Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Architecture and Design
Department of Architecture and Technology

Miriam Kinck Kolstad & Maren Lovise Øby

Human Nurture

Designing for Sustainable Mental Health Treatment

Master's thesis in Master of Sustainable Architecture
Supervisor: Pasi Aalto
Co-supervisor: Eva Patricia Schneider-Marin
June 2024

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Human Nurture

- Designing for Sustainable Mental Health Treatment

Master in Sustainable Architecture (MSc)
Norges Teknisk-Vitenskapelige Universitet
Spring 2024

Miriam Kinck Kolstad
Maren Lovise Øby

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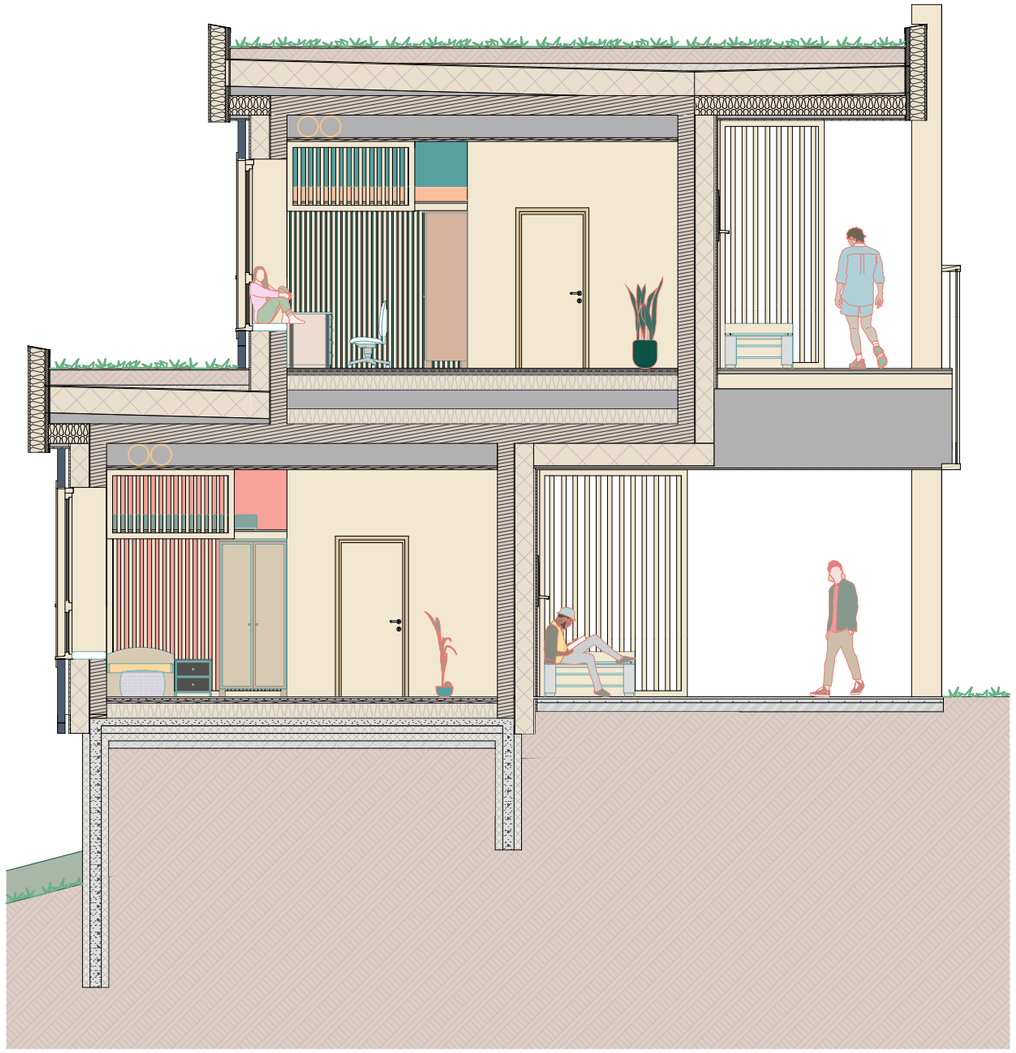


Figure No. 0.2: Section through the Project - Not in Scale

Abstract

Research shows that exposure to nature and natural elements has a positive effect on well-being, physical and psychological health, as well as rehabilitation. This lead to an interest in exploring biophilic design thinking within the architectural design of a mental health institution. The Psykiatrisk Døgnenhet was chosen as a design typology due to it's nature as a a low security, low risk facility, allowing for alternative design solutions and less rigid security measures.

The project was initiated by a deep dive into existing research, and a summary of existing literature within the fields of mental health treatment, biophilic design, environmental psychology and institutional architecture is collected within this booklet. In addition to the review of research, users of the facilities, as well as architects that had experience with this typology were contacted. Through meetings and discussions with Sykehusbygg HF, former SINTEF-employees, psychiatric nurses and psychologists, as well as former patients, insight into the needs, wants and experiences of the people using these buildings was gained. Along with case studies this forms the basis for the design decisions.

The project uses biophilic and evidence-based sustainable principles, but the goals and results of the design are difficult to measure. It's impossible to know the exact effect the design will have on the users of the building, and the theory booklet therefore discusses different ways of quantifying and measuring the project's success.

The main goal of the thesis is to explore the themes of Biophilic Architecture, Mental Health, and the Connection between Nature and Well-being. The final result is a design proposal for a new Mental Health Hospital within the forest outside of Trondheim, as well as a theory booklet that summarise the research and overall values regarding sustainability, mental health and dignity that has influenced the final design choices.

Research Question
Can Biophilic Design Philosophy create a Mental Health Facility where users experience quicker recovery rates and greater success of therapy?
Due to the nature of the project, a set of overarching design goals were chosen in the initial phase of the project, rather than a specific research question.

- Create an environment where patients thrive and recover
- Create a building with little negative impact on the immediate environment
- Create a functional and welcoming psychiatric hospital

Chapter 11 in the Theory Booklet provides a set of detailed, measurable goals for the project. Chapter 3 - Quantification also discuss how the design may be assessed in order to determine whether the overarching goals have been met.

This booklet showcases the resulting design project, the main part of this master thesis.

Figure No. 0.3: Interior render - Group Therapy

Project Brief

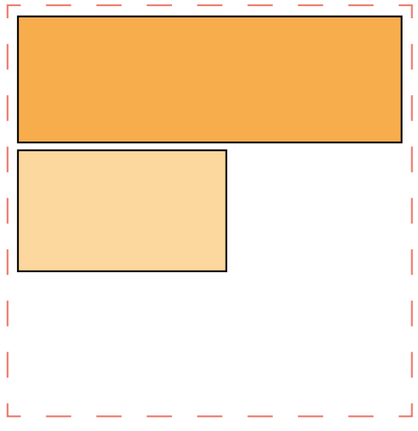
The Design Project within this Master thesis explores how Biophilic Design Principles and Evidence Based Design can result in a building that's economically, socially and environmentally sustainable.

The final design is a new Psychiatric Hospital Facility for Nidaros DPS, that will serve low risk patients that are admitted for shorter periods in an environment that offers rest and rehabilitation. The current facilities places short term patients with low risk diagnosis in the same ward as patients experiencing suicidal thoughts, aggressive behavior and other critical conditions. With a total of 17 patient units within the ward, the facilities can only accommodate a limited number of low risk-patients as they have to prioritize patients with more severe diagnoses.

A separate location for low risk patients allows for less security measures and a less "institutional" design than the current facilities. A more dignifying environment will increase the patients self worth and mastery of self. Combined with an increased number of patient units this may lead to more people being admitted at an earlier stage, and preventing a more severe diagnosis.

The exterior and interior design both immerse the users in nature, and creates surroundings that elevates the status of the patient and motivates them to actively participate in their own recovery. The design invokes a sense of freedom and trust within the patients, where patients can move freely while still being within an enclosed space.

Size & Area



Footprint of project should not exceed 30% of the total size area. Footprint of building must not exceed exceed 20% of total site area.

Figure No. 0.4: Project Size

Program

Low Risk Psychiatric Hospital (Døgnenhet)

Short Term Stay (1 Week to 3 Months)

Two Wards

x40

Total Staff

Design Philosophy

Biophilic Design

Implementing nature as an integral part of the design, and rehabilitation program

Evidence Based Design

Learning from Environmental & Behavioral Psychology, as well as user experiences

Social Sustainability

Figure No. 0.5: Program & Design Philosophy

Project Goals

Biophilic Design

- Keep the total project footprint below 30% of the total site
- 90% of the roof area must be covered in vegetation
- The project must use a massive wood construction system
- The project must provide outdoor space equal to 60% of the building footprint
- 10% of the outdoor area must be suitable for growing food

Environmental Design

- The project must have building-integrated PVs for local energy production
- The building should demonstrate a 40% reduction in embodied carbon from building materials compared to the DFØ Benchmark for Retirement Homes
- Reduce net energy use by 10% compared to TEK-17 requirement for retirement homes
- Achieve good indoor air quality through the use of hybrid ventilation
- Achieve a daylight factor of 4% for 50% of usable area

Design for Psychiatry

- The Design should invoke a feeling of mastery and control within the patients, in order to foster self-esteem and mastery of self
- The design must offer users a high level of freedom
- The design must adapt a high level of safety and security
- All patients must have a view of natural landscapes from their rooms
- The common areas must be more attractive than the patients personal spaces

Figure No. 0.6: Project Goals

Part 1

Context

Figure No. 1.1: Site Photo

Defining the User

Spatial Considerations

When suffering from mental illness one might experience space differently. Sense of space is highly individual but can generally be defined by what one might refer to as personal space. Personal space is measured as a radius from the centre of a person and can be split into four zones which tells us about the desired distance to another individual:

The 4 zones of personal space

Public zone (25 to 12 feet in diameter /4-8m

Social zone (12 feet to 4 feet / 1m-4m),

Personal zone (4 feet to 1 foot / 0.5-1m)

Intimate zone (1 foot to contact / 0-50cm)

**Measurements are approximate conversions from feet and inches to metres and centimetres.*

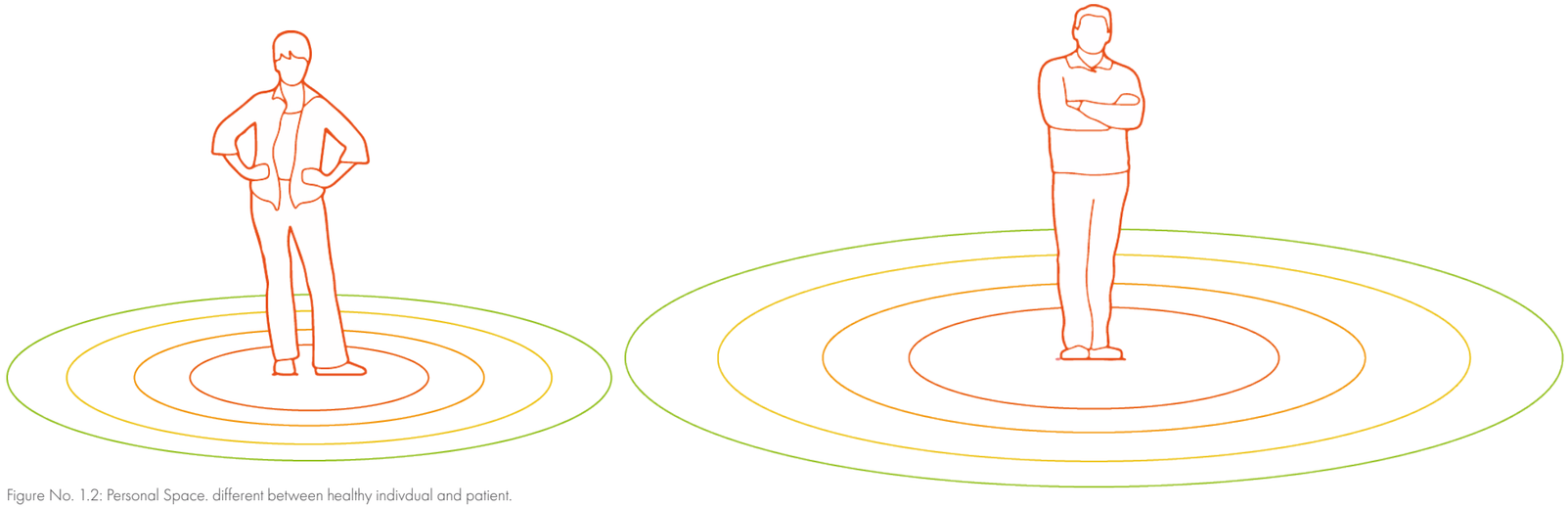


Figure No. 1.2: Personal Space. different between healthy indivdual and patient.

Territorial space is also crucial to consider when designing for mental health patients due to their increased need for control in both social and spatial environments.

Territorial space can be divided into 5 categories:

Territory:
A visibly marked area defended by an individual to feel in control of situation that could pose a threat

Individual Distance:
The desired space between self and others.

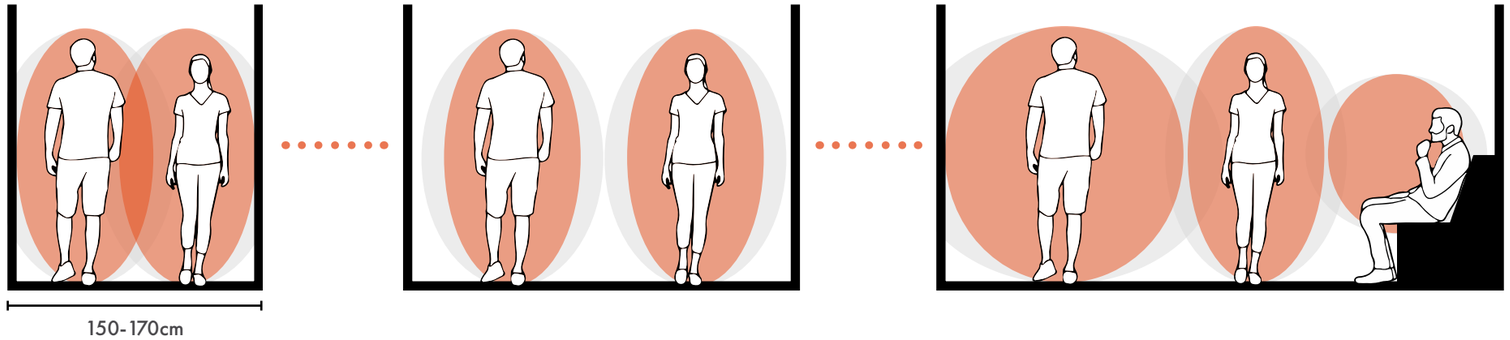
Flight Distance:
Distance between the individual and a potential threat - the distance needed to flee a potentially harmful situation (space invasion)

Distancing:
Enlarging the physical distance between individuals to increase the level of privacy

Defend Space:
Physically marked and/or surveilled territory that increases the feeling of safety to its inhabitants (e.g. surveillance cameras, fencing etc.)

For a person suffering from mental illness, these sones tend to be bigger, how much depends on diagnosis, experiences and need for control. While this project targets low-risk patients, there is still a risk of e.g. psychosis or an increase of symptoms. Therefore, the personal space of the patient in this project has been increased by half or double that of a healthy individual, depending on the room and the activity taking place.

See relevant chapter: 8. Physical Environment and Health.



* 150-170cm is considered enough hallway space for healthy persons to comfortably pass by one another. For a person suffering from mental health problems a hallway rarely offers room for escape and the options are usually to retreat or pass by a stranger (unknown threat). This might elevate levels of anxiety an increase chances of agitated behaviour. When you then have two patients with different needs of control this space would cause even more stress as they are both aware of each other's need of environmental control. By increasing the hallway width one can accommodate for differen activities and space requirement. A hallway that serves as more than a transit area might appear less threatening as it allows for more discreet disengagement than a standard hallway where disengagement or avoidance would be more obviouse and could impose discomfort on both individuals.

