLLOWING CRITERIA BASED ON ADVICE OF CONTRACTOR AVAILABLE RIGS.

   DIAMETER OF PILES (TBC)
   SAFE WORKING LOAD CAPACITY (TBC)

   IN THE ABSENCE OF THIS INFORMATION LOADING HAS BEEN PROVIDED AT EACH COLUMN LOCATION. THE ABOVE IS BASED ON GEOTECHNICAL ASSUMPTIONS. THE FINAL DESIGN OF THE PILES INCLUDING DIAMETER, LENGTH AND REINFORCEMENT IS TO BE UNDERTAKEN BY THE SPECIALIST PILING CONTRACTOR AND WILL ALSO BE SUBJECT TO THE RESULTS OF THE SITE SPECIFIC GEOTECHNICAL REPORTS.
   ALL PILES ARE TO BE DESIGNED TO RESIST A HORIZONTAL LOAD OF (TO BE CONFIRMED) kN TO MEET THE REQUIREMENTS FOR LATERAL AND SEISMIC STABILITY.
4. PILE CUT OFF LEVELS ARE SUBJECT TO THE FINALISATION OF THE ARCHITECTS AND SERVICE ENGINEERS PROPOSED FINISHED FLOOR LEVELS AND THE LOCATION OF SERVICE TRENCHES, LIFT PITS, ESCALATOR PITS AND ANY OTHER RECESSES REQUIRED.
5. FOUNDATION LOADS HAVE BEEN BASED ON THE FOLLOWING IMPOSED LOADING CRITERIA FOR THE BUILDINGS ABOVE

OFFICE AREAS	=3.5+1.0kN/m²
CIRCULATION, STAIRS AND CORRIDORS	=4.0kN/m²
LABORATORY AREAS	=5.0kN/m²
ROOF AREAS	=0.75kN/m²
PLANT ARES	=7.5kN/m²
TRANSPORT SYSTEMS AND HIGHWAYS	=10.0kN/m²
PLANTING	=TBC

6. PILE LOADINGS PROVIDED HAVE BEEN DERIVED FROM THE IMPOSED LOADINGS GIVEN ABOVE TOGETHER WITH AN ALLOWANCE FOR THE SELF WEIGHT OF THE STRUCTURE BASED ON THE SPANS AND ASSUMED POSITIONS OF COLUMNS AND WALLS AS PER THE GREYED LAYOUT OVER. ANY CHANGES TO THE LAYOUT, POSITION OR NUMBER OF SUPPORTING COLUMNS/WALLS/CORES WILL AFFECT THESE ASSUMPTIONS AND MAY REQUIRE ADDITIONAL PILES AS A RESULT.

KEY

PILE CAP TYPE	COLUMN REACTION	PILE CUT OFF LEVELS
PC1	10,000 kN	-
PC2	11,000 kN	-
PC3	12,000 kN	-
PC4	13,000 kN	-
PC5	14,000 kN	-
PC6	15,000 kN	-
PC7	16,000 kN	-
PC8	17,000 kN	-
PC9	18,000 kN	-
PC10	19,000 kN	-
PC11	20,000 kN	-
PC12	21,000 kN	-
PC13	22,000 kN	-
PC14	23,000 kN	-
PC15	24,000 kN	-
PC16	25,000 kN	-
PC17	26,000 kN	-
PC18	27,000 kN	-

REV	DATE	DESCRIPTION	BY	CHECKED
P1	15.01.08	ISSUED FOR COMMENT	JCM	PE

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CLIENT: MASDAR

PROJECT: MASDAR UNIVERSITY

TITLE: PILE GENERAL ARRANGEMENT

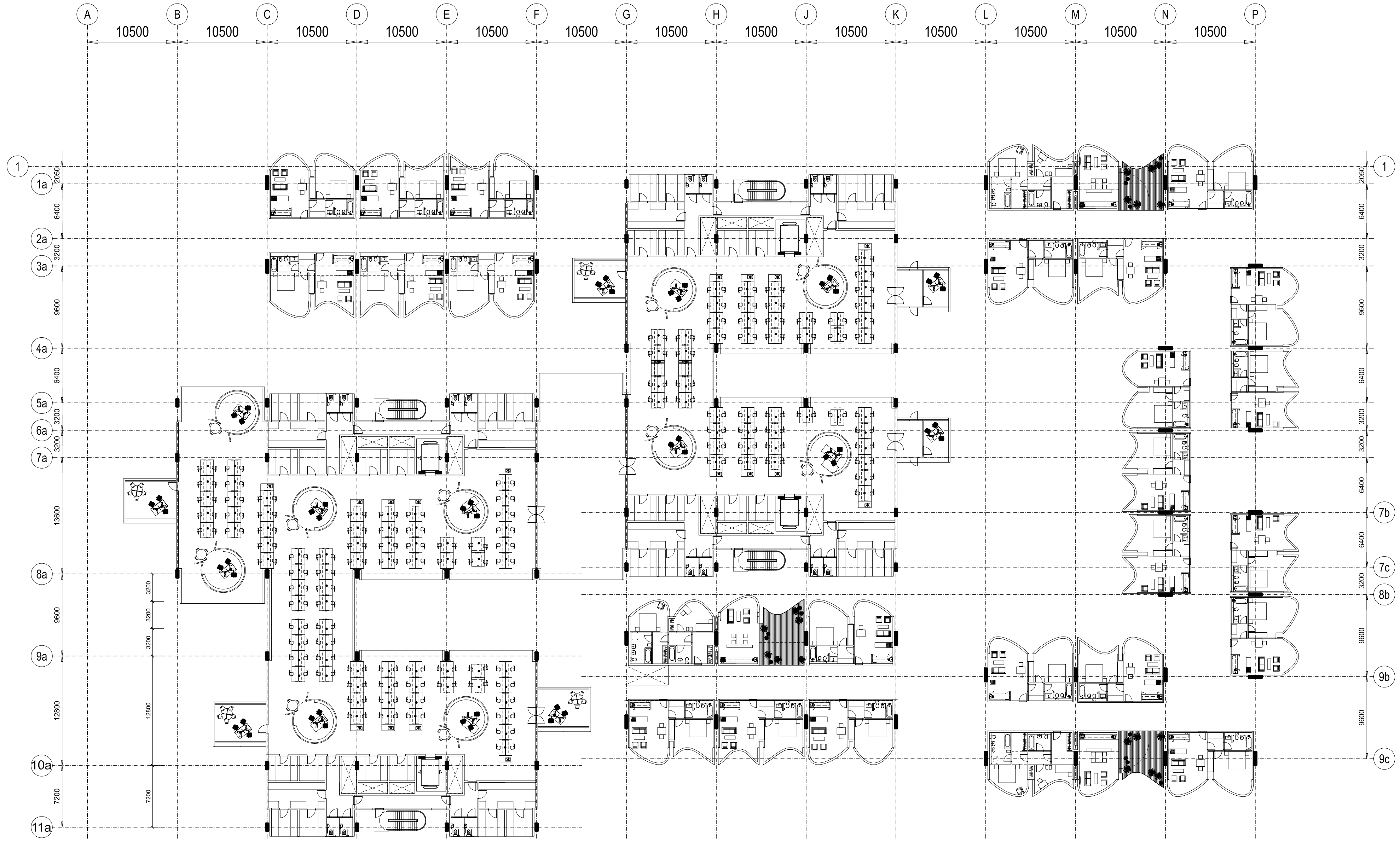
DRAWN NB	SCALE 1:250	CAD FILENAME A042153-s-100.dgn
DATE JAN' 2008	CHECKED PE	STATUS PRELIMINARY
PROJECT No. A042153	DRAWING No. S/100	REVISION P1

PLOT DATE $DATE$ BY $USERNAME$

Levels 01 and 02 General Arrangement

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL STRUCTURAL SPECIFICATIONS AND DETAILS AND ALL OTHER RELEVANT CONSULTANTS DRAWINGS AND SPECIFICATIONS.
2. THE GRID SYSTEM USED IS BASED ON THE ARCHITECTURAL LAYOUTS. REFERENCE SHOULD BE MADE TO THE ARCHITECTS DRAWINGS FOR SETTING OUT OF THE GRID WITHIN THE SITE BOUNDARY.



REV DATE DESCRIPTION BY CHECKED

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MASDAR
CLIENT

MASDAR UNIVERSITY
PROJECT

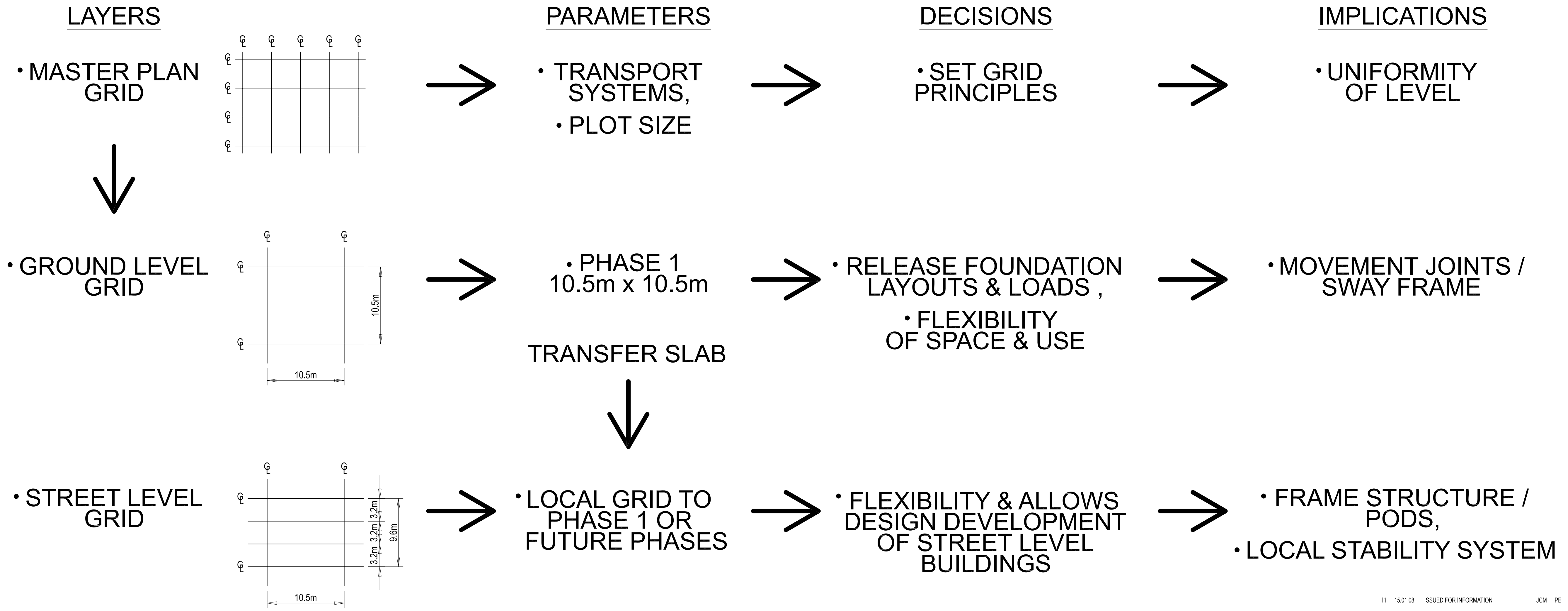
LEVELS 01 AND 02
GENERAL ARRANGEMENT
TITLE