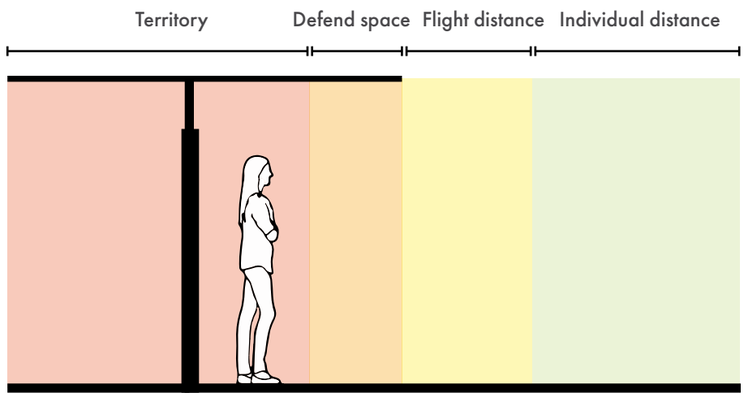


Figure No. 1.3: Psychiatric Design Strategies

History & Location

Fjellseter

Fjellseter sanatorium opened in 1899 with the primary function to serve as a treatment facility for patients with tuberculosis as well as a recreational service for the upper class. The facility consisted of two buildings the main building (Hovedbygget) and the annex known as 'Sporten'. The sanatorium later served as a hotel from 1912, until a second fire destroyed the remaining buildings in 1946. The facility was internationally renowned and was highly popular amongst ski enthusiasts. Architect Axel Guldahl drew the original facility [Strinda Historielag, 2023]. Today the site serves as a parking lot and there are nothing left of the original building structures.

Figure No. 1.3: Site Photo

Figure No. 1.4: Site Photo

Figure No. 1.5: Photograph of Fjellseter Sanatorium

Figure No. 1.6: Site Photo

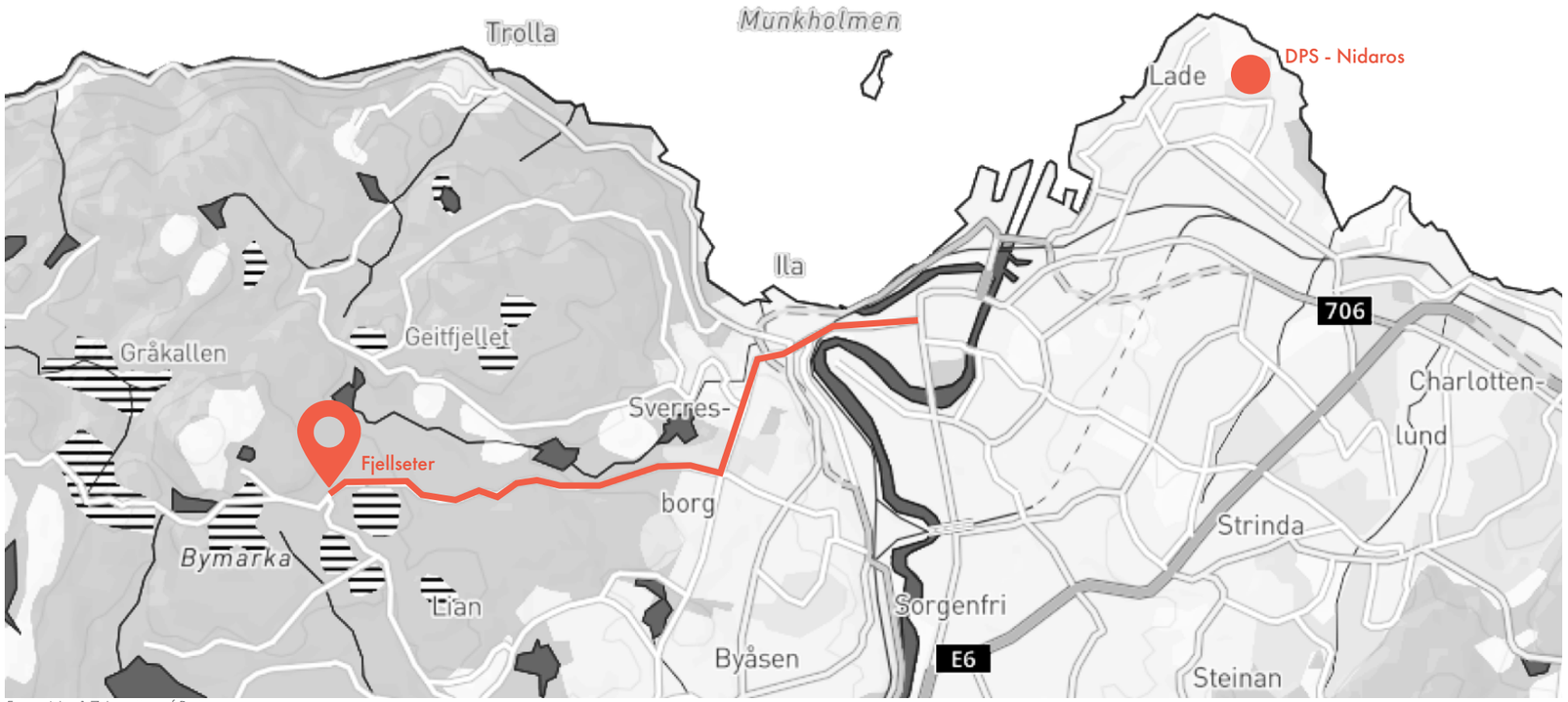


Figure No. 1.7: Location of Project

Site Photos

Figure No. 1.8: Site Photo

Figure No. 1.9: Site Photo

Figure No. 1.10: Site Photo

Figure No. 1.11: Site Photo

Site Analysis

SWOT

Figure No. 1.12: Site Photo

Figure No. 1.13: Site Photo

Figure No. 1.14: Site Photo

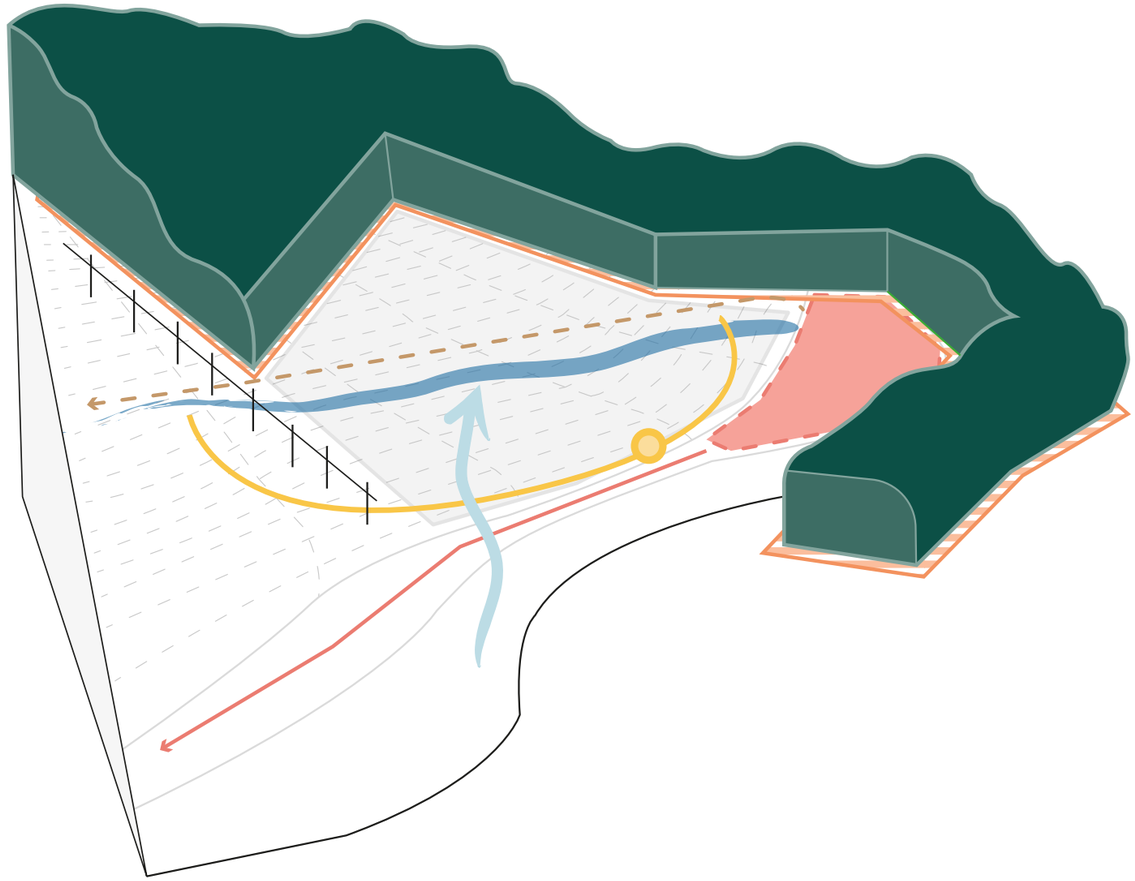


Figure No. 1.15: SWOT Analysis of Site

Climate

The following diagrams and graphs illustrate the local climate conditions within Trondheim. Temperature range and sun paths have been of particular interest when developing the design.

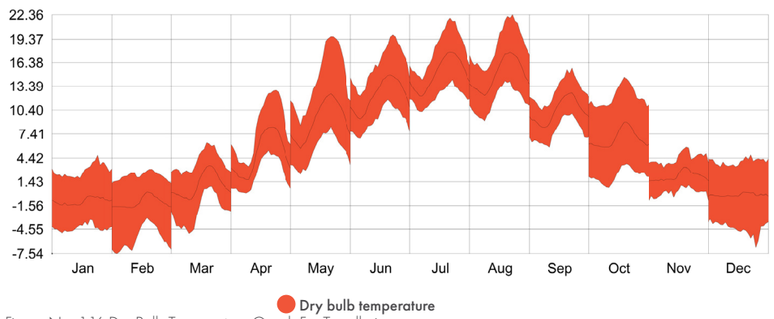


Figure No. 1.16:Dry Bulb Temperature Graph For Trondheim

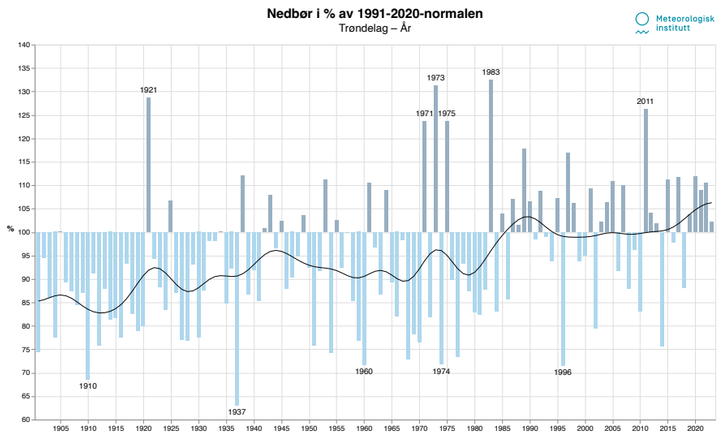


Figure No. 1.17: Graph Depiction Average Rainfall in Trøndelag from 1991 to 2020

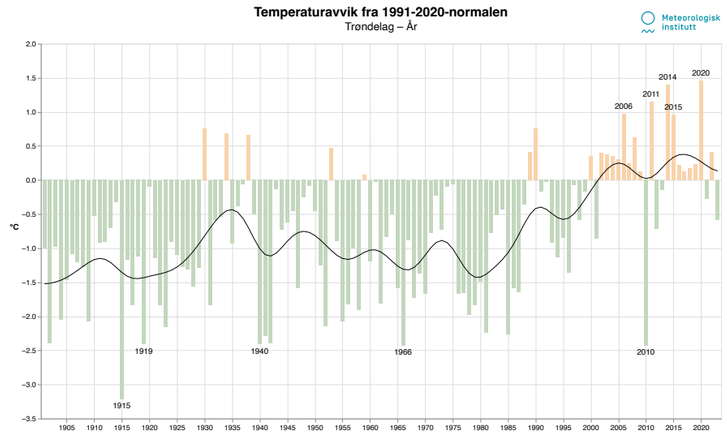
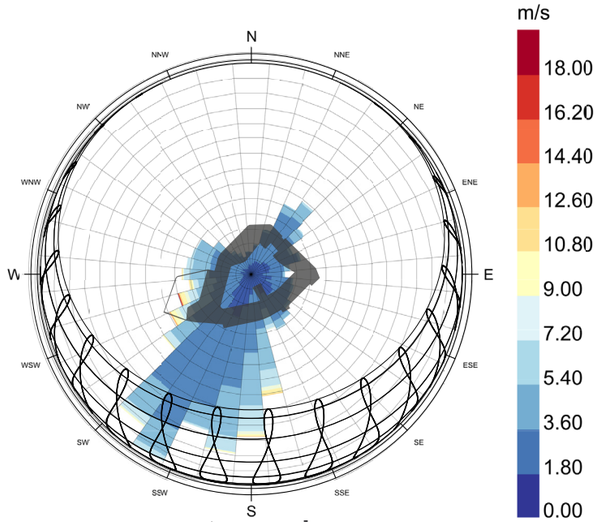
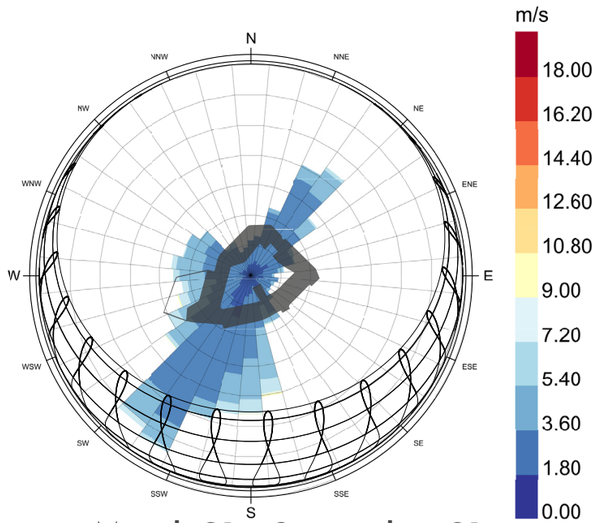


Figure No. 1.18: Graph Depiction Average Temperaturesl in Trøndelag from 1991 to 2020





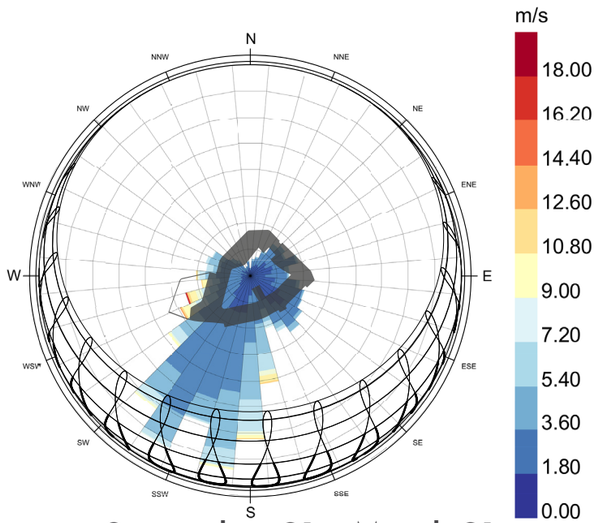


Figure No. 1.19: Sun Path & Wind Diagram

Part 2
Building Design

Figure No. 2.1: Rendering of Courtyard

Overview

Building Programme

The overall functions within the building are structured in zones. The main patient areas, including both wards with the patients bedrooms and smaller living rooms or social zones are grouped together, while the main offices and staff areas are organized in a similar fashion. Common and public areas, including activity rooms are located within the same zone, and the main treatment areas with therapy rooms and doctors and psychologists offices make up the healthcare zone.