DRAWN NB | SCALE 1:250 | CAD FILENAME A042153-s-105.dgn

DATE JAN' 2008 | CHECKED PE | STATUS PRELIMINARY

PROJECT No. A042153 | DRAWING No. S/105 | REVISION P1

PLOT DATE $DATE$ BY $USERNAME$



REV	DATE	DESCRIPTION	BY	CHECKED
I1	15.01.08	ISSUED FOR INFORMATION	JCM	PE

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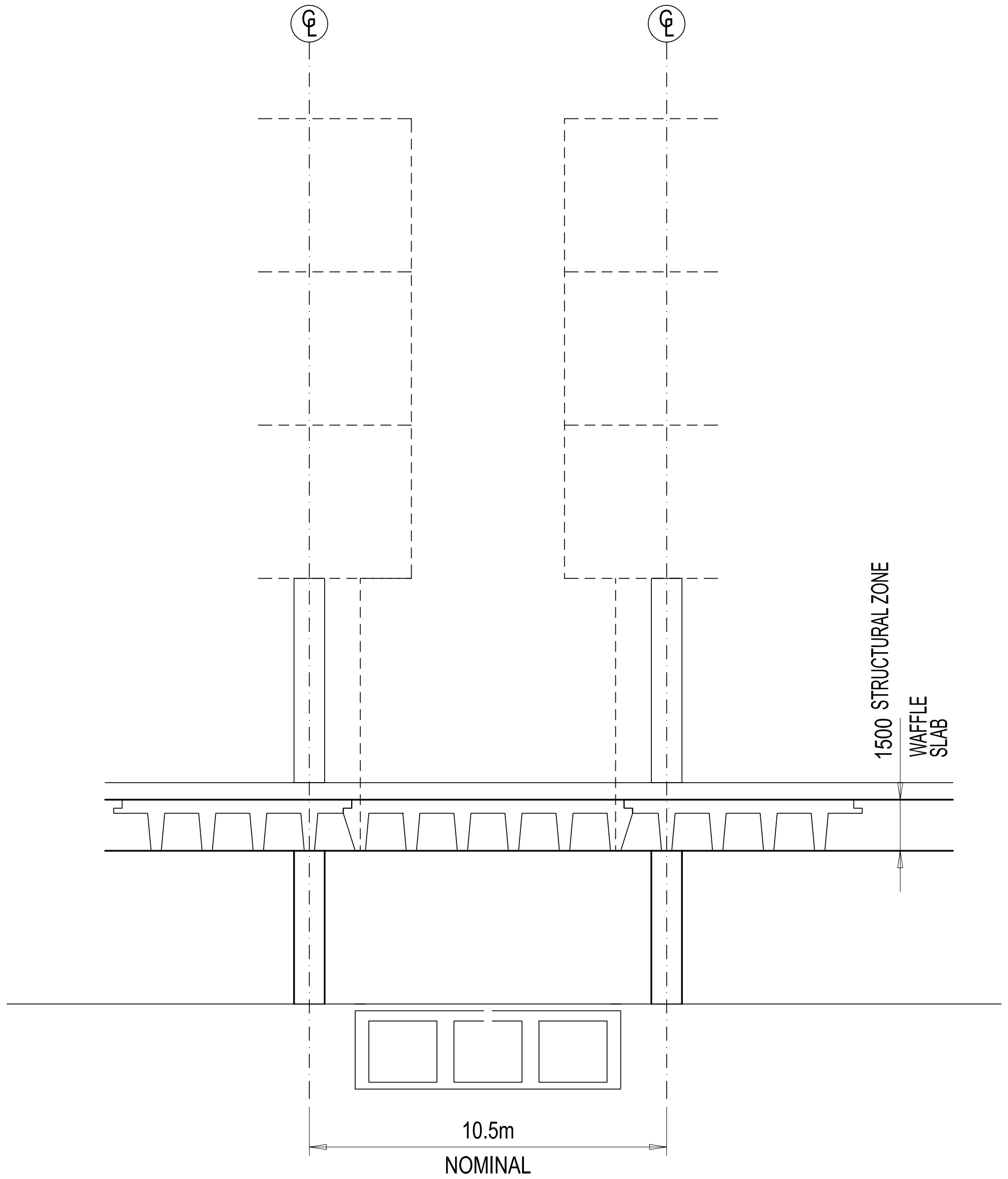
CLIENT: MASDAR

PROJECT: MASDAR UNIVERSITY

TITLE: STRATEGIC GRID DECISIONS

DRAWN JCM	SCALE 1:1	CAD FILENAME A042153-SK021.dgn
DATE JAN 2008	CHECKED PE	STATUS INFORMATION
PROJECT No. A042153	DRAWING No. SK021	REVISION I1

PLOT DATE $DATES$ BY $USERNAMES$



STRUCTURAL SECTION

- 1500mm DEEP STRUCTURAL ZONE ALLOWS FLEXIBILITY OF LOAD POINTS & DESIGN DEVELOPMENT .
- RELEASE FOUNDATION LOADS & LAYOUTS FOR PILING.
- SETS STREET LEVEL & STRUCTURAL PRINCIPLES OF MASTER PLAN.
- POTENTIAL TO INCORPORATE LIFT PITS, PLANTING & ESCALATORS.
- POTENTIAL TO INCORPORATE GLASS LENSES & LIGHTING BELOW.

I1 15.01.08 ISSUED FOR INFORMATION JCM PE

REV DATE DESCRIPTION BY CHECKED

akt ADAMS KARA TAYLOR

MASDAR

MASDAR UNIVERSITY

STRUCTURAL SECTION

DRAWN JCM SCALE 1:100 CAD FILENAME A042153-SK024.dgn

DATE JAN 2008 CHECKED PE STATUS INFORMATION

A042153 SK024 I1

	Phase 1A 2009	Phase 1B 2011	Phase 2 2014	Phase 3 2015
Students	100	441	739	800
% students accomodated on site	90%	90%	90%	90%
Programs	5	10	10	10
Average Program Size	20	44	74	80
Faculty Staff	30	44	74	80
Support Staff (escl. technicians)	30	37	62	67
Total Resident Population (*incl. wives and kids*)	**113**	**496**	**831**	**900**
Total Commuting Population	**70**	**125**	**210**	**227**

The Trip Generation calculation is based on the design quantities as per inputs from designers. The relevant parameter is assumed the number of students for each phase and their split into family-type profiles.

Residential units are provided for 90% of the students whereas staff will live either outside Masdar, likely in the first phases, or within the Citadel boundaries.

From the traffic generation point of view, two scenarios are developed:

WORST CASE – All MIST related traffic will commute from remote areas hence impacting on the external road network and parking with the only exception of the resident students.

BEST CASE – MIST related traffic will split into internal commuting, i.e. between MIST and MASDAR, and external commuting, i.e. between MIST and remote areas across Abu Dhabi. The population growth profile as per MASDAR Detailed Masterplan is adopted.

Allowance for High Occupancy Vehicles is made in this calculation consistently with MASDAR's Trip Generation whereas reduction of private traffic due to any public transport is not taken into account. Projections on modal share across Abu Dhabi will be made available only after official communication from DoT on LRT alignments and Metro schedule.

Worst case scenario

- 100% of the MIST users will commute to/from remote destinations with the sole exception of resident students.
- The impact of event at the Multi-purpose Hall is considered assuming 115% of its occupancy rate.
- Vehicle occupancy rates are based on calculations form the MASDAR trip generation and allow for greater implementation of HOVs.

	Phase 1A	Phase 1B	Phase 2	Phase 3
Worst case - AM hyp	**2009**	**2011**	**2014**	**2015**
Students on site	90	397	665	720
Students' family members	18	79	133	144
Students not resident at MIST	10	44	74	80
Staff - not resident at MIST	60	81	136	147
N° of individuals transbordering MASDAR	**88**	**204**	**343**	**371**
Average vehicle occupancy - CAR+HOVs	1.26	1.30	1.44	1.57
Number of vehicles	70	157	237	237
Multipurpose Hall - N° of seats	0	0	300	300
Degree of occupancy	115%	115%	115%	115%
Multipurpose Hall - Effective N° of attendees	0	0	345	345
Average vehicle occupancy - CAR+HOVs	2.5	2.5	2.5	2.5
Number of vehicles	0	0	138	138
Total n° of vehicles impacting on external network	**70**	**157**	**375**	**375**