A large part of the initial design revolved around the placement and interaction between these different zones. A tactic from the very beginning was to ensure all zones had access to a central outdoor space, that could serve as a circulation space that connects them. The zones were then moved and adapted to make sure that proper levels of daylight, views and noise concerns were maintained. Other important aspects of the shaping and placement of the zones included levels of privacy within the patients bedrooms, views of surrounding landscapes from bedrooms and common areas, as well as "escape routes" from unwanted social situations. The placement of the healthcare and treatment facilities were especially important, as the patients should have the opportunity to quickly retreat to their bedrooms after therapy without having to walk through the most crowded common areas.

The design was then refined using principles learnt from Biophilic Design and Environmental Psychology as well as guidelines for psychiatric institutions. The theory informing our design choices has been gathered in the Theory Booklet. Chapter 10 summarizes the design framework that made up the guidelines for the design choices made, while chapters 6 - 8 are particularly concerned with Design for Mental Health, Biophilia and Environmental Psychology.

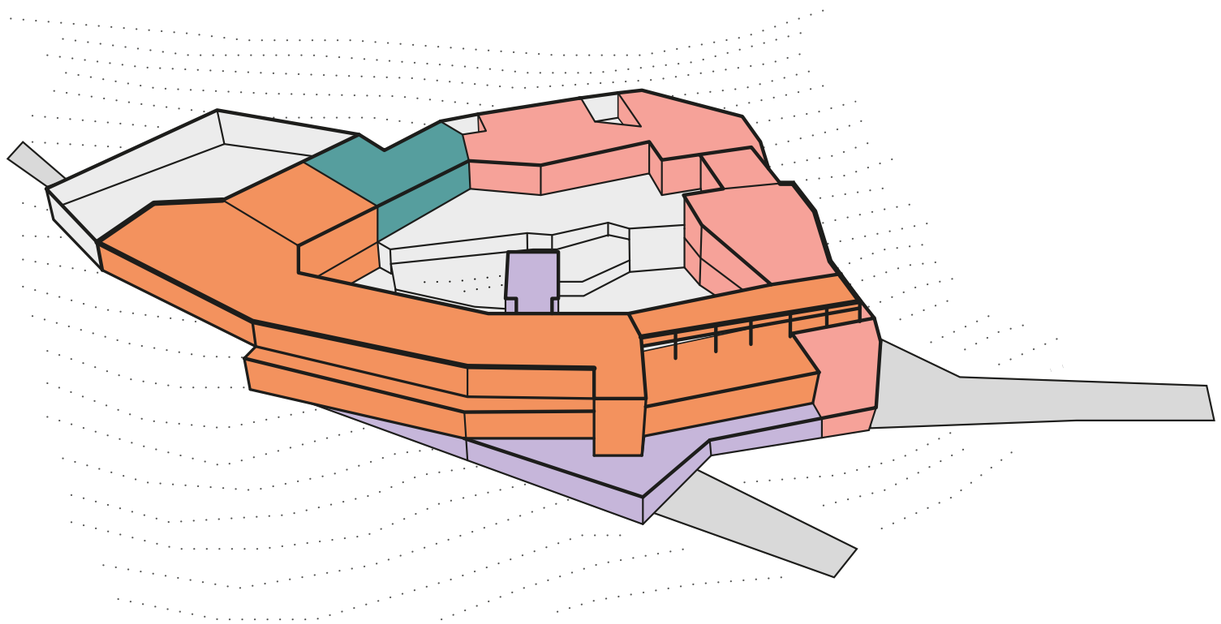
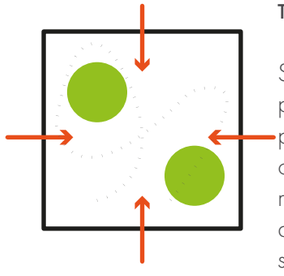


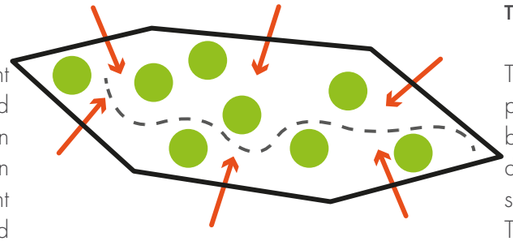
Figure No. 2.2: Zones within the project

Psychiatric Design Strategies



To "fit inside the box"

Symbolism plays an important part in psychology and psychiatric design. Certain objects or environments can metaphorically remind the patient about their challenges and social expectations. While being allowed access to an exterior space, they are often squared this could be percieved as one can "roam freely as long as one fits within the constraints of society"

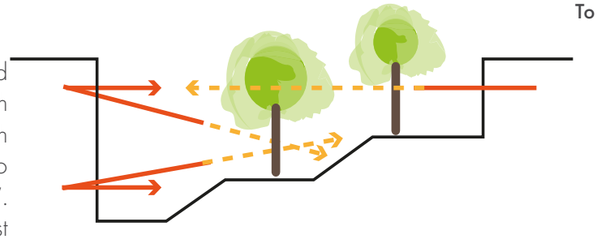


To lose train "trail" of thought

Through introducing an enlonged atrium one could potentially avoid the feeling of being stuck in a "fish bowl*" and through a longer walking route with different levels of stimuli provide enough distraction to stop or decrease "rumination* in a distresesed patient". The angled walls will hopefully feel less intense as most panes of glass won't face the patient directly.

*"Fish bowl" is a term often used by psychiatric patients to refer to (glazed) areas posing a high feeling of surveilance.

*Rumination - dwelling or overthinking a situation and the potential consequences.



To be "in a line of sight"

Through the use of a terraced terrain, one can utilise the incline in combination with shrubs and smaller trees to shelter or reduce the feelings of direct view while also providing a more stimulating environment for the user.

Figure No. 2.3: Psychiatric Design Strategies

Site Plan - 1:1000

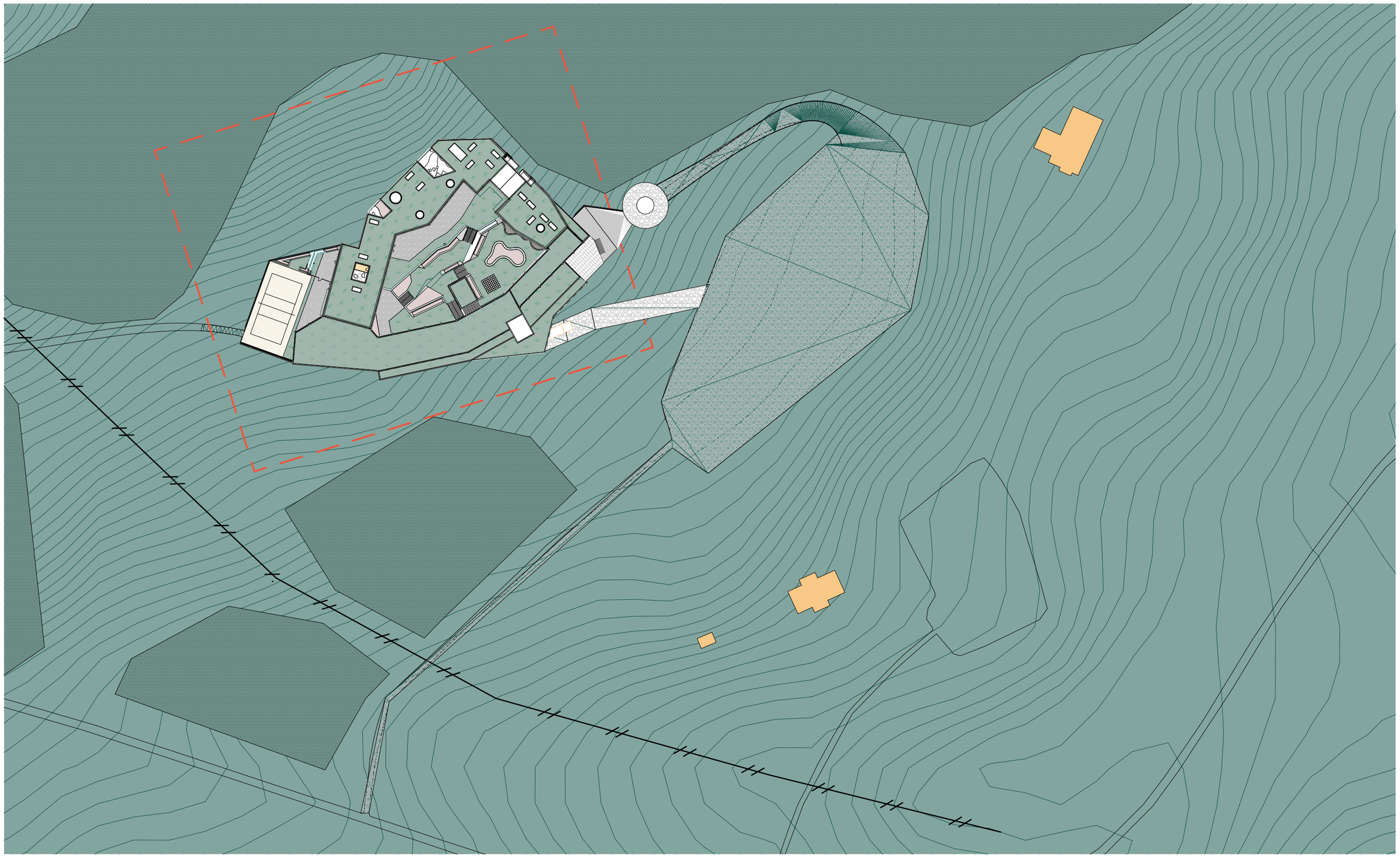


Figure No. 2.4: Site Plan - Scale 1:1000.

Ground Floor Plan - 1:200

Figure No. 2.5: Ground Floor Plan - 1:200

First Floor Plan - 1:200

Figure No. 2.6 First Floor Plan - 1:200

Second Floor Plan - 1:200

Figure No. 2.7 Second Floor Plan - 1:200

Sections - 1:200

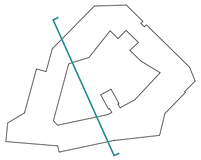
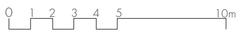
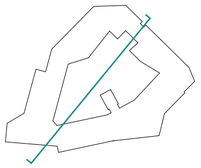


Figure No. 2.8: Section A - 1:200





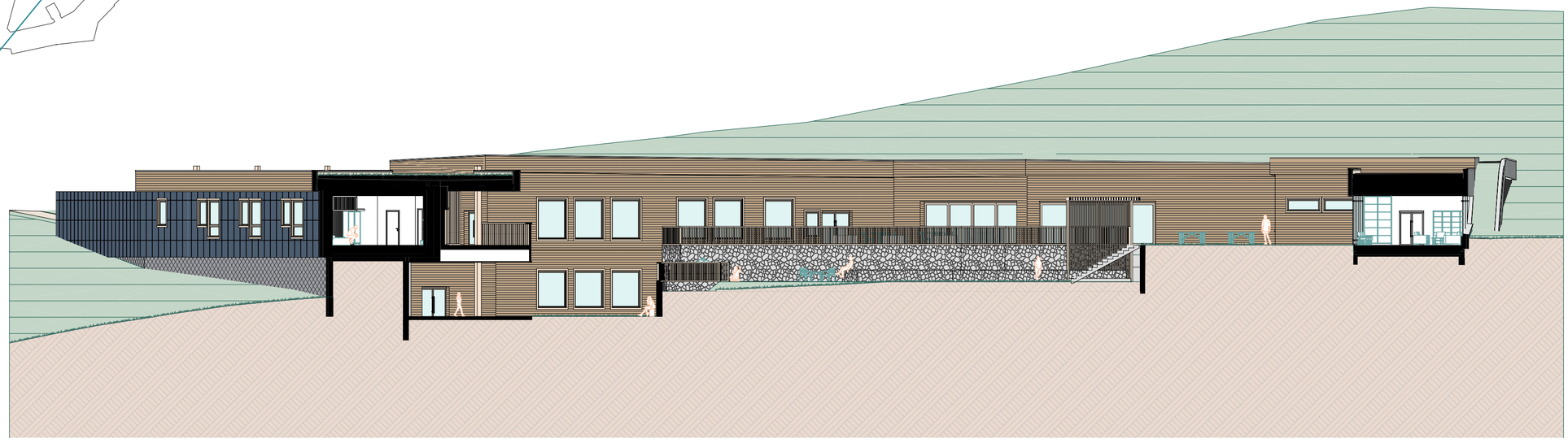
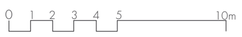


Figure No. 2.9: Section B - 1:200



Sections - 1:200

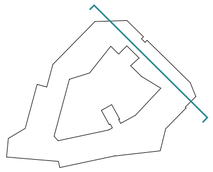
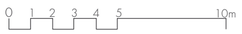


Figure No. 2.10: Section C - 1:200



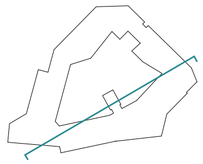
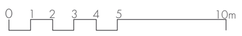