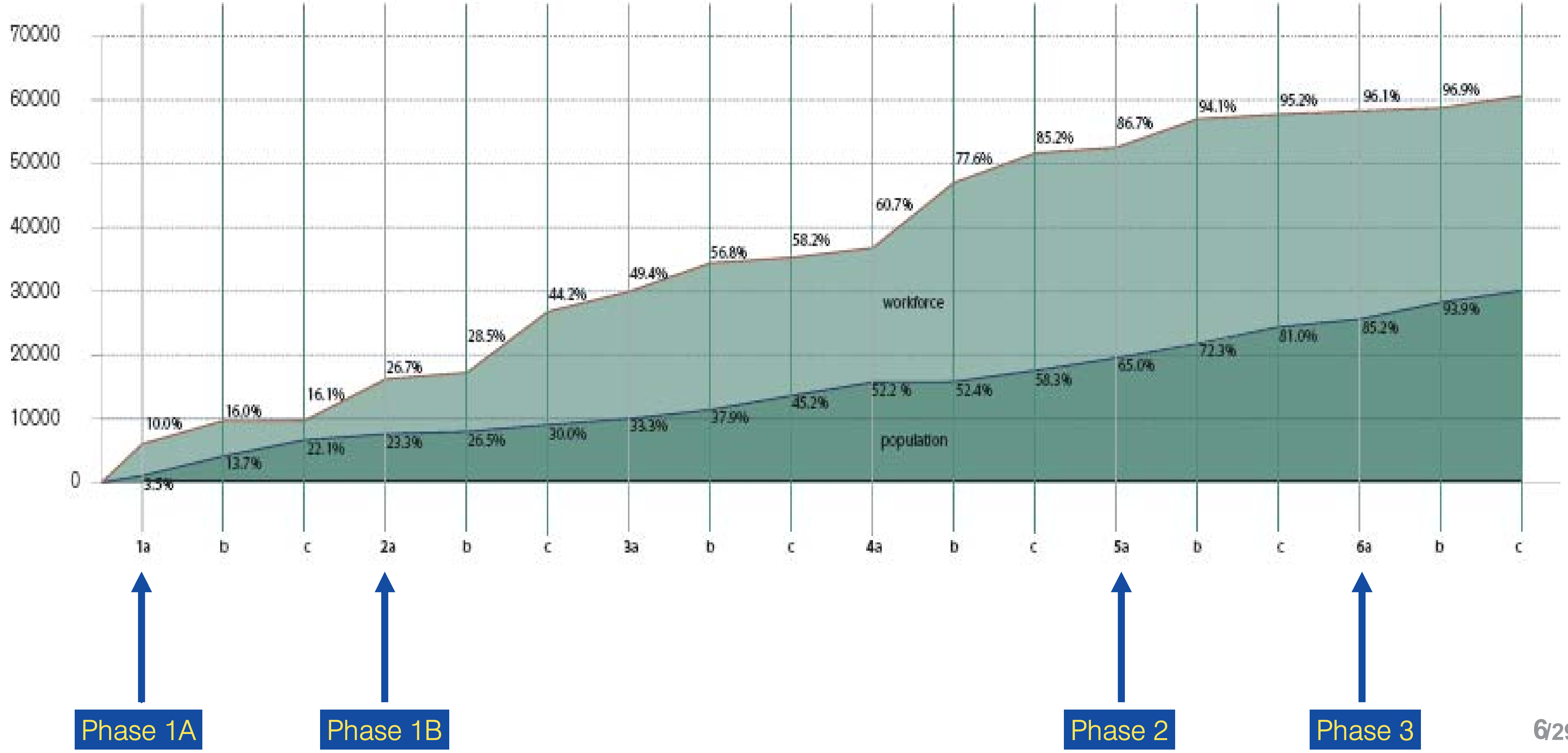
Best case scenario

- Assuming that MIST will be developed together with the rest of the citadel of MASDAR, MIST non-resident users will have the chance to live outside the campus but within the Citadel, therefore not impacting on the external road system.
- The split between remote and MASDAR commuters changes according to the profile of MASDAR population growth.
- The impact of event at the Multi-purpose Hall is considered assuming 85% of its occupancy rate.
- Vehicle occupancy rates are based on calculations form the MASDAR trip generation and allow for greater implementation of HOVs.

	Phase 1A	Phase 1B	Phase 2	Phase 3
Best case - AM hyp	**2009**	**2011**	**2014**	**2015**
Students on site	90	397	665	720
Students not resident at MIST → within MASDAR	2	19	29	34
Students not resident at MIST → outside MASDAR	8	25	45	46
Students' family members on site	18	79	133	144
members not resident at MIST → within MASDAR	4	34	51	62
members not resident at MIST → outside MASDAR	14	46	82	82
Staff employed	60	81	136	147
Staff not resident at MIST → within MASDAR	14	34	53	63
Staff not resident at MIST → outside MASDAR	46	47	83	84
N° of individuals transbordering MASDAR	**68**	**118**	**210**	**212**
Average vehicle occupancy - CAR+HOVs	1.26	1.30	1.44	1.57
Number of vehicles	54	90	146	136
Multipurpose Hall - N° of seats	0	0	300	300
Degree of occupancy	85%	85%	85%	85%
Multipurpose Hall - Effective N° of attendees	0	0	255	255
Average vehicle occupancy - CAR+HOVs	2.5	2.5	2.5	2.5
Number of vehicles	0	0	102	102
Total n° of vehicles impacting on external network	**54**	**90**	**248**	**238**

Population growth profile

	Phase 1A 2009	Phase 1B 2011	Phase 2 2014	Phase 3 2015
Residents of MASDAR - 2015	30665			
Commuters - 2015	36400			
Residents on site - MASDAR [%]	0.035	0.233	0.65	0.852
	1073	7145	19932	26127
Commuters - MASDAR [%]	0.1	0.267	0.867	0.961
	3640	9719	31559	34980
Internal "PRT" commuting	22.77%	42.37%	38.71%	42.76%
Commuting between MIST and Abu Dhabi	77.23%	57.63%	61.29%	57.24%



Reference calculation – Dubai Trip Generation Manual

DUBAI TRIP GENERATION MANUAL	peak	units	trip rate	LU Code	hh.mm	IN	OUT
University - Institute of Higher Education	AM	students	0.37	**308**	07:00 - 9:00	66%	34%
	PM	students	0.26	**308**	12:00 - 14:00	42%	58%
	EV	students	0.15	**308**	17:30 - 20:00	36%	64%
	Max peak	students	0.41	**308**	generally in the morning	60%	40%

2-WAYS	Phase 1A 2009	Phase 1B 2011	Phase 2 2014	Phase 3 2015	
AM	**37**	**163**	**273**	**296**	**07:00 - 9:00**
PM	26	115	192	208	12:00 - 14:00
EV	15	66	111	120	17:30 - 20:00
Max peak	41	181	303	328	generally in the morning

INBOUND					
AM	**24**	**108**	**180**	**195**	**07:00 - 9:00**
PM	11	48	81	87	12:00 - 14:00
EV	5	24	40	43	17:30 - 20:00
Max peak	25	108	182	197	generally in the morning

OUTBOUND					
AM	**13**	**55**	**93**	**101**	**07:00 - 9:00**
PM	15	67	111	121	12:00 - 14:00
EV	10	42	71	77	17:30 - 20:00
Max peak	16	72	121	131	generally in the morning

Reference calculation – SAN DIEGO Trip Generation Manual

SAN DIEGO TRIP GENERATION MANUAL	peak	units	trip rate	LU Code	hh.mm	IN	OUT
University - Institute of Higher Education	AM	students	0.10	-	07:00 - 9:00	90%	10%
	PM	students	0.00	-	12:00 - 14:00	0%	0%
	EV	students	0.09	-	17:30 - 20:00	30%	70%
	Max peak	students	0.15	-	generally in the morning	90%	10%

2-WAYS	Phase 1A 2009	Phase 1B 2011	Phase 2 2014	Phase 3 2015	
AM	**10**	**44**	**74**	**80**	**07:00 - 9:00**
PM	0	0	0	0	12:00 - 14:00
EV	9	40	67	72	17:30 - 20:00
Max peak	15	66	111	120	generally in the morning

INBOUND					
AM	**9**	**40**	**67**	**72**	**07:00 - 9:00**
PM	0	0	0	0	12:00 - 14:00
EV	3	12	20	22	17:30 - 20:00
Max peak	14	60	100	108	generally in the morning

OUTBOUND					
AM	**1**	**4**	**7**	**8**	**07:00 - 9:00**
PM	0	0	0	0	12:00 - 14:00
EV	6	28	47	50	17:30 - 20:00
Max peak	2	7	11	12	generally in the morning

Reference calculation – ITE Trip Generation Manual

ITE TRIP GENERATION MANUAL	peak	units	trip rate	LU Code	hh.mm	IN	OUT
University - Institute of Higher Education	AM	students	0.19	**550**	07:00 - 9:00	82%	18%
	PM	students	0.00	**550**	12:00 - 14:00	0%	0%
	EV	students	0.23	**550**	17:30 - 20:00	29%	71%
	Max peak	students	0.24	**550**	generally in the afternoon	30%	70%

2-WAYS	Phase 1A 2009	Phase 1B 2011	Phase 2 2014	Phase 3 2015	
AM	**19**	**84**	**140**	**152**	**07:00 - 9:00**
PM	0	0	0	0	12:00 - 14:00
EV	23	101	170	184	17:30 - 20:00
Max peak	24	106	177	192	generally in the afternoon

INBOUND

AM	**16**	**69**	**115**	**125**	**07:00 - 9:00**
PM	0	0	0	0	12:00 - 14:00
EV	7	29	49	53	17:30 - 20:00
Max peak	7	32	53	58	generally in the afternoon

OUTBOUND

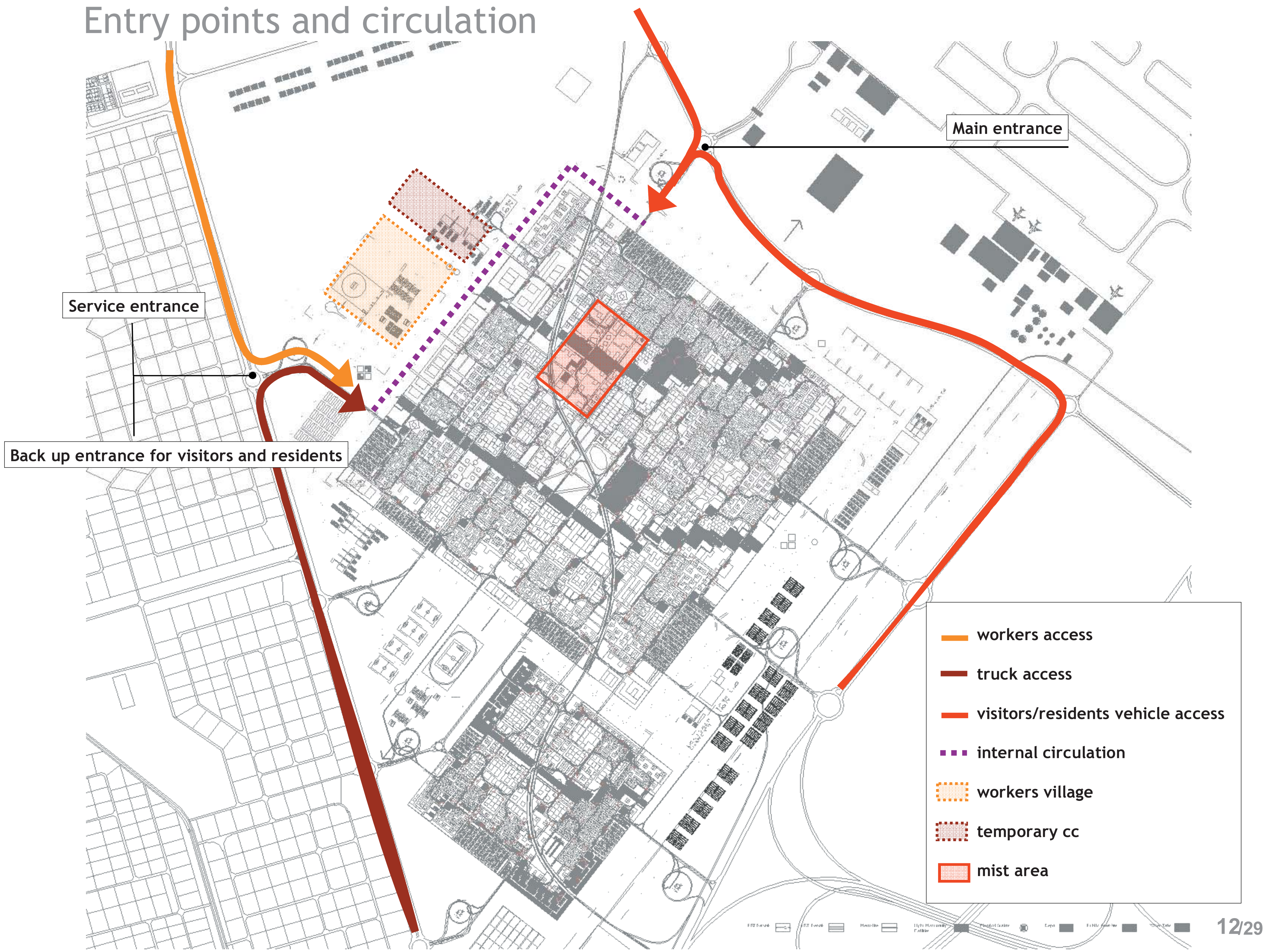
AM	**3**	**15**	**25**	**27**	**07:00 - 9:00**
PM	0	0	0	0	12:00 - 14:00
EV	16	72	121	131	17:30 - 20:00
Max peak	17	74	124	134	generally in the afternoon

Comparison

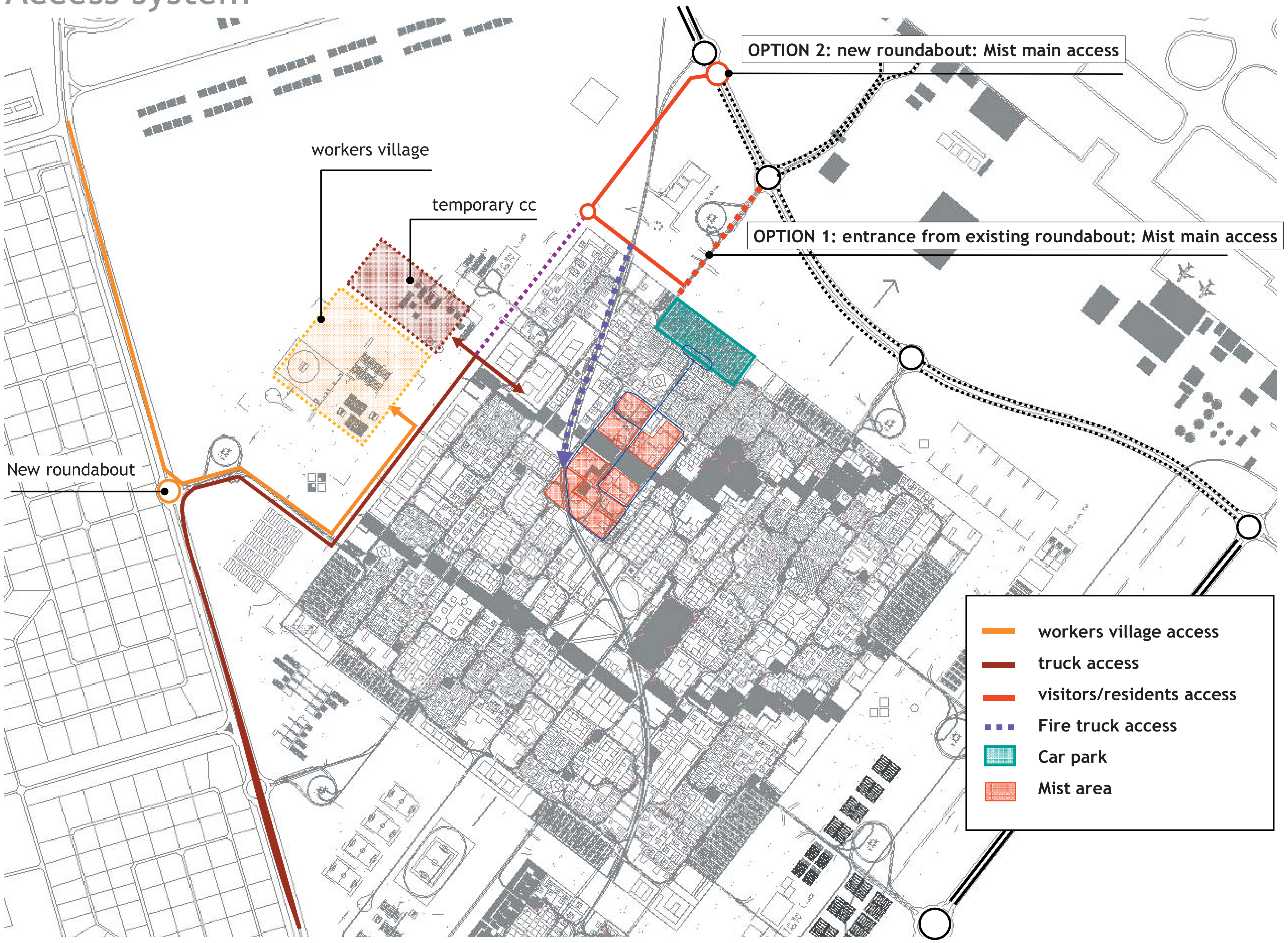
As it can be evinced from the table below, Systematica's WORST case calculation is higher than the Dubai Trip Generation Manual (term of reference for Traffic Impact Study Guidelines). Having ignored any assumption on Public Transport ridership, figures make allowance for further reduction once more precise indications will come from the Department of Transport.

Importantly also is to notice that these calculated quantities – 2-way AM peak – are compatible with parking construction phasing and the proposed accessibility strategy.

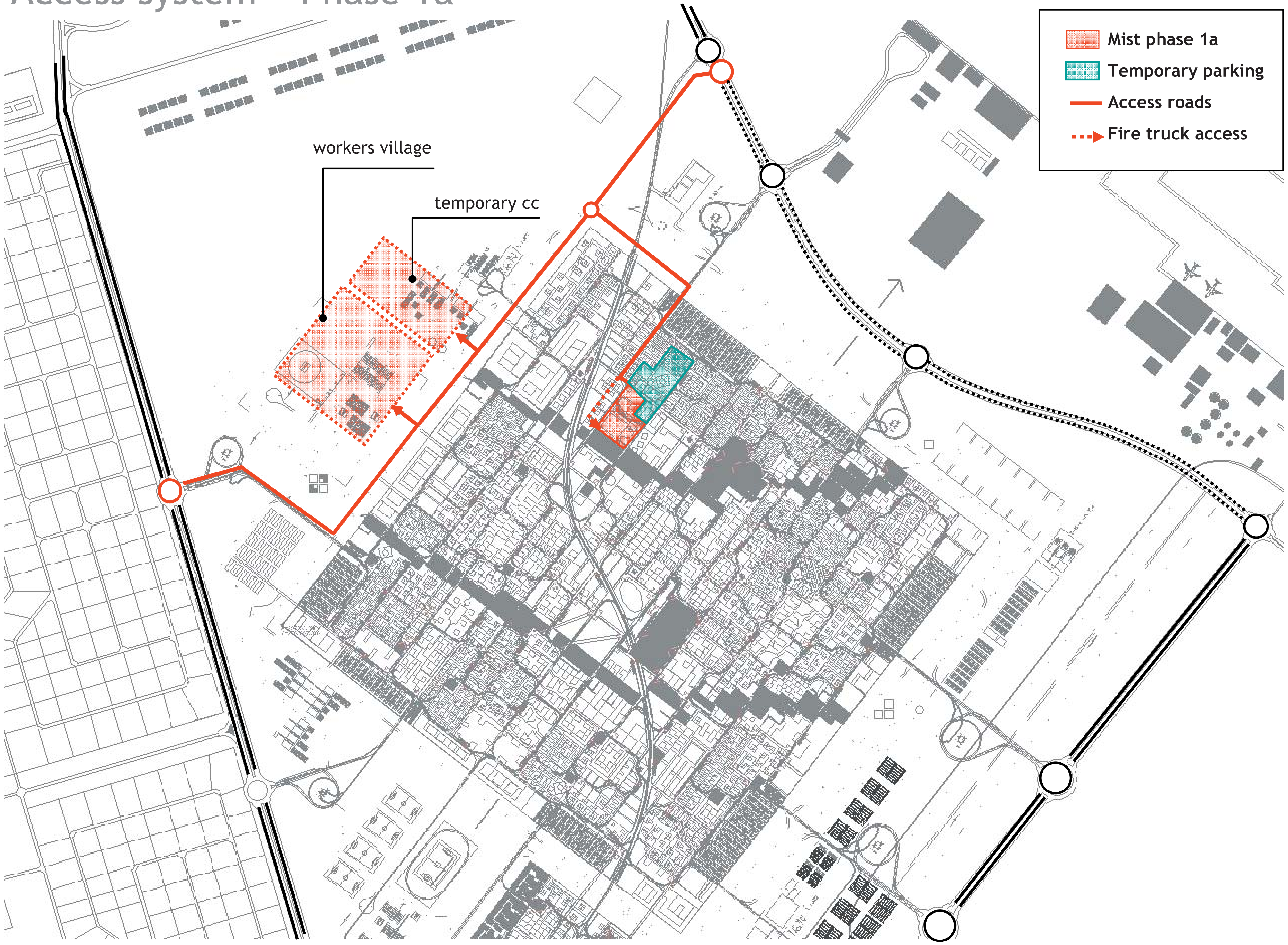
	Phase 1A 2009	Phase 1B 2011	Phase 2 2014	Phase 3 2015
Worst case - AM hyp	70	157	375	375
Best case - AM hyp	54	90	248	238
DUBAI TRIP GENERATION MANUAL	37	163	273	296
SAN DIEGO TRIP GENERATION MANUAL	10	44	74	80
ITE TRIP GENERATION MANUAL	19	84	140	152


Entry points and circulation
Main entrance
Service entrance
Back up entrance for visitors and residents
workers access
truck access
visitors/residents vehicle access
internal circulation
workers village
temporary cc
mist area
12/29