Figure No. 2.11: Section D - 1:200



Elevations - 1:200

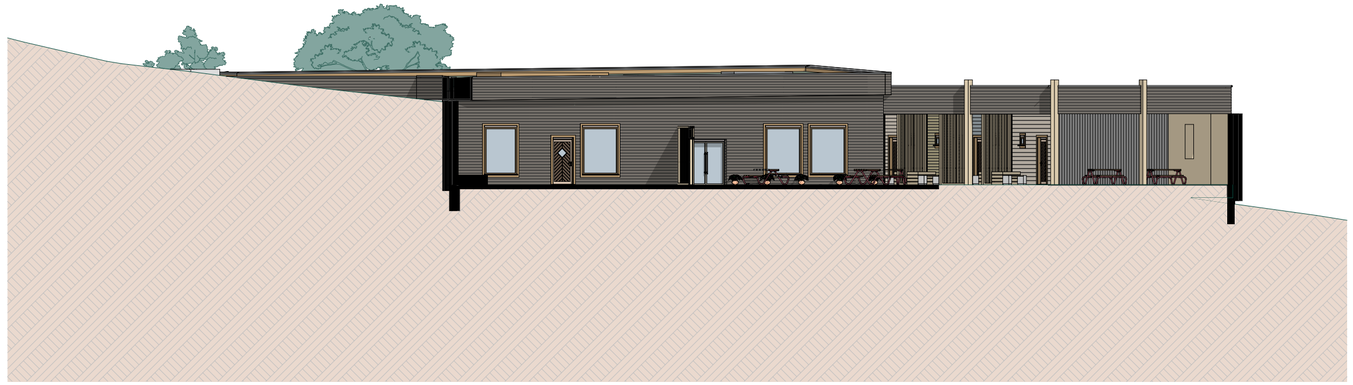


Figure No. 2.12: North-West 1:200

0 1 2 3 4 5 10m

Figure No. 2.13: South-West1:200

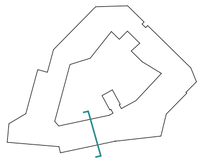
0 1 2 3 4 5 10m

Elevations - 1:200

Figure No. 2.14: North-East 1:200

Figure No. 2.15 South-East 1:200

Sections - 1:50



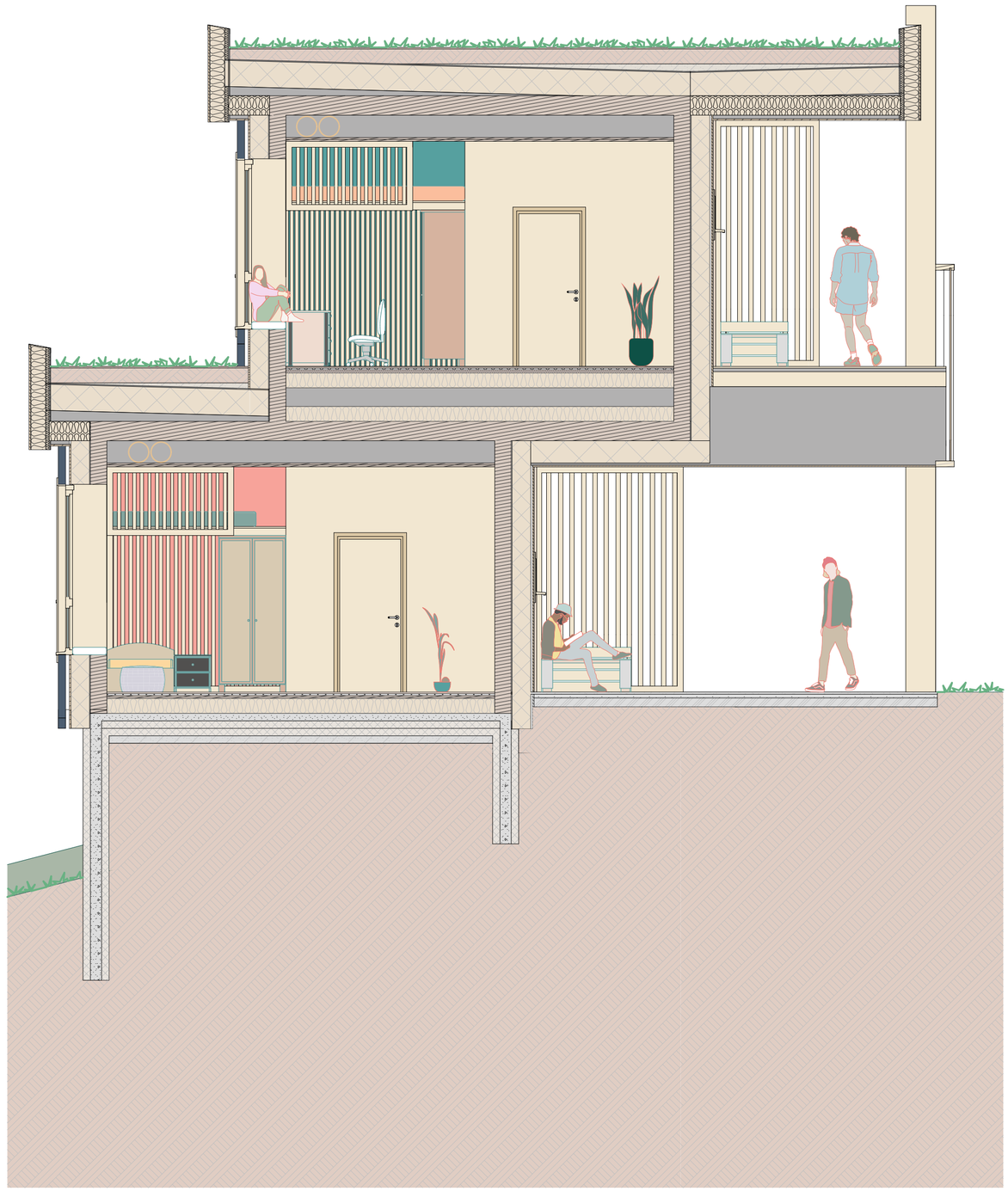


Figure No. 2.16: Detailed Section 1 - 1:50

Sections - 1:50

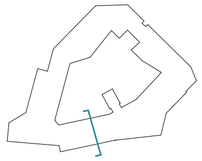


Figure No. 2.17: Detailed Section 2 - 1:50

0 1 2 3 4 5m

Partial Floor Plan - 1:50

Practice
7.4 m²

Reception
11.1 m²

Lobby
126.5 m²

WC
6.0 m²

WC
2.4 m²

WC
2.4 m²

Wardrobe
15.0 m²

Wardrobe
14.3 m²

Administration
8.9 m²

Office
23.3 m²

0 1 2 3 4 5m

Figure No. 2.18: First Floor - 1:50

Partial Floor Plan - 1:50

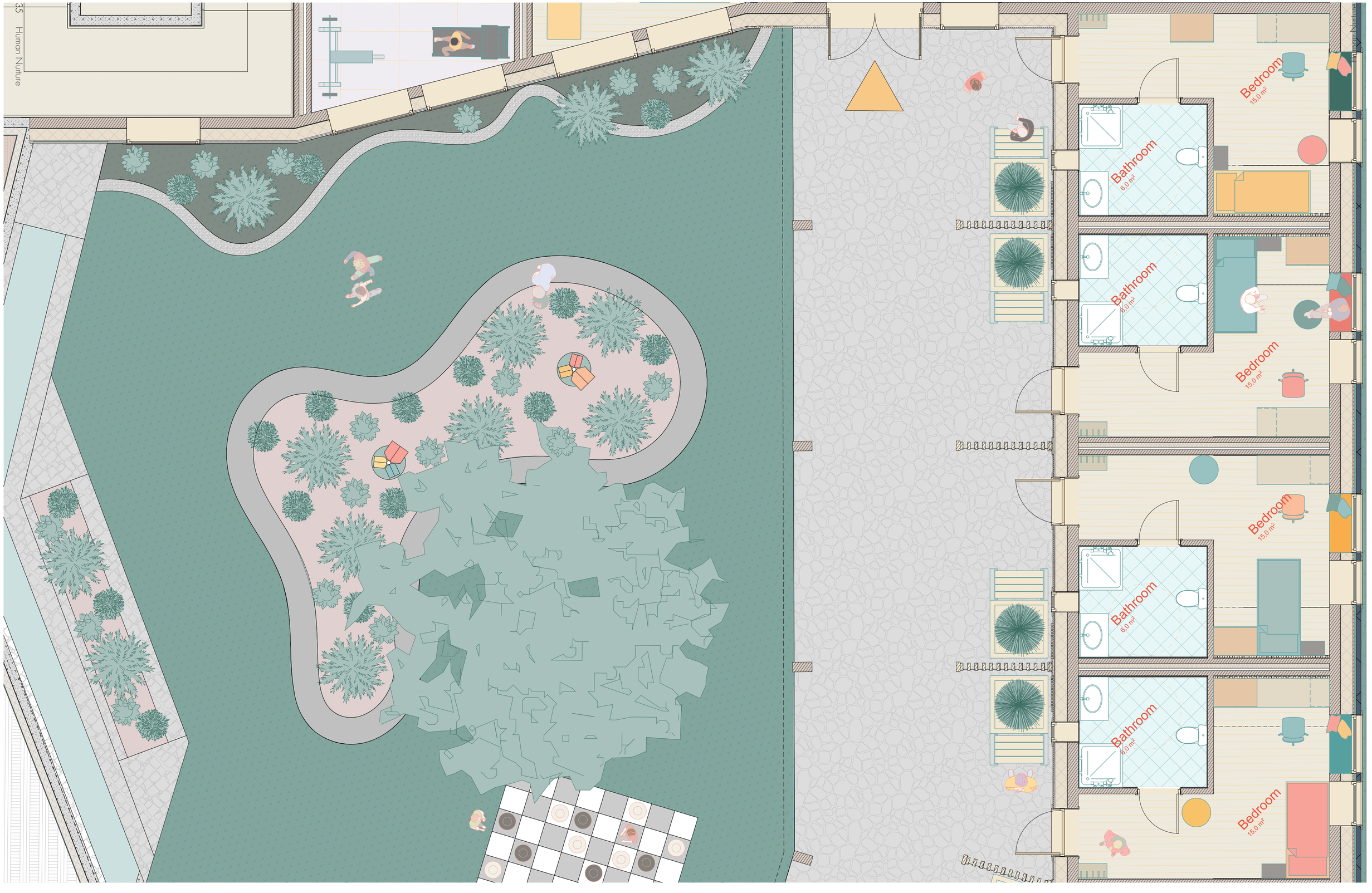


Figure No. 2.19: First Floor - 1:50

Partial Floor Plan - 1:50

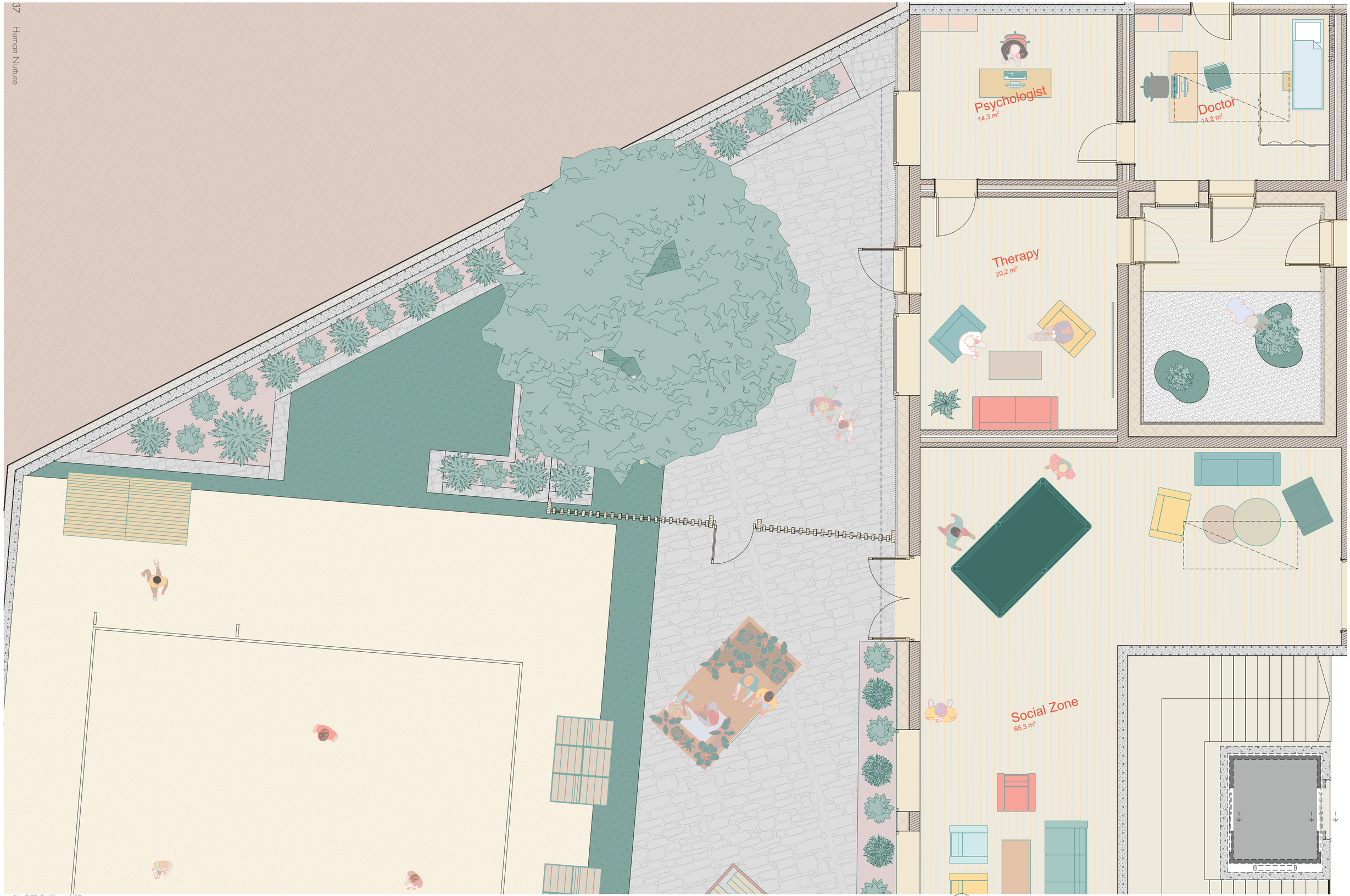


Figure No. 2.20: First Floor - 1:50

Partial Floor Plan - 1:50

Calm Area
11.1 m²

WC
1.9 m²

Group Therapy
33.2 m²

Freezer
3.8 m²

Dishwashing
3.9 m²

DW

Storage
3.6 m²

Cold Storage
4.9 m²

Kitchen
34.2 m²

Walkway
54.2 m²

Walkway
m²

Dining Area
77.8 m²

Stage Area
13.0 m²

Social Area
11.2 m²

0 1 2 3 4 5m

Figure No. 2.21: First Floor - 1:50

Interior Illustrations

Lobby/Reception Area

Figure No. 2.22: Render

Interior Illustrations

Patient Bedrooms

Figure No. 2.23: Render

Interior Illustrations

Dining Area

Figure No. 2.24: Render

Interior Illustrations

Living Room

Figure No. 2.25: Render

Exterior Illustrations

Atrium

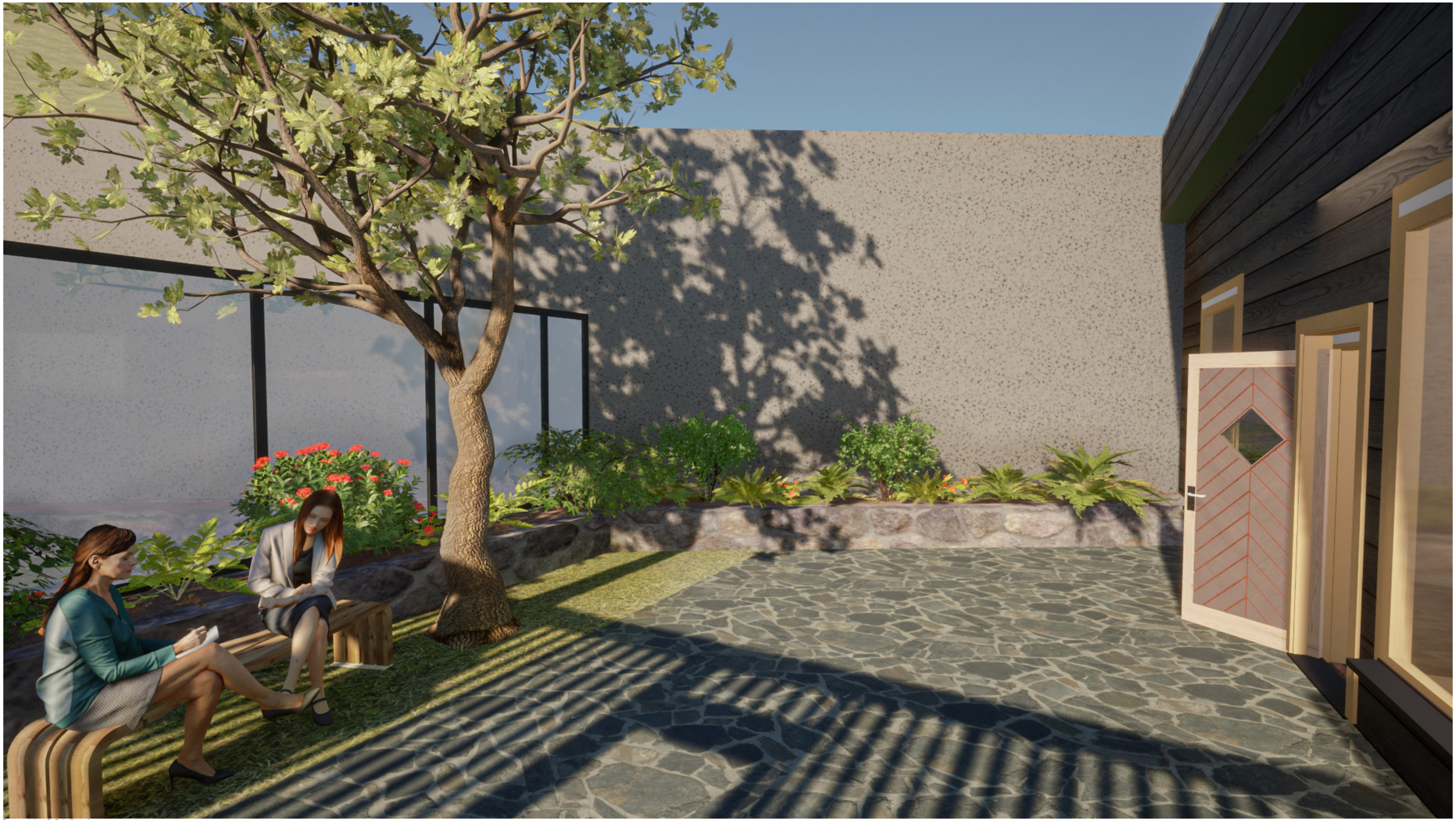
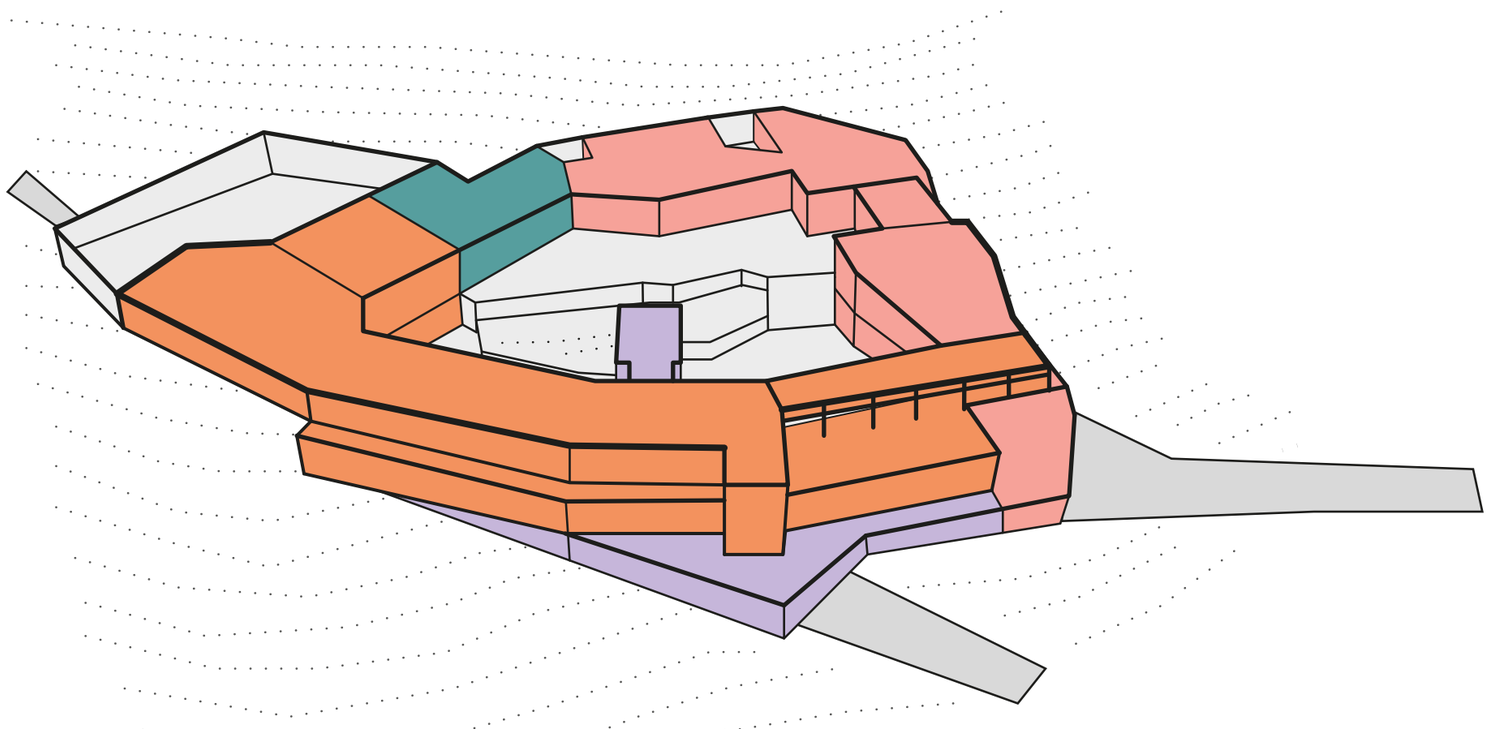


Figure No. 2.26: Render

Exterior Illustrations

Courtyard

Figure No. 2.27: Render



Part 3

Concept

Figure No. 3.1: Organisation of building functions/zones

Psychiatric Strategies

G + 1. Floor

Reception

Upon arrival, the reception desk is located diagonally from the point of entry to avoid feeling of direct view of arriving patients but still being easy to spot upon entry. As there is a general lack of healthcare workers, it can be challenging to provide a receptionist at all hours of the day. This is improved by providing a double ceiling height whereby the patients can be greeted from the second floor. The lobby is also strategically placed as the main connection point between the staff area and ward area, improving the chances of being met by staff or other patients within short times of notice. The area is designed to serve as a more public social area whereby patients and visitors can engage. A private room for taking visitors is also available upon entry to the ward on the 1st floor.

Patient room

Each patient unit has its own both as part of the interior and the exterior, to provide a sense of ownership of the unit. Through the use of assigned colours, one improves wayfinding for both staff and patients which can contribute to less stress and reduction in error and mismedication. The room is fitted with an additional loft bed or storage space that can serve as an extra sleeping spot for visitors or additional storage. The wooden slats are fitted with a clear plastic panel behind to reduce the risk of self-harm.The entrance of each unit is further equipped with wooden screens that allow the patient to carefully observe the activity in the hallway without being fully exposed. it also marks one's territory and prohibits people from passing by straight outside one's door (increase feeling of control + safety). This area is also fitted with seating and a plant box that encourages the patient to display their personality outside of their unit as well.

Courtyards

The courtyards provide a number of spaces for both quietness and activity. the activity-based areas feature table tennis, life size chess, and volleyball which are all activities that are easy to take part in, whether through actively joining or passively watching. The terraced garden allows walks with different levels of interaction and light levels. It features a variety of plants adapted to the different lighting conditions of the area. The idea of the terraced garden is to provide a calm area that serves more like a natural trail (changes in incline) while still being limited to an enclosed area, hence the name "trail of thought". The garden also contains a very shallow water installation that is partly accessible to engage with and allows, visual, sensory and auditory stimuli. All flowerbeds are wide enough for seating while also serving as a retaining wall and allowing a comfortable working position during maintenance.

See relevant chapters: 6. Design for Mental health + 8. Physical Environment and Health

Refuge plan for distressed patient

* Not to scale - illustration only

Patient location point start/end

Exit

From medical unit

Figure No. 3.2: Psychiatric Design Strategies

Psychiatric Strategies

2. Floor

Dining area

Light: The dining area is the common area that receives the most light. By providing the best views and light conditions in the main common areas, it could encourage patients to engage more with each other andalso providing a greater sense of safety.
Table arrangements: While rectangular tables are good for joining tables together, they are less inclusive and social. There are variable seating numbers to accommodate preferences, however, patients are highly encouraged to sit together and interact.
Glazed bifold doors: Bifold doors allow for the opportunity to extend the interior space to the exterior during the warmer months. This way one could e.g. use the space to dine outside or seat larger crowds such as during visitor's days or as a way to bring parts of the sensory experiences of the outside inside (hearing birds, rustling of trees, feeling the wind etc).
Planter: The planter allows for greenery year around while also serving as seating and to break up the space and makes a visual and safe focal point in an area with high numbers of people.

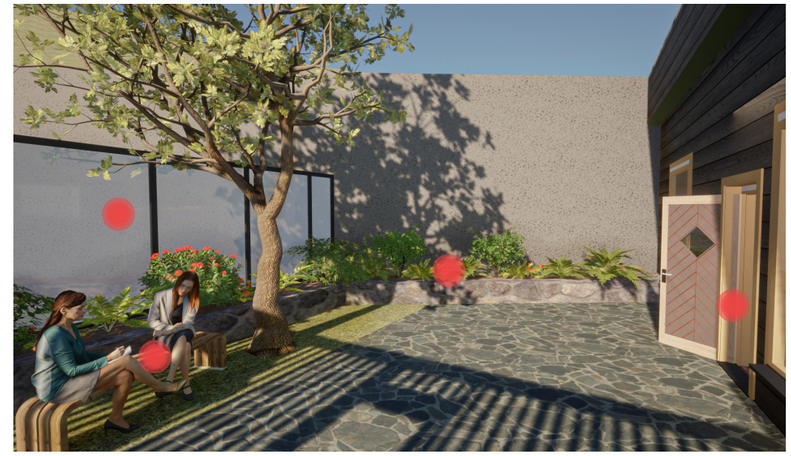
Main living room area

Skylight: The main living room area is located in the deepest portion of the building. By providing a great skylight the space goes from being dark and dim to providing a dynamic range of weather and lighting throughout the year.