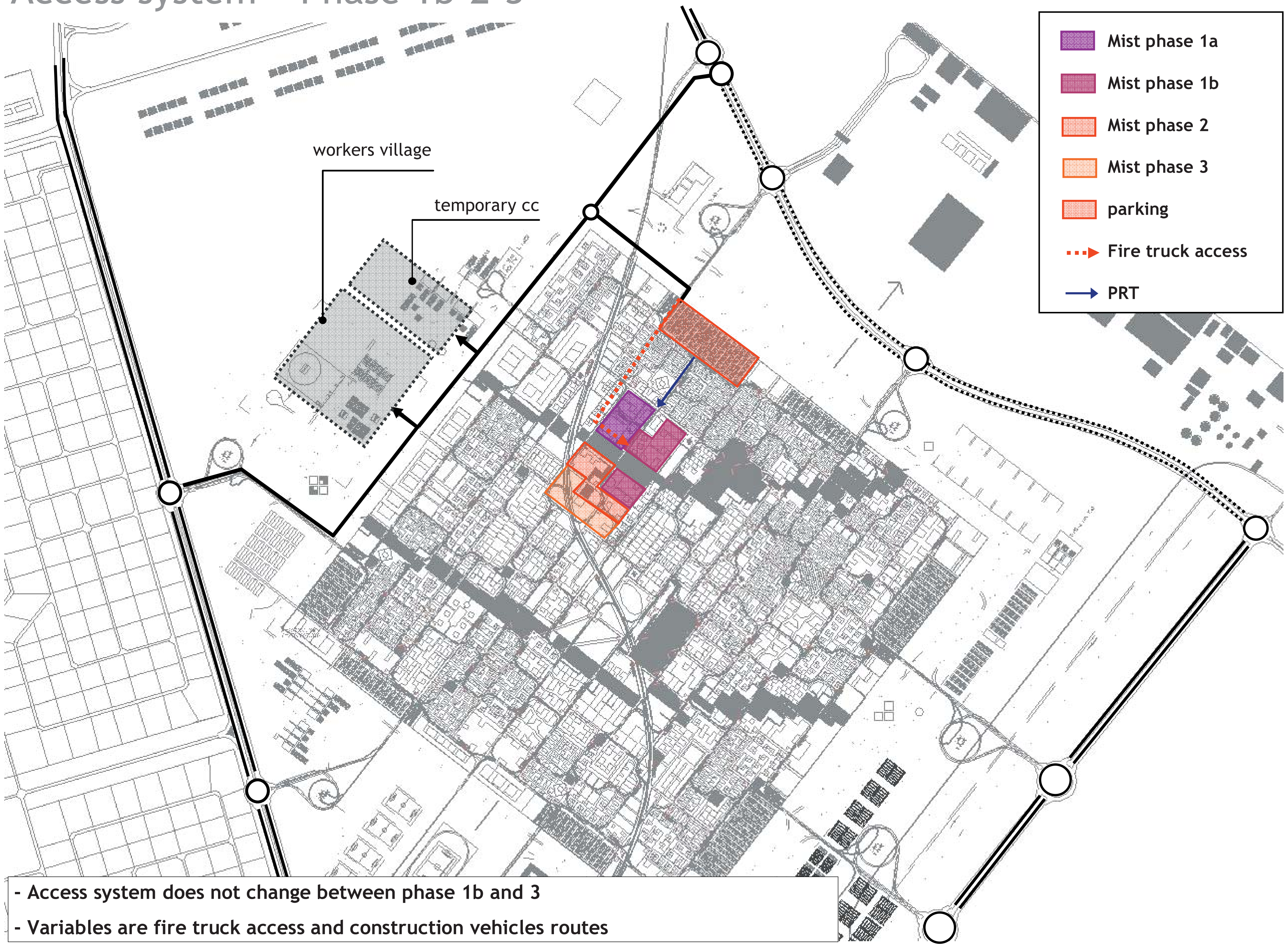
Access system



Access system – Phase 1a

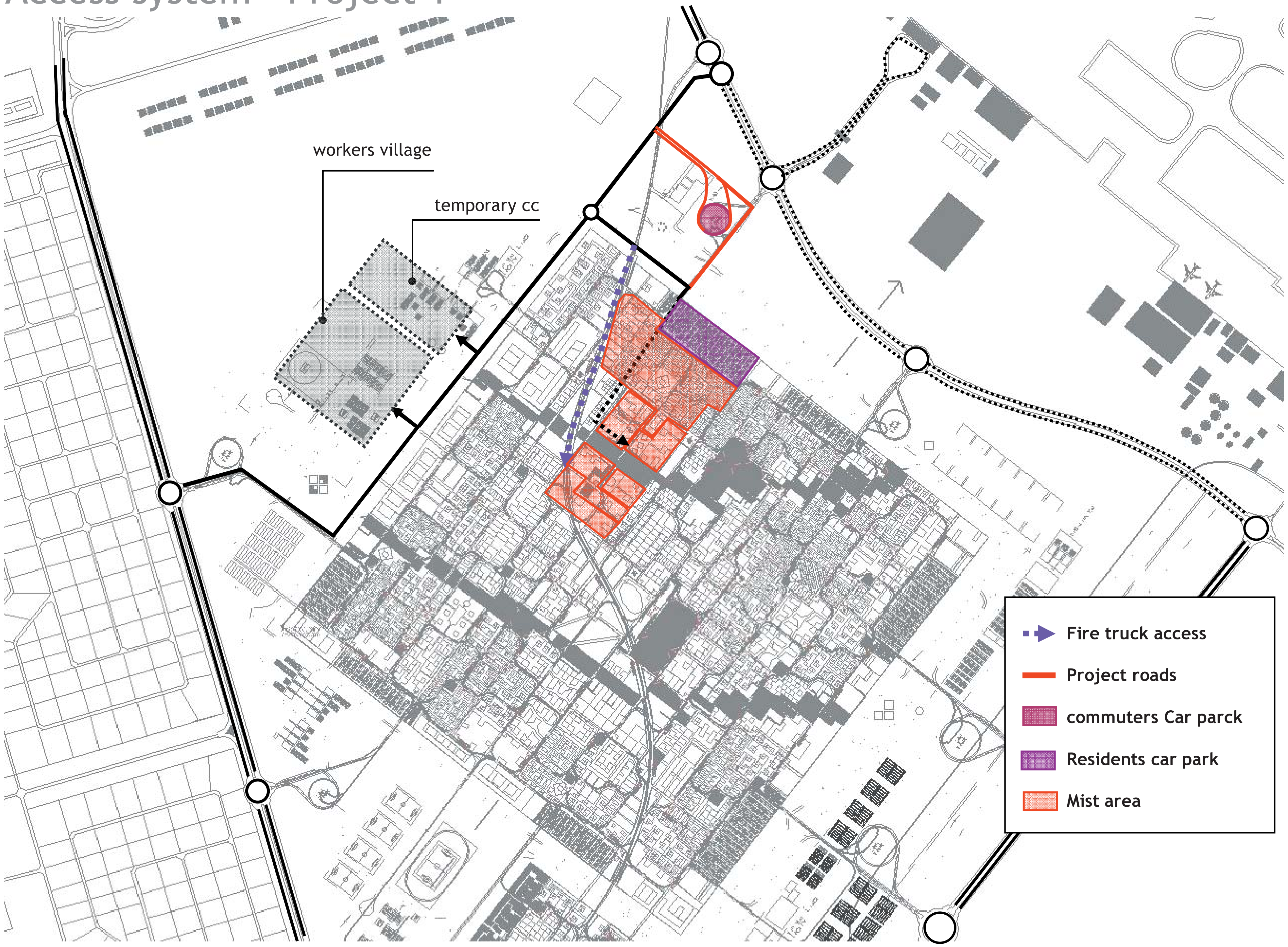


Access system – Phase 1b-2-3



- Access system does not change between phase 1b and 3
- Variables are fire truck access and construction vehicles routes

Access system – Project 1



ROAD INFRASTRUCTURES OUTSTANDING ISSUES

- TIS approval in order to start piling

- Civil defence approval in order to start piling

- definition of access roundabouts (option 1 or 2 of slide13) in order to start road works

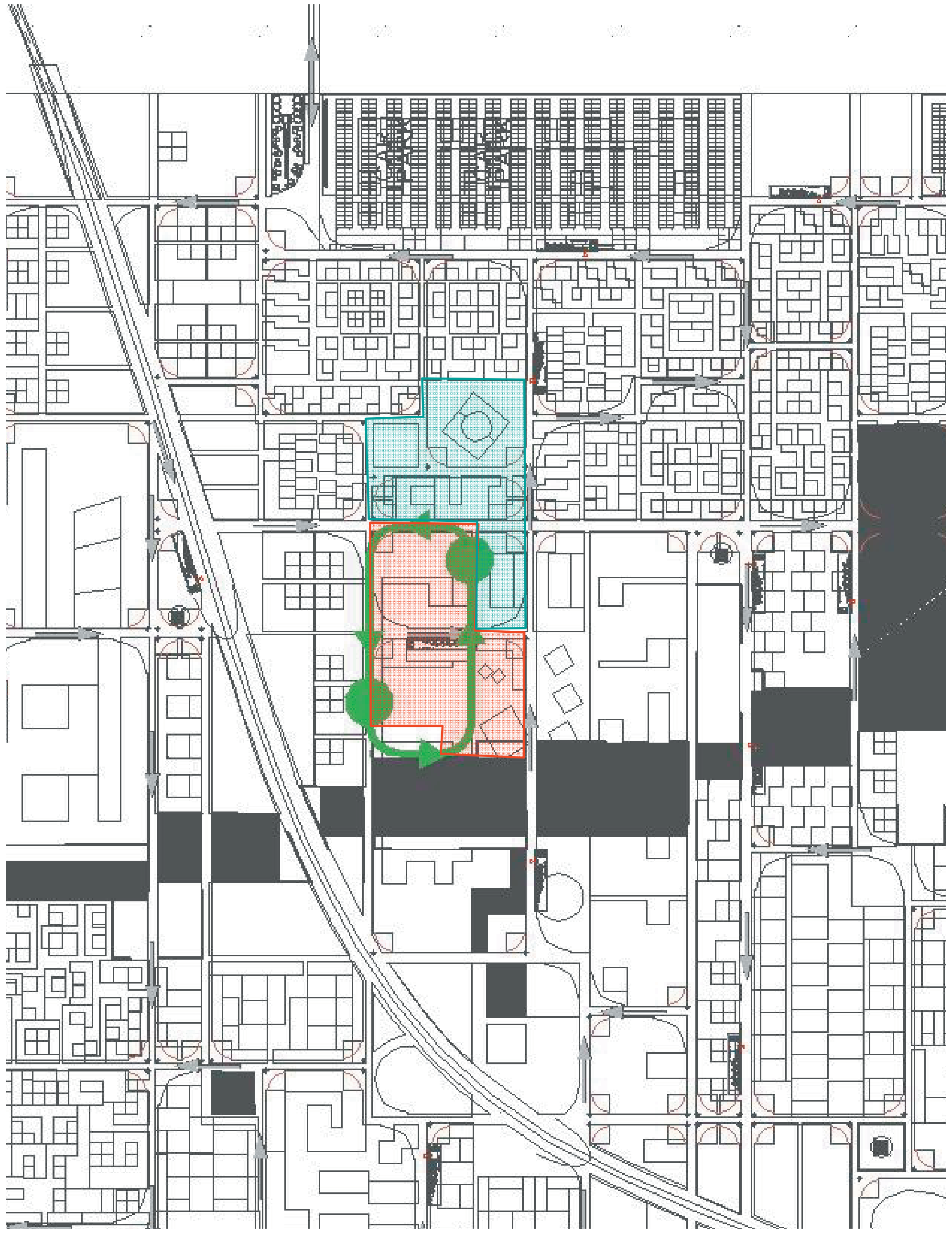
- detailed design of access roads

- definition and clarification on phasing (project1 and parking structures)