Atrium and quiet space: Attached to the living room is a small atrium that combined with the skylight provides a dynamic scenery. The atrium allows views towards nature even from the darkest point of the building and provides an opportunity for stress relief in an area of high occupation and activity. While access to the atrium is available through glazed bifold doors, it is primarily accessible from the nearby quiet space. The planting in the atrium is arranged in such way that the patient entering the atrium from the quiet space is not in direct line of sight from the living room area and therefore providing a sense of privacy for both user groups.
Fireplace: Fireplaces are usually associated with a domestic feature and as a safe space and social gathering point.
Artwork: Art is an appreciated feature that provides focal points, a topic of conversation as well as a way to decrease the sterile feeling often associated with institutions. However, the choice of art is particularly important in an environment for the troubled mind. Expressionist-like art is discouraged as it requires a high level of interpretation and can serve as a (symbolic) reminder of the patient's struggles or increase feelings of disorganisation. Therefore, the choice of art in this case is illustrations from natural science, that allow for easy interpretation while still providing a level of detail that keeps it interesting both up close and from a distance.
Seating: While attempting to fit as many users as possible it is still important to provide flexible seating to avoid feelings of crowding and provide a feeling of safety and 'control'. Therefore the heavier and larger furniture like the sofa is located along the walls to allow a larger space for the more mobile furniture such as armchairs and tables. The placement of furniture allows for re-arrangement of the environment and encourages different levels of social interactions. Furthest away is a book nook which is quieter, but still allows you to engage through listening or observation. The double seating by the atrium provides a calm view while one can still follow, join and observe the ongoing activities or conversations taking place in the main area of sofa groups. The coffee tables are sturdy and space-saving which allows them to be used and moved in different locations and to adjust to the number of people engaging around the table. The area is also fit with a small couronne table rather than a bigger pool table to allow more flexibility of the space but still provide an activity that is seen as low-risk engagement (typical games: pool, table tennis, ball games etc.)

Group therapy

The group therapy space can fit 8+ people which is a common size for therapy groups. The space is located next to the dining area and is separated by wooden bifold doors that allow the space to be used for other types of activities outside of therapy hours. The discussion on seating type resulted in stackable chairs despite their more office look. This type of seating is fit for all age groups and can conveniently be used for supply chairs during dinner or certain events and they are stackable so they can easily be cleared after the session. By making the room a flexible space within the main common areas it might not be associated with "the therapy room" which might take away some stress from the situation for certain patients. The circular arrangements of group therapy sessions can feel overwhelming to some and it was important to provide different elements that would allow the patient a break from where they are seated. By including a big circular skylight above the therapy ring, one provides a focal point that requires no turning away from the other members of the group. This is important as the session is a vulnerable situation for many individuals and therefore having the opportunity to look up rather than behind or to the side might feel less 'rejective' or distractive as some patients might experience another person turning away from them as a sign of rejection. Views towards the attached atrium further, further provide a sense of relief and is located between the group therapy space and the second quiet space with views partially obstructed by plants and greenery. The group therapy space's close relation to the quiet space allows patients easy access to a break room if a situation occurs or if feeling particularly overwhelmed after the session.

Figure No. 3.3: Psychiatric Design Strategies



Therapist office

The psychiatric office is located in the connecting building between the patient unit and the common area. The location provides the patients the opportunity to retreat to their rooms without passing through larger social areas while also providing the opportunity to seek out sociable areas after the session. The office is split into indoor and outdoor therapy area. The indoor therapy area provides multiple seating options that can allow a full overview of the situation and the surrounding environment while still being able to follow the session closely. There is also a watch located above the board to provide an easy track of time and to aid in topic control and length (avoid the risk of discussing heavier subjects at the end of a session).

For the outside therapy space, there is a small courtyard fitted with 'Shoji screens' in frosted glass that "blocks" the view but provides shadow displays so one can still experience nature's play or people getting too close by. While located close to the outdoor activity area it is still up to the patient to decide which therapy space to use at any time. There is also private access to the outdoor activity area from the therapy space that provides direct access to the hiking trails outside of the ward. This way one can go on therapy hikes or hikes in general, however, patients are mainly allowed to leave the ward if accompanied by staff or family as they are responsible for their safety.

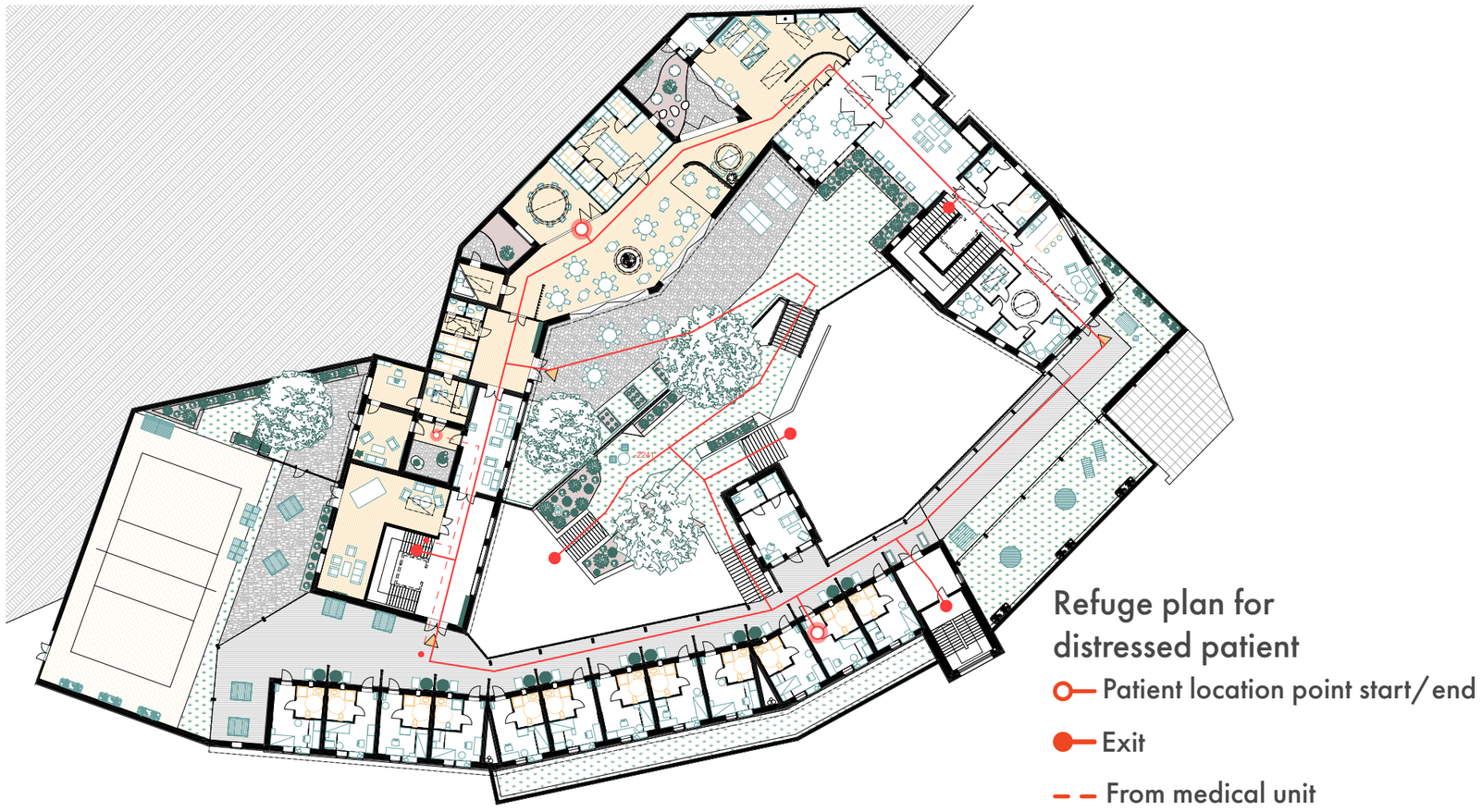


Figure No. 3.4: Psychiatric Design Strategies

Sustainable Design Strategies

The Biophilic Design Philosophy has been a guideline for the development of the project, and as Biophilic Design aims to create buildings that minds and implements the local nature, it's only fitting that several Biophilic Design Strategies coincide with well known passive sustainable strategies that result in lower energy use and emissions.