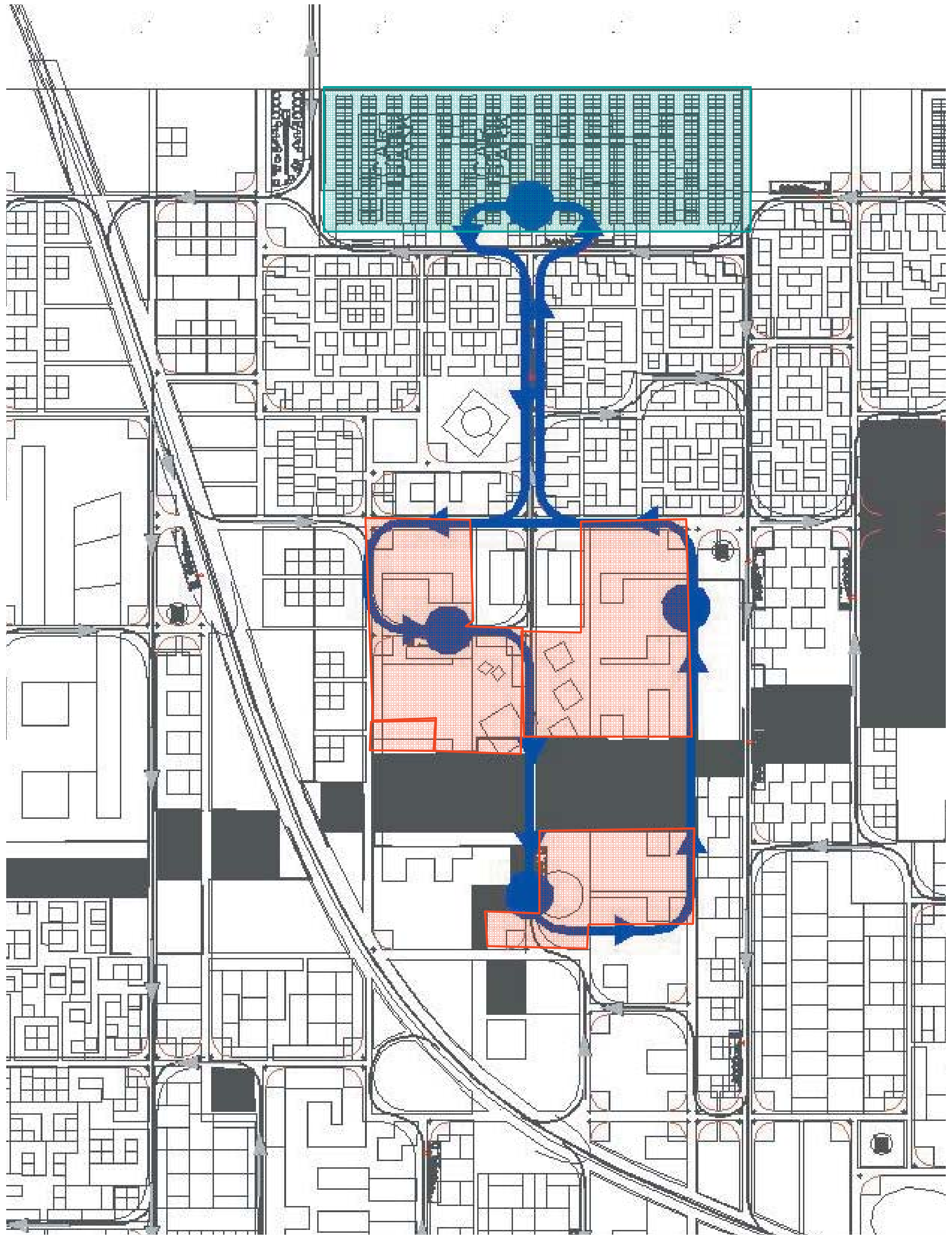
- scheme design of parking K-13

PRT: phase 1a-1b

Phase 1a (shuttle bus)