In order keep in line with Biophilic Design's principle of using natural materials and reducing the overall emissions related to the building materials. The site has previously housed several buildings and the forest has been cleared, so the natural habitats have already been somewhat disturbed. The project seeks to avoid further disturbance by minimizing the interventions and leaving the area outside the project boundary as it is.

Still the site requires some refinement in order to allow for the placement of such a large building. The excavated masses will be reused in order to level out the terrain closest to the building as well as within the courtyard. In order to make up for lost land area the majority of the roofs are green, allowing for local flora, insects and small animals to continue habitating the area.

The courtyard also has water features, a common element in Biophilic Design, which serves a double feature as a collection point for rainwater. The rainwater is then reused within the garden. In addition the project includes small plots and planters that allows for low scale food production, in particular herbs, berries and fruits to be used by staff and patients alike.

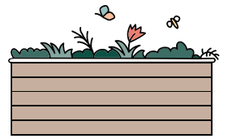
The building has a well insulating thermal envelope, using primarily wood fibre insulation, to prevent heat loss, and takes advantage of other passive strategies such as high levels of daylight and natural ventilation within the summer. Benefits of increased levels of daylighting and natural ventilation are described in chapter 8.3 in the theory booklet, but include a positive impact on the circadian rhythm and an improvement in general wellbeing.

The active sustainable strategies include a hybrid ventilation system, with a heat recovery system, that kicks in when the outdoor temperature is below comfort temperature. Ground source heating takes advantage of the buildings location in a hillside, extracting ground heat to supplement heating in the colder months, and an efficient water based system helps distribute heat throughout the building.

Building integrated photovoltaics produce onsite electricity to supplement the building. The placement of the PVs was determined using simulations of solar radiation levels of the surfaces of the design, and a calculation of the possible production can be found on page 61.

Figure No. 3.5: Sustainable design strategies

Biophilic Design Strategies

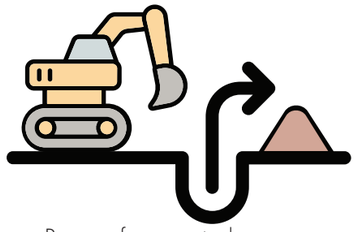


Green Roof

Natural Materials

Maintaining Habitats

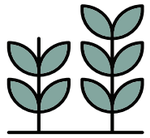
Building on already disturbed land



Reuse of excavated masses

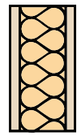
Natural Light

Reuse of Water in Garden



Food Production

Passive Sustainable Strategies



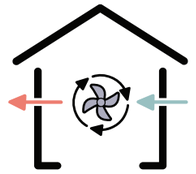
Thermal Insulation

Massive Wood Construction System

Natural Ventilation

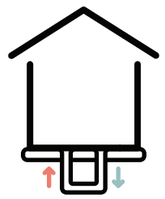
Active Sustainable Strategies

Photovoltaics



Hybrid Ventilation

Heat Recovery System



Ground Source Heating

Water Based Heat Distribution

Materiality & Construction

Details

The building elements within the project have been developed based on requirements and recommendations from Byggforsk, TEK-17 and Norwegian CLT-manufacturers.

The exterior walls, roofs (excluding soil and grass) and ground floor all have a U-value of 0,12. As a result the exterior walls allow for solutions such as deep window frames that double as benches and shelves.

The illustrated details highlight especially important elements of the building - the thermal envelope, the floor slabs separating living areas, and the sound and fire insulating walls. An important inspiration was the solutions used within the student housing at Moholt, which also faces several of the same challenges as this project regarding fire safety and sound insulation.

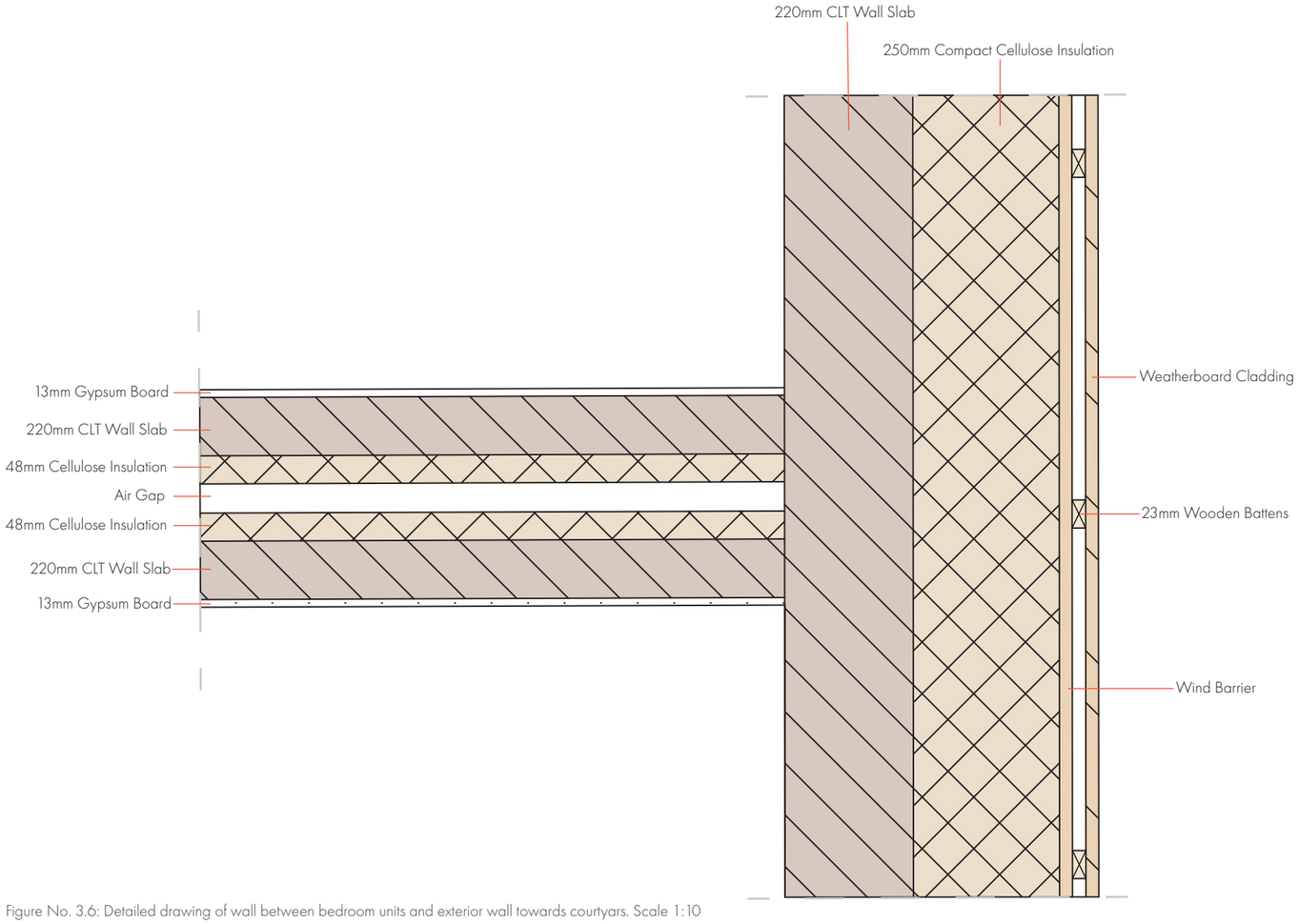


Figure No. 3.6: Detailed drawing of wall between bedroom units and exterior wall towards courtyars. Scale 1:10

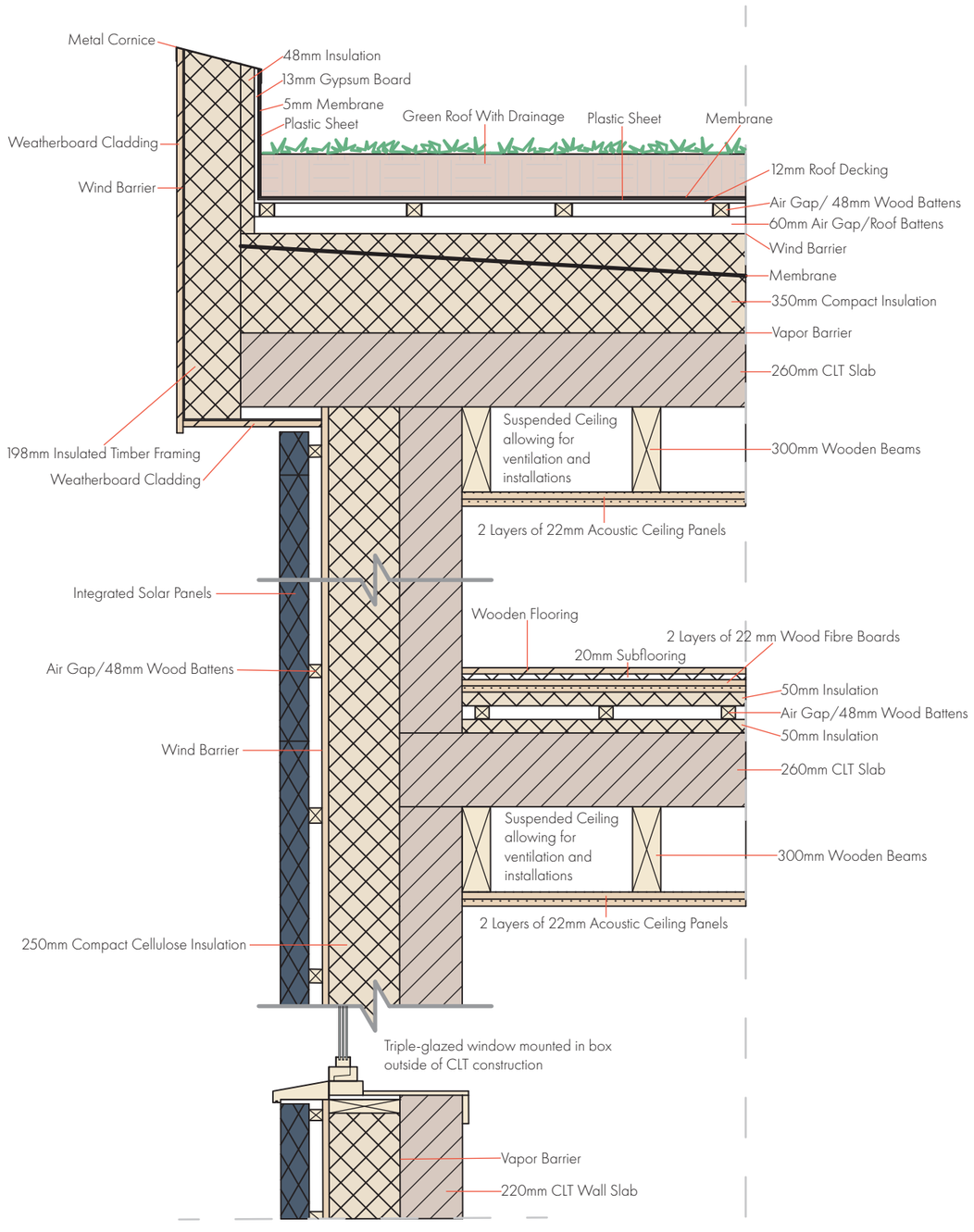


Figure No. 3.8: Detailed drawing of exterior wall, floor slab and green roof. Scale 1:20

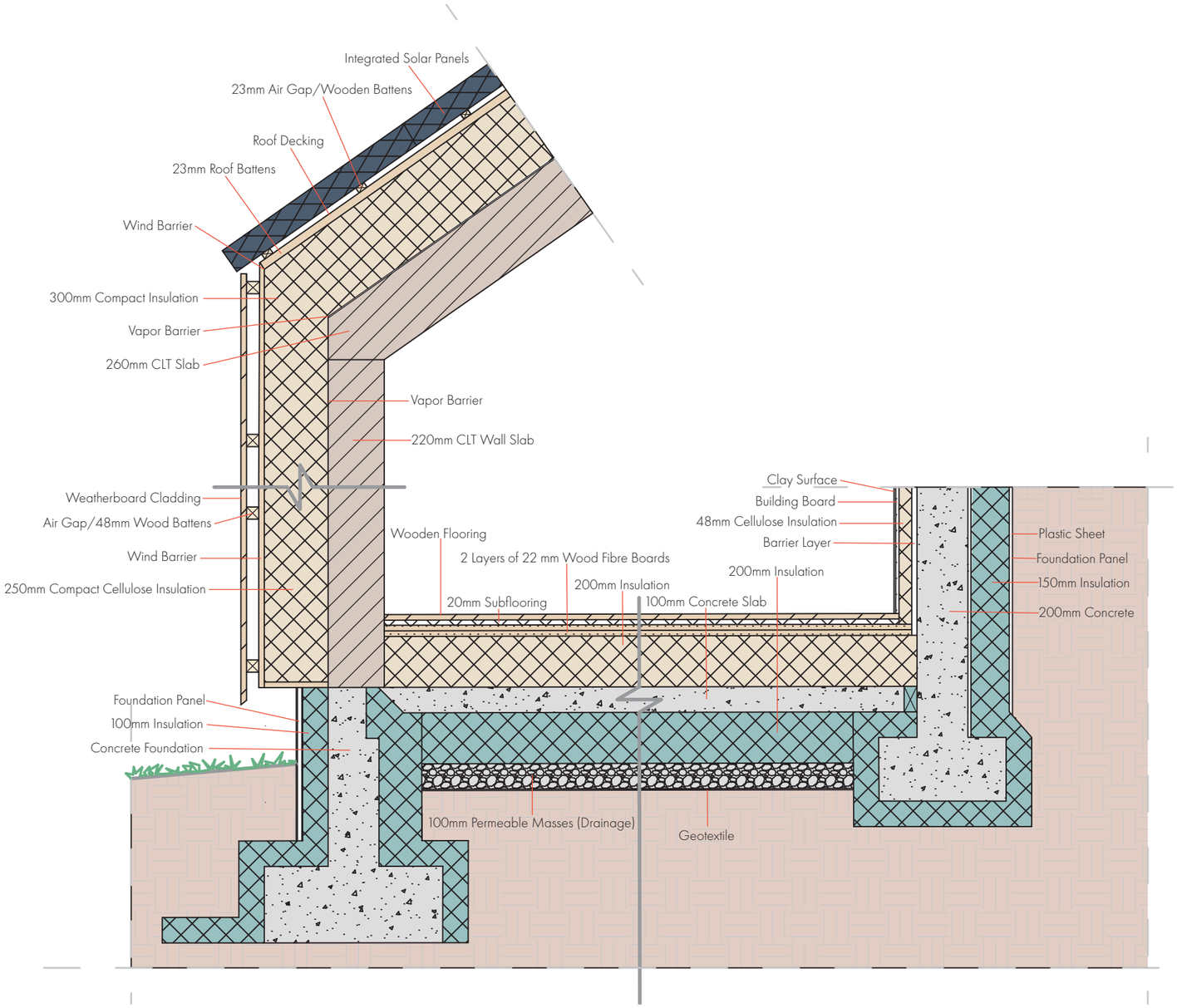


Figure No. 3.7: Detailed drawing of exterior wall, foundation, ground floor slab, wall towards terrain and solar panel roof. Scale 1:20

Part 4
Assessment of the Final Design

Figure No. 4.1: Render of Therapy Room

About Assessment

A major challenge for the project has been the assessment and quantification of the result. How can we determine whether or not the initial research question: *Can Biophilic Design Philosophy create a Mental Health Facility where users experience quicker recovery rates and greater success of therapy?* as well as the initial, overarching goals of *creating an environment where patients can thrive and recover, a building with little negative impact on the immediate environment and functional and welcoming hospital* have been successfully achieved?