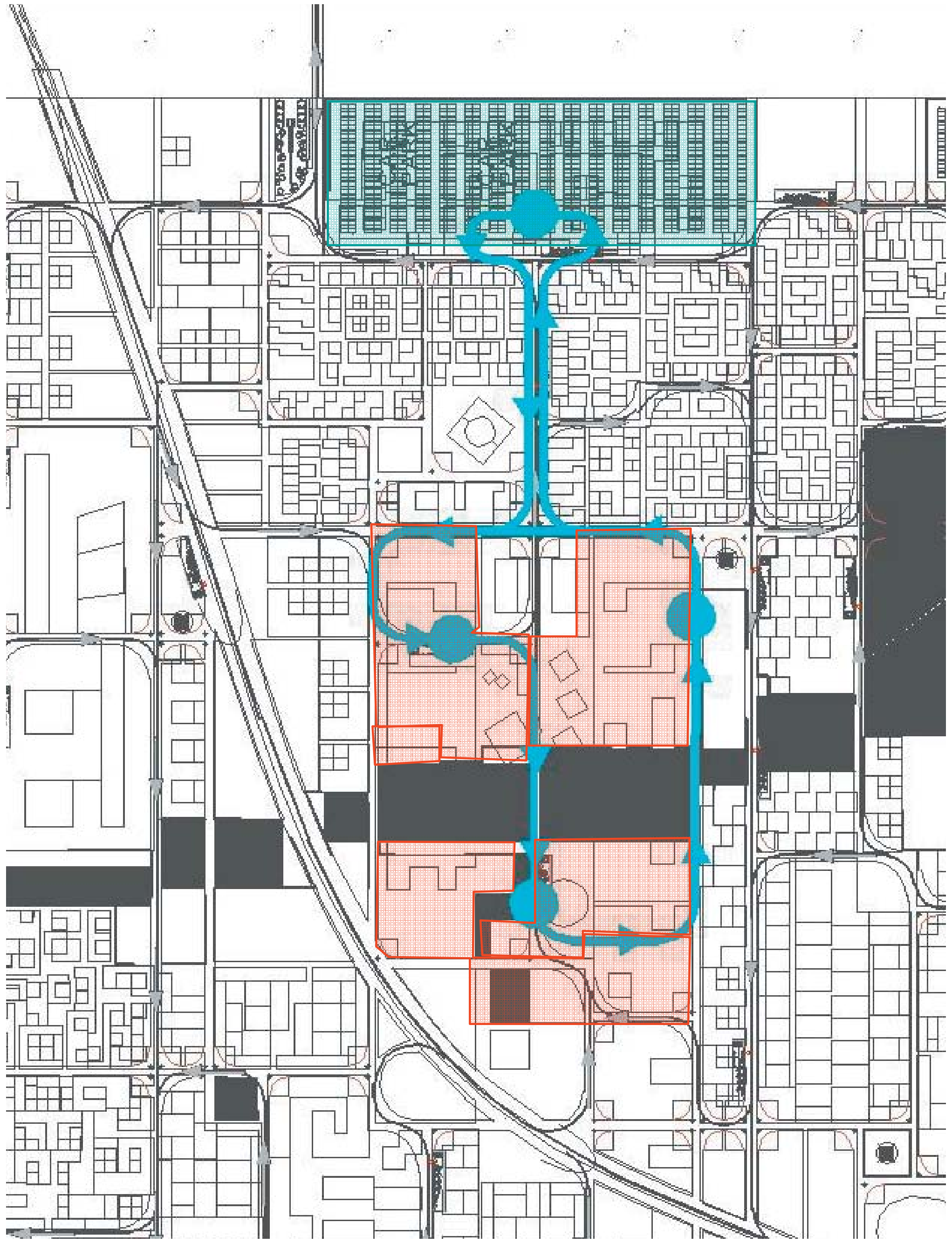


Phase 1b

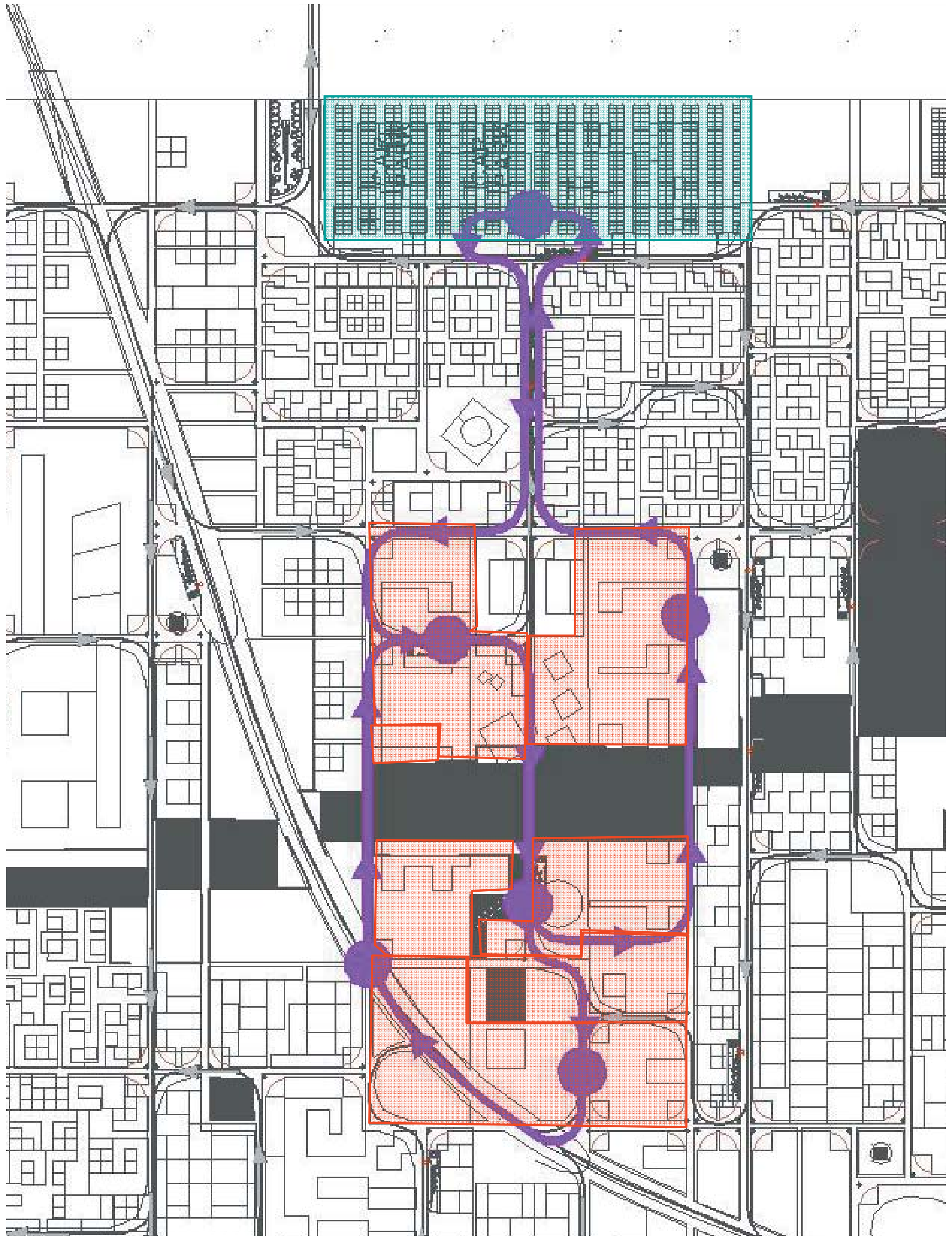


PRT: phase 2-3

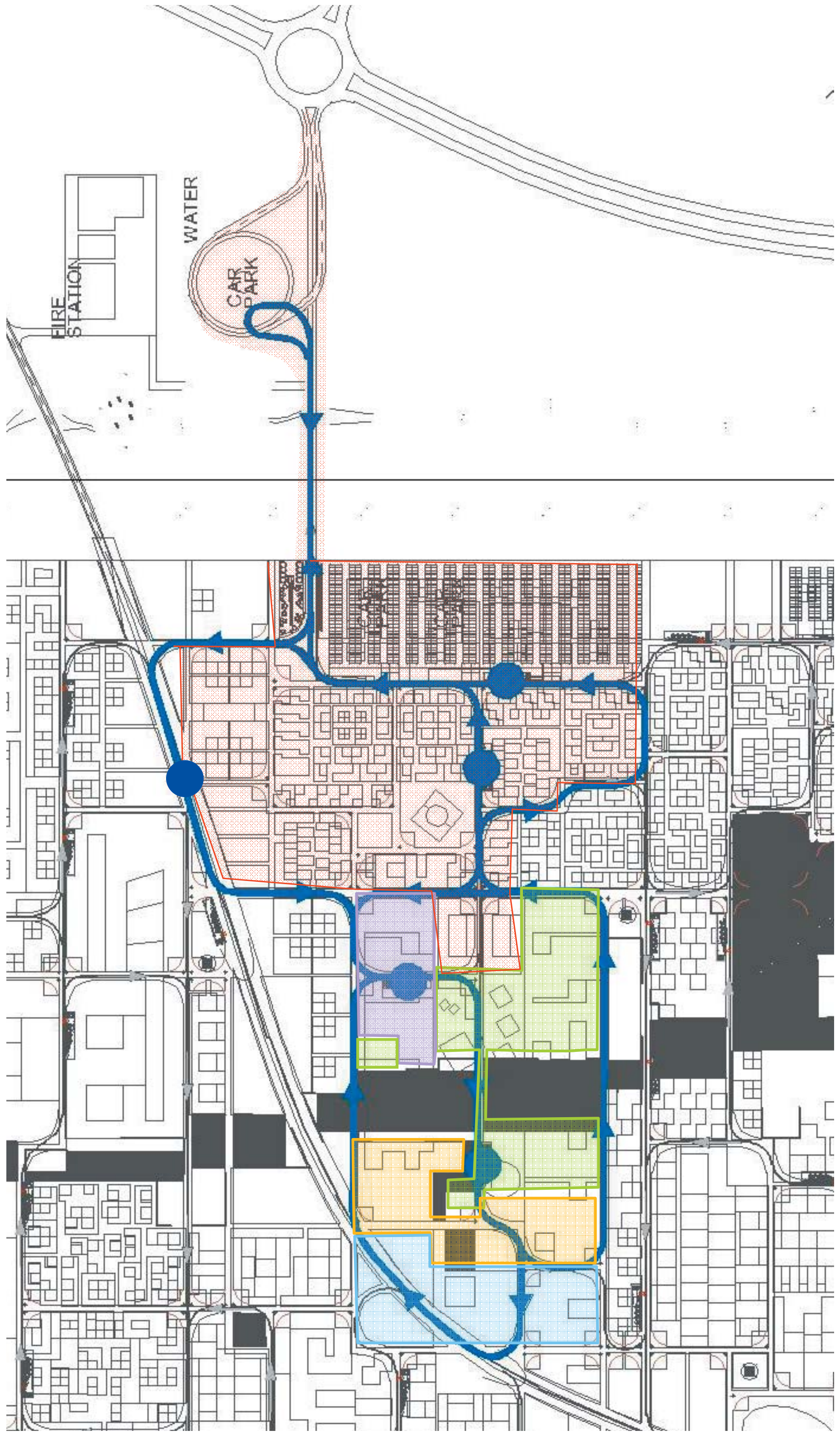
Phase 2



Phase 3



PRT: phase Project 1



- mist phase 1a
- mist phase 1b
- mist phase 2
- mist phase 3
- project 1
- PRT

PRT OUTSTANDING ISSUES

- timing: timing will be very tight. PRT can start testing in mid-2009 but cannot start operation before early 2010

- definition of structural grid interface in order to start piling

- replacement: a replacement system will be necessary to transport people, goods and waste during the testing period: electric vehicles with human driver can be used to avoid using polluting vehicles in the undercroft. Automated vehicles and manned vehicles cannot run together so during testing will no manned vehicles will be allowed on the tracks.

- phasing: the network and service will be phased along with the development of the building of phase 1. The first "network" will be a simple line going to the parking lot and through the MIST grounds. A temporary roundabout at the far end will allow vehicles to reverse direction. With phases 1b and 1c the network will expand. Temporary connections will be built to be demolished when the network will be completed.

-compatibility: the system will have to be compatible with the system that will run in rest of Masdar, ideally, it will be the same system that will expand

- dimensioning: the network, the road infrastructure and the stations will have to be dimensioned according to the traffic that will take place when Masdar will be completely built and inhabited. No road should be less than 7 m wide; all stations must be off-line, main stations will have 6-8 bays

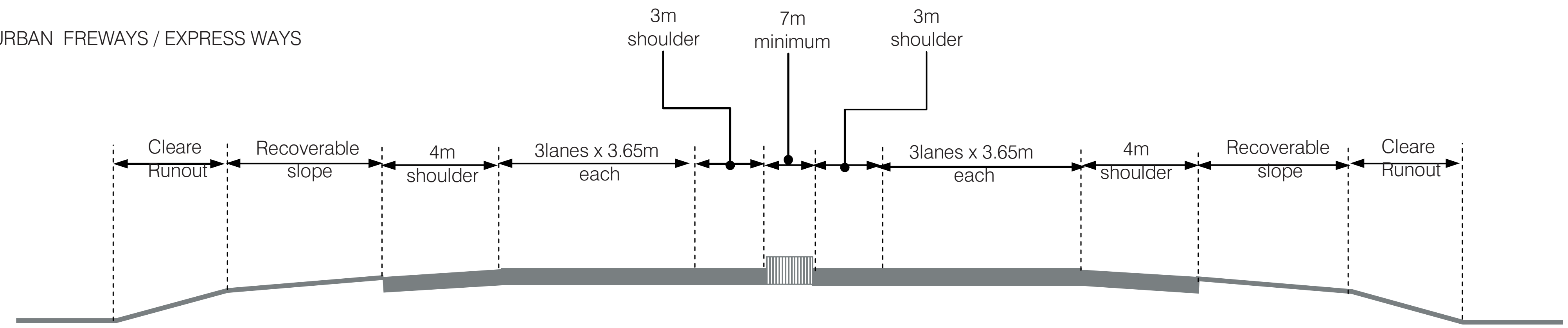
- choice of the system(s): the PRT system, or combination of systems has not been chosen yet. This leaves a significant uncertainty. The design is oriented towards a specific system, and this system is used as a "template" but it is not the official choice.

- undercroft and elevated systems: as a mitigation measure against congestion, an elevated PRT system has been suggested in addition to the undercroft system. The decision on this system is still not final. However it is necessary to leave the room to allow the passage of the guideways between the buildings. The elevated system will have less tracdks, less stations, less interchanges than the undercroft system. Its vehicles will be faster and may connect locations outside Masdar (e.g. the airport)

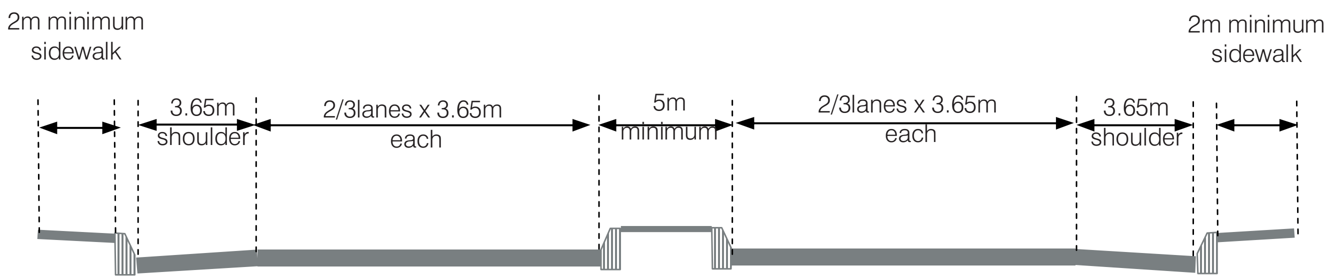
- freight delivery and waste collection: passages and loading-unloading bays must exist at every major building. Every building/dwelling must have an entrance for freight. And a waste collection point. These should be out of the main guideway. Special vehicles and operation procedures will have to be defined for waste collection.

Roads typology (from “Road Design Manual” Abu Dhabi regulation)