The process of finding ways of assessing and measuring the design is thoroughly described in Chapter 3 of the design booklet. Several methods for evaluating the design were discussed, and the following were chosen based on the suitability in relation to the more specific goals listed within the design brief as well as time constraints on the project.

The level is biophilic design within the project was done through the Biophilic Design Matrix developed by McGee & Marshall-Baker (2015), and the Biophilic Interior Design Matrix developed by McGee et al. (2019). The matrix lists the biophilic design elements found within the project and the corresponding biophilic attributes they represent. The levels of presence of each element has not been assessed, as a self-reported score would be biased.

The levels of daylight have been simulated using local weather data, ensuring that the courtyard, bedrooms and different common areas receive sufficient light throughout the year. The data was also used to calculate potential PV production and energy savings.

Isovists taken from central points within the project, such as outside of staff areas and within common rooms visualise viewpoints and visual privacy within the project, while the Hierarchy of Isolation and Privacy in Architecture Tool (HIPAT) developed by McCartney & Rosenvasser is used to assess the levels of agency and territories within the complex.

Space Syntax has been used to evaluate the connectivity and spatial within the floor plans.

And as a way of analysing the sustainability and environmental impact of the building a Life Cycle Analysis was conducted using Reduzer. The resulting GWP of the building was measured against both the DFØ Benchmark and the new psychiatric hospital in Kristiansand which opened in 2023.

Figure No. 4.2: Render of Living Room

Biophilic Design

Biophilic Design Matrix

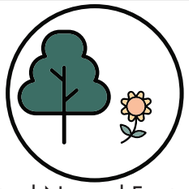
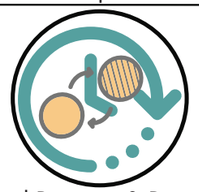
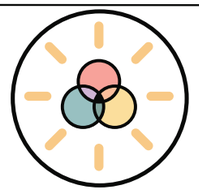
Element	Project Elements		Attributes	
 Actual Natural Features	Outside Areas (courtyard, atriums) Hybrid Ventilation Flower Beds, Plant Boxes & Potted Plants Insect Hotels & Bird Boxes Local Plants	Wood Construction & Finishes Cork, Moss, Gravel & Clay Interior Organic Textiles Curated Views & Landscapes Fireplace & Water Fountain Green Roof	Air Water Plants Animals Natural Materials	Views & Vistas Habitats Fire
 Natural Shapes & Forms	Art with Natural & Botanical Motifs Organicly Shaped Garden Elements Curved Wall Elements Wooden Slats & Columns Outside Hallway In Wards Floor-to-Ceiling Glass Elements		Botanical Motifs Curves & Arches Fluid Forms Abstraction of Nature Inside-Outside Relationships	
 Natural Patterns & Processes	Natural Materials with Smells, Texture & Changing Expressions Central Focal Points & Curated Views (both as wayfinding and decorative elements) Slate Floor & Wall Cover	Enclosed Outdoor Spaces Open, Multifunctional Common Area Wood Slat Partitions & Glass Walls Meeting of Materials & Finishes	Sensory Richness Age, Change & the Patina of Time Area of Emphasis Patterned Wholes Bounded Spaces	Linked Series & Chains Integration of Parts to Wholes Complementary Contrasts
 Color & Light	Unified & Complimentary Color & Material Scheme Different Colors for Each Patient Unit Painted Partition Walls, Natural Massive Wood Walls Skylights & Large Windows	Calming Colors & Hues, With Occasional Contrasting Elements Durable Materials & Finishes Spacious Common Areas	Composition Communication Engagement Pragmatics Natural Light	Light Pools Spaciousness Spatial Variety Space as Shape & Form Spatial Harmony
 PlaceBased Relationships	Local Plants & Wildlife Views of Landscape & Cityscape Local Materials Located Within Nature Historic Connection Trough Use (Fjellseter Sanatorium)	Well-known Location (personal connection)	Geographic Connection to Place Historic Connection to Place Ecological Connection to Place Cultural Connection to Place Spirit of Place	
 Human-Nature Relationships	Open Common Areas with Semi-enclosed Spaces All Patient-Rooms Faces Courtyard All Patient Rooms Visible For Staff Variation & Change of Direction in Main Walkway	Control of Personal Environment Freedom of Movement Large, Circular Skylights Nearby Chapel	Prospect/Refuge Curiosity/Enticement Mastery/Control Attraction/Attachment	Exploration/Discovery Reverence/Spirituality

Figure No. 4.3: Biophilic Design Matrix adaoted from McGee et al. Matrix summarises Biophilic Attributes and the related Design Elements within the project.

Sun & Lighting Conditions

Indoor Daylight Factor

According to TEK-17 a room mean for prolonged use should provide a DF of minimum 2% while for this project the goal is to obtain a DF of minimum 4% due to the beneficial effects lights have on mind and body in terms of recovery and overall happiness.
The rooms were tested based on the project orientation and use.

The daylight factor has been tested for the following rooms:
Main living room on 3rd floor
Patient room on 3rd floor
Living room on 2nd floor
Patient room on 2nd floor
Office space on 1st floor

Living rooms:
The main living room is located at the deepest point within the building. It has an attached atrium and fitted with a large skylight to provide a dynamic environment. Still, there was a small concern about whether the sun and light would be enough for the space not to feel dark and secluded. The results showed a DF of 2% only in the deepest corners of the space. For the 2nd floor, the living room showed a Df of 0.2% in the darkest area. While not ideal, the darkest area provides a good space for activities that do not gain any particular benefit from daylight such as watching tv. Still, the majority of the space does obtain adequate levels of daylight to perform most activities.

Patient rooms:
The patient room on the second floor located far west was of concern especially during winter while the patient room close to the stairwell to the east were a concern in terms of shading. However, the results from the DF analysis show that both rooms obtain adequate amounts of daylight in the main area of use while the entry will require supplemental lighting.

Office space:
The main staff area is located on the first floor with the main areas of use towards the SV facade to provide the best view and lighting conditions for staff working there while also having quick access to both delivery point and main reception. This portion of the building is the only part that primarily receives light from one direction and is expected to require artificial lighting in the secondary spaces such as storage, wardrobes and hallway.

See relevant chapters: 6. Design for Mental Health

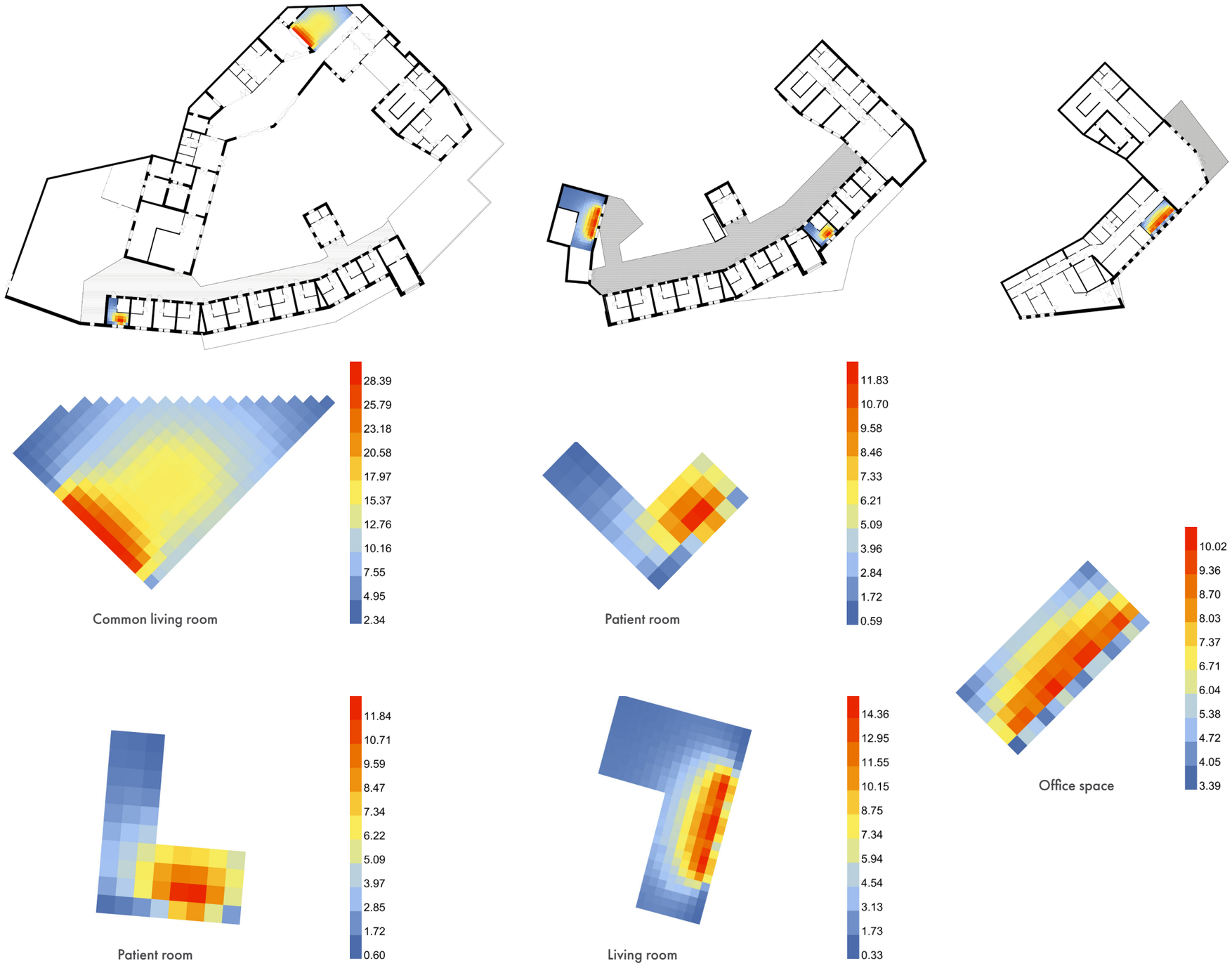
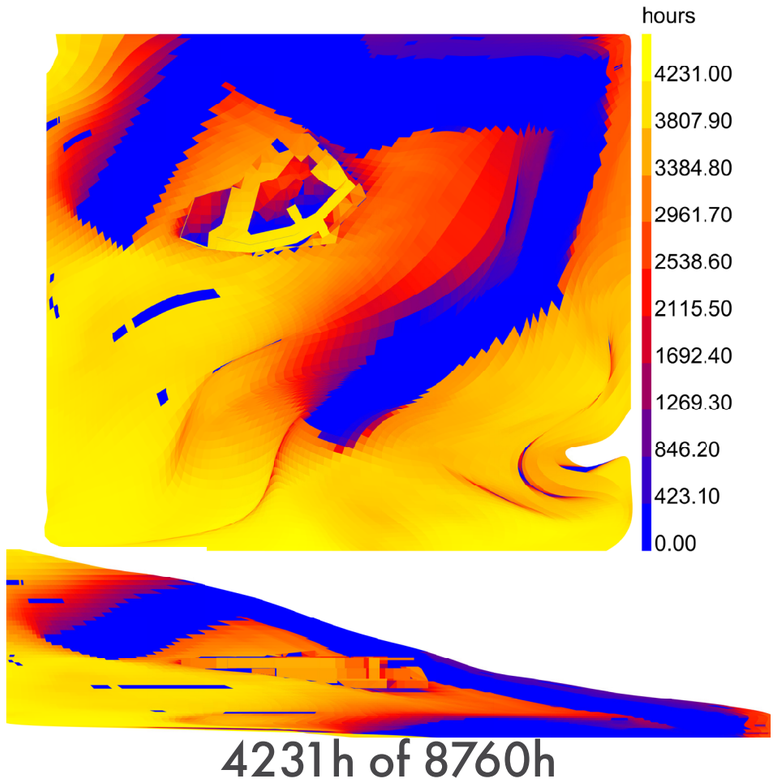


Figure No. 4.4: Daylight Simulations

Daylight In Courtyard

Annual



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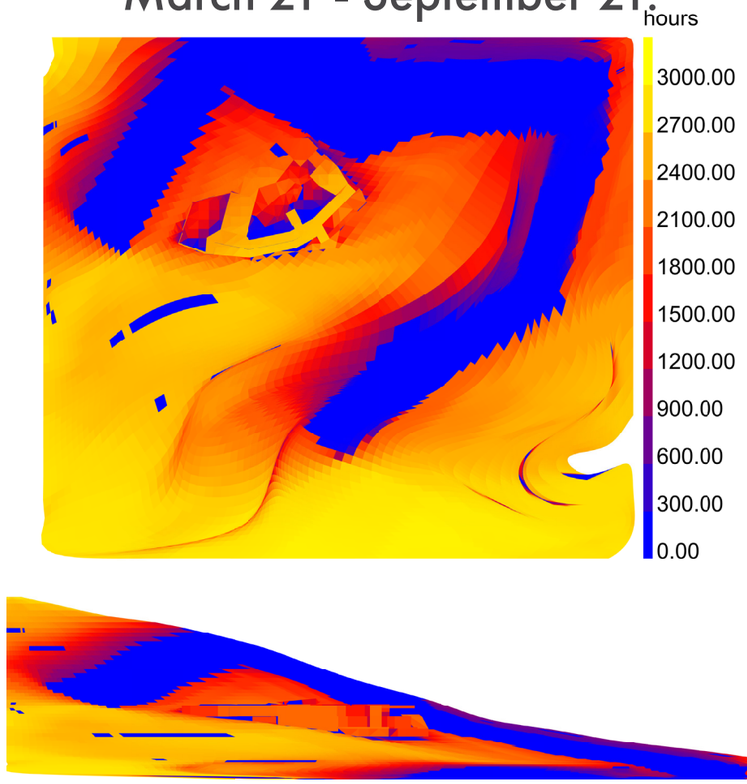
March 21 - September 21.