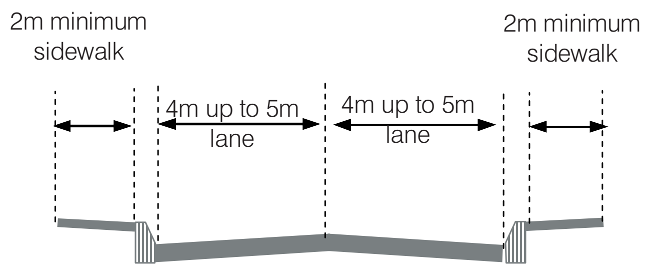
RURAL / URBAN FREWAYS / EXPRESS WAYS



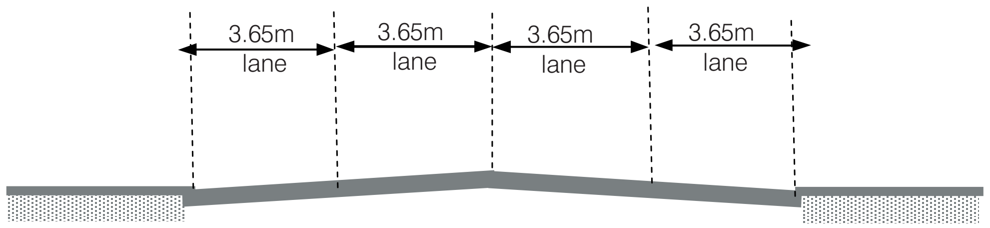
MAIN ROADS



SECTOR ROAD _ ONE LANE EACH DIRECTION

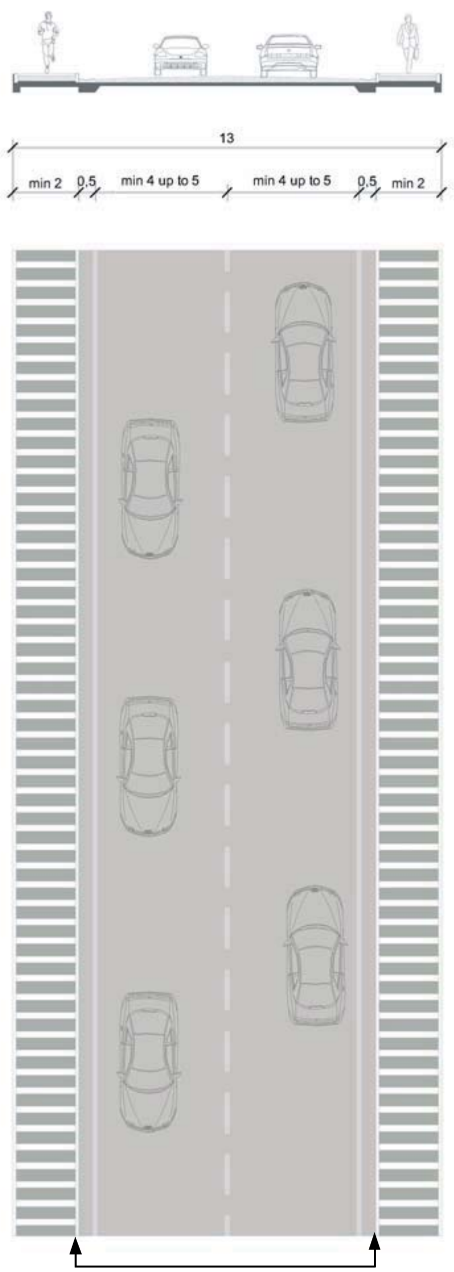


SECTOR ROAD _ TWO LANE EACH DIRECTION



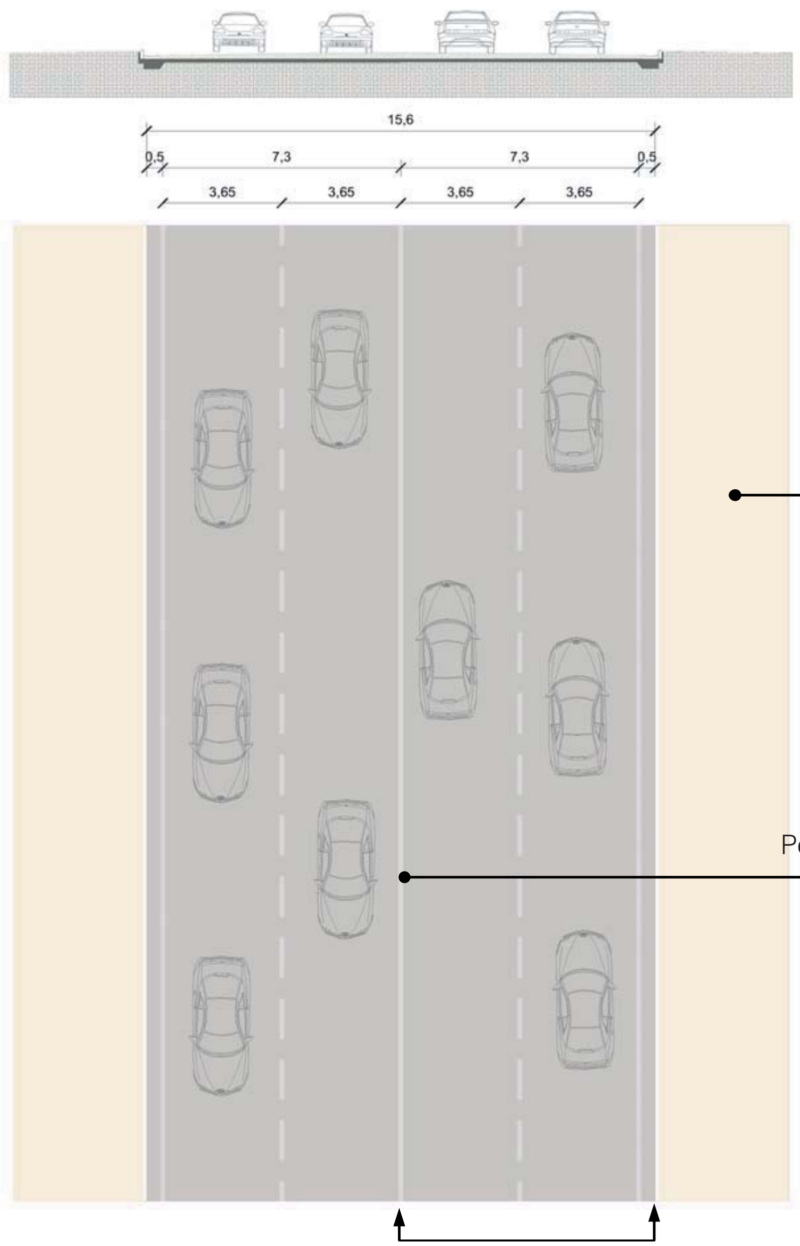
Proposed road sections

MASDAR INTERNAL ROAD TYPE 1

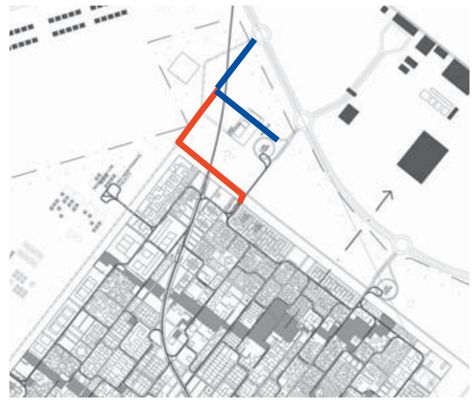


Section dimension fit to fire truck transit

MASDAR INTERNAL ROAD TYPE 2



Section dimension fit to fire truck transit



Possibility to increase path with sidewalk and/or green area

Possibility to include a traffic island

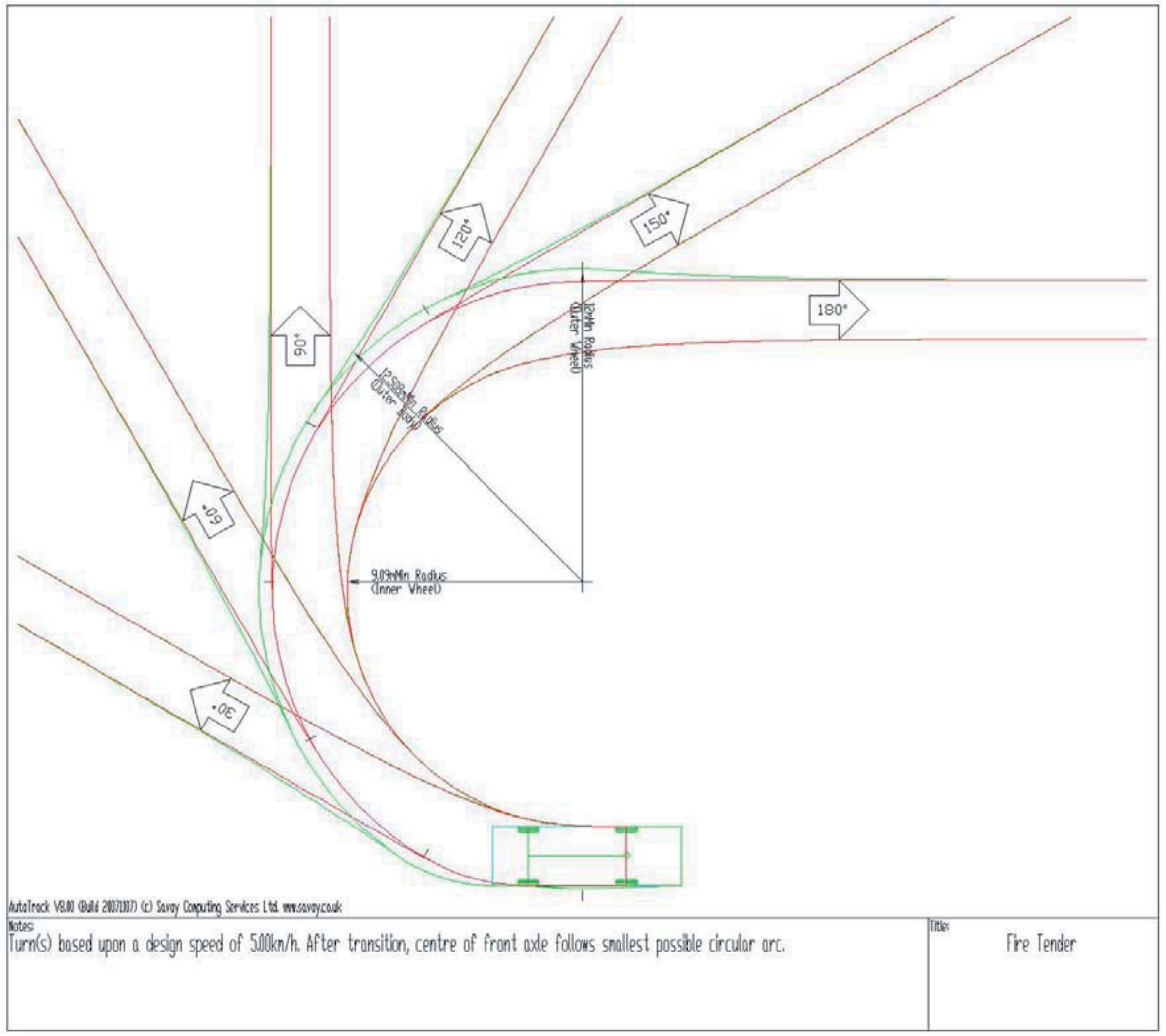
Fire truck regulations

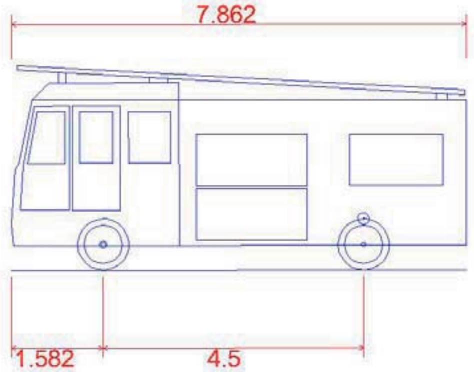
The Abu Dhabi Civil Defence (ACDC) requires its fire fighting vehicles to have access to all buildings and enclosed areas.
The following is a summary of the main requirements for accessibility for fire fighting and emergency vehicles as imposed by the Abu Dhabi Civil Defence Authority (CD).
The data is extracted from the UAE Civil Defence Code.

parameter	requirement
Road width	Min 6m
Ceiling height	Min 4.5m
Turning radius	Min 16m
Bearing capacity	Min 30 tonnes
Incline	Max 10%
Dead ends	If longer than 45m then roundabout of 16m radius is required
Side clearance from CD vehicle	Min 2m
Distance from dry hydrant	Max 45m

Height of the building as to storey	Volume of the bldg (1000 M3)	Type of necessary civil defense machine	Max. distance	Arrival points and number of facades.
1.	Any volume	Fire pump	45	Main exits
2.	Less than 7	Fire pump	30	Main exits
	7-27	Fire pump	18	One façade or more + main exits
	More than 27-57	Fire pump	18	Two facades + main exits
	More than 57-85	Fire pump	18	Three facades + main exits
	More than 85	Fire pump	18	all facades
3 or more	Less than 7	Automatic ladder + fire pump	10-15	At least one façade + main exits
	7-28	Automatic ladder + fire pump	10-15	Two facades+ main exits
	More than 28-57	Automatic ladder + fire pump	10-15	Three facades + main exits
	More than 57	Automatic ladder + fire pump	10-15	all facades

AD fire truck dimensions and swept path





Fire Tender Abu dhabi	
Overall Length	7.862m
Overall Width	2.550m
Overall Body Height	3.541m
Min Body Ground Clearance	0.426m
Track Width	2.550m
Lock to Lock Time	5.00 sec
Kerb to Kerb Turning Radius	8.850m

AD fire truck swept path verification in the undercroft structure (5km/h)

- the proposed 10.5m structure allow for easy turning of the fire truck vehicles inside the undercroft

- the proposed 10.5m structure allow for easy turning of the fire truck vehicles inside the undercroft

AD fire truck swept path verification in the undercroft structure (35km/h)