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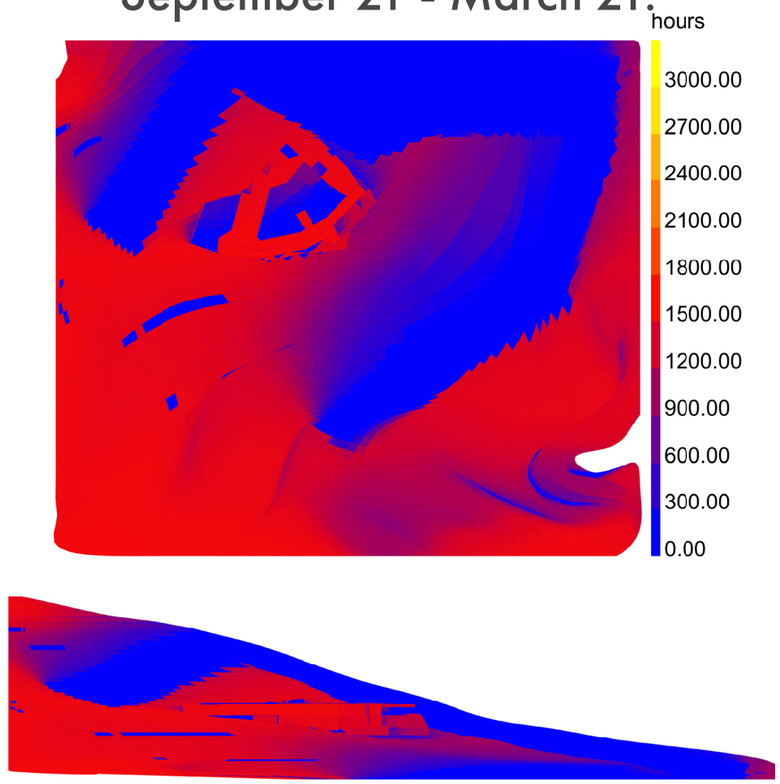
September 21 - March 21.



1410 out of 4439

Figure No. 4.5: Daylight Simulations

Solar Radiation and Photovoltaic Panels

For photovoltaic panels, the site is in optimal position facing south/south-west. A simulation was then run on the building in the Rhino software Grasshopper through Ladybug Tools to get an idea of which areas would benefit most from PV panels. The results showed that putting PV-panels on the south facade of the first and second-floor patient units would be the most optimal choice together with the exterior facade of the ground floor.

From there, energy calculations were attempted using the pre-defined "Small Hotel" programme. The results showed some errors that could possibly be related to the complex geometry of the building, however, the issues were not resolved when trying a simpler shape. Therefore we opted for the energy calculation that provides only a simple overview. The results showed a high heating load compared to the other loads and would likely show a more balanced result if a more detailed calculation had considered a detailed building envelope and material inventory as well as its hybrid ventilation system. The system takes advantage of a ground source heat pump in the main common areas and de-sentralised ventilation systems for the patient units (patient rooms must be individual fire cells). The system relies on heat recovery through the winter months and utilises natural ventilation during the summer months.

PV -PRODUCTION		
System efficency	0.8	80 %
Soiling factor (dust etc.)	0.8	80 %
Soiling factor (dust etc.)	0.2	20 %
PV simulation area		740 m^2
Building area		4329 m^2

Month	Kwh - Sim. output	Kwh Sim - Corrected	Kwh/m2
January	31373.23	4015.77	5.43
February	57501.57	7360.20	9.95
March	68778.79	8803.69	11.90
April	70033.40	8964.27	12.11
May	53988.35	6910.51	9.34
June	57119.37	7311.28	9.88
July	57999.19	7423.90	10.03
August	49009.78	6273.25	8.48
September	39658.67	5076.31	6.86
October	10625.00	1360.00	1.84
November	3368.62	431.18	0.58
December	11797.71	1510.11	2.04
TOTAL:	511253.68	65440.47	88.43

ANNUAL LOADS Kwh/M2	
Cooling	0.23
Heating	134.39
Lighting	24.76
Electrcal equipment	27.97
TOTAL	187.36

TOTAL ENERGY COSTS			
-	=	-98.92	Kwh/m2 for supplied energy needs
TOTAL ENERGY			

Checking the overall building potential for PV

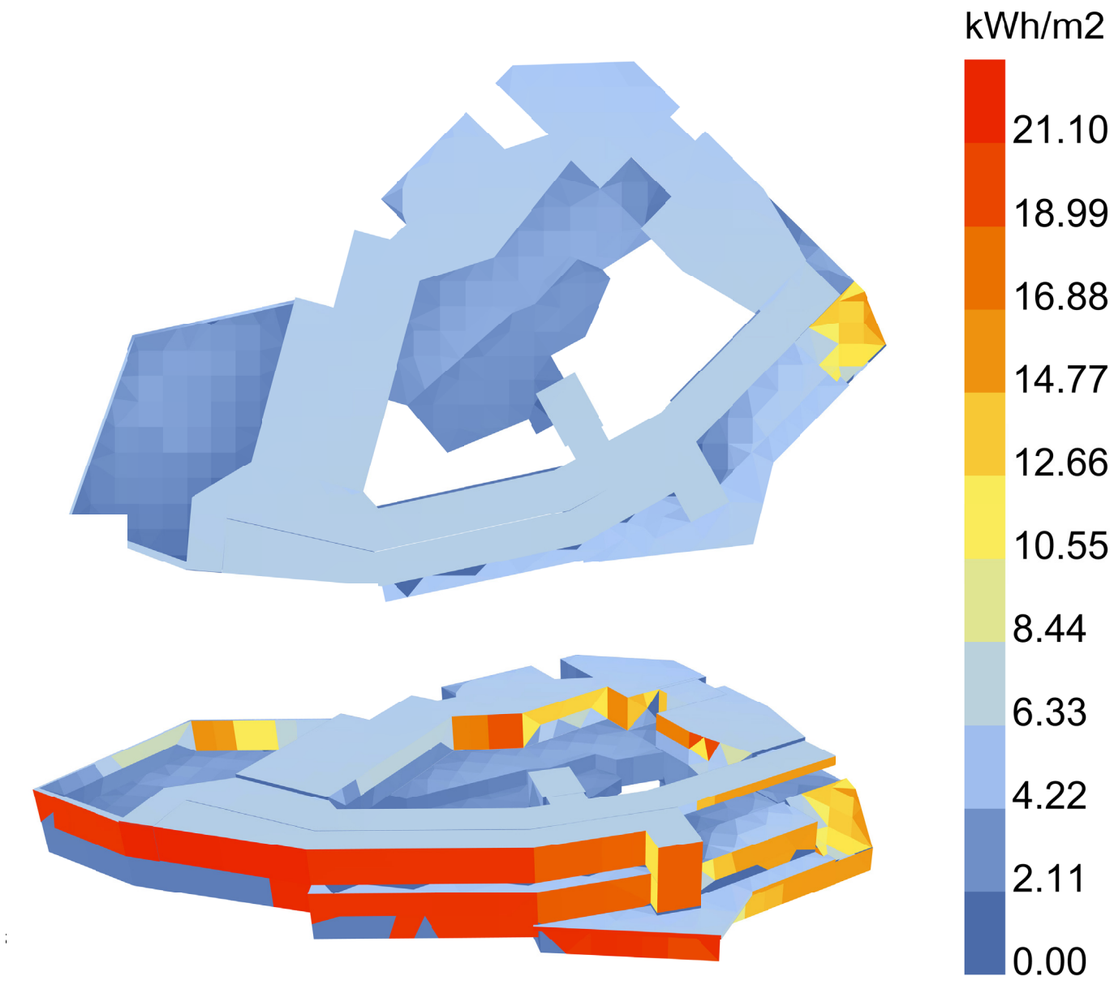


Figure No. 4.6: Potential Energy Production

Privacy

Hipat

The HIPAT method was originally developed to analyse the levels of privacy and control within student housing complexes. The levels of privacy have been adapted to fit the project, and the spaces found within it.

Levels 1-2 are primary territories for the patients, while level 3 is the primary territory for the staff. Within these areas the user groups have the greatest level of control over their environment. There should be little to no presence of outside agents within these areas.

Level 4 and 6 acts as secondary territories for all primary users (patients and staff), these are territories where the users to a higher degree have to adapt to each other's needs and interact with all other users. Visitors may be present within the secondary territories at times.

Level 5 is public domain and contains the Lobby and visitors areas. This is where staff and users primarily interact with outside agents.

Although the users should ideally feel a sense of belonging and security within all parts of the building, it's especially important that they know what to expect within the areas they will be using every day. When moving around the project the patients should know which groups of people and approximately how many they can expect to meet within the different areas. This establishes a greater feeling of safety and predictability during the recovery process. Knowing where to go to experience a sense of privacy and agency is also of importance.

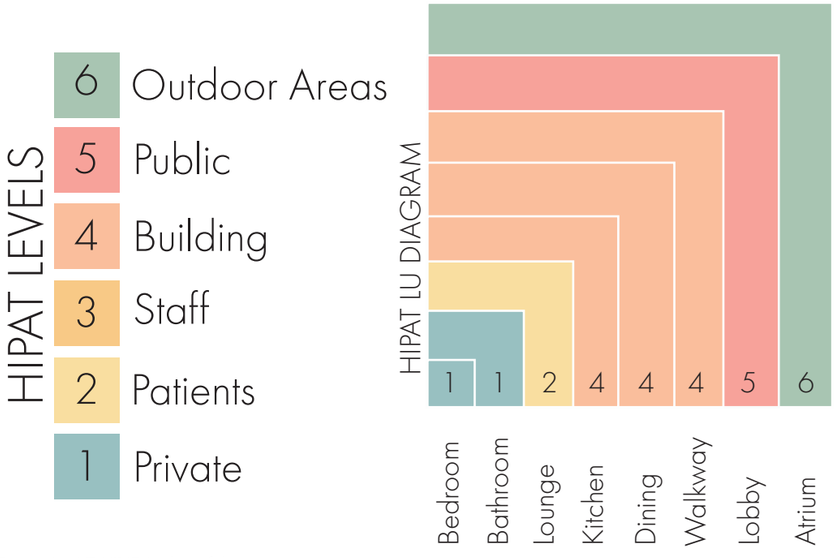
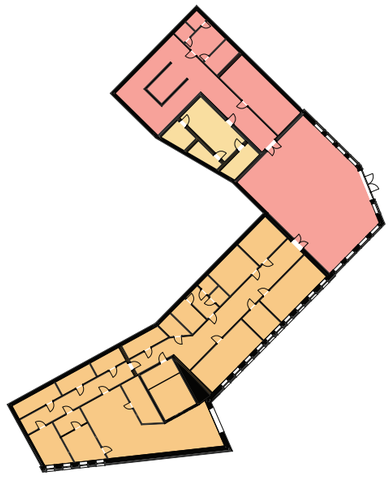
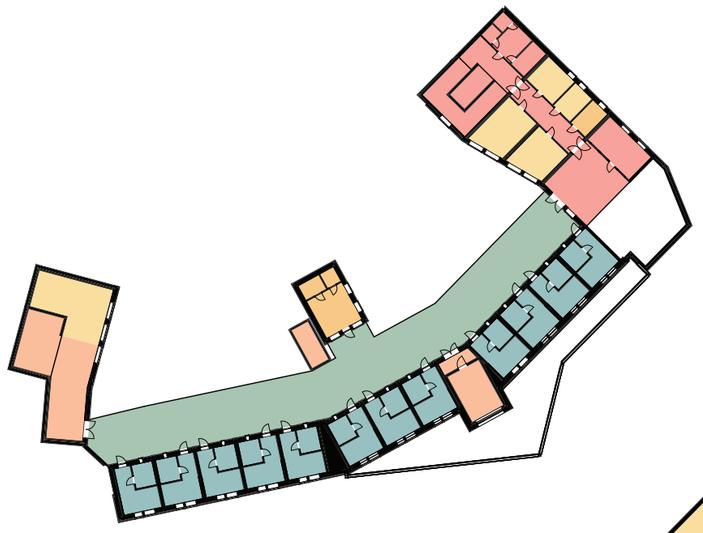


Figure No. 4.7: HIPAT Analysis of design



Ground Floor



First Floor

Second Floor

Isovist

The views and view-lines within the project are important for both the staff's ability to keep track of the patient's movements and behaviour in order to prevent unwanted situations, as well as the patients ability to survey their environments. In order to avoid invoking feelings of surveillance, while maintaining a sense of privacy the design combines wooden slat elements, plants, change of direction and levels of retraction within the building shape.

Figure 1 shows the view as one enters the building. Clear views of the seating areas, reception and staircase makes it easy to know where to go.

Figure 2 depicts the views from the hallway next to the patients living room on the first floor (orange). The patient gets an overview of the area as soon as they enter the room, and may assess whether they want to enter the social area or not. The views from inside the staff room (red) shows what area the staff can see without having to step outside the door. The view from outside the door is depicted on Figure 3. Figure 4 and 5 shows the views from inside and outside of the staff room on the second floor.

The view within and from the dining space is visualized in Figure 6. The viewlines makes it easy for staff and patients to assess the social situations within the area and navigate the social spaces. From this point one can also see the majority of the courtyard.

Figure No. 4.8: Isovists taken from points within the project

Environmental Sustainability

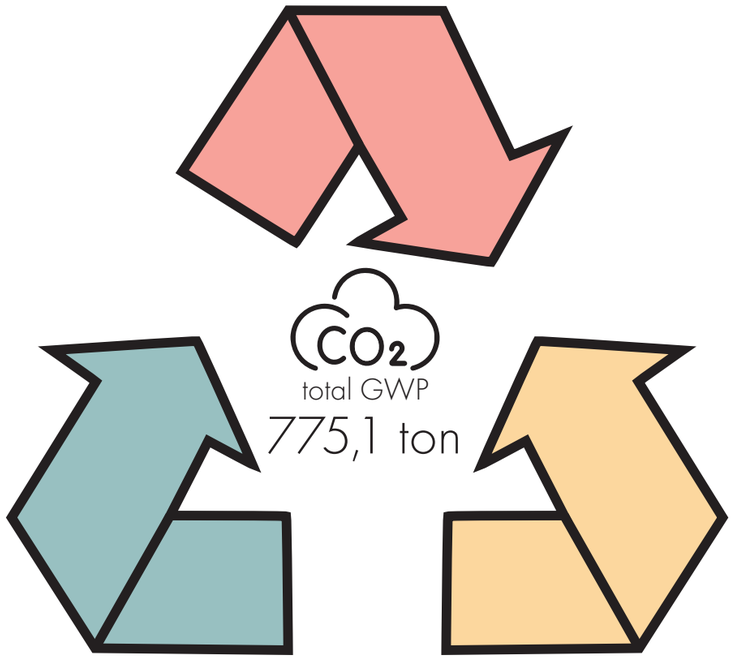
LCA

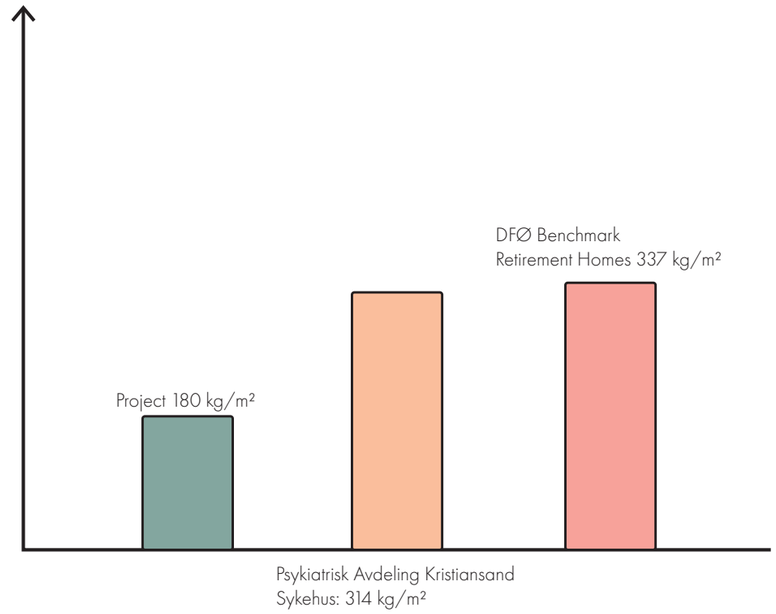
The LCA calculations for the project are based on the TEK-17 requirements and the Norsk Standard NS 3720:2018 Metode for klimagassberegninger for bygninger. The calculation method covers a building lifetime of 50 years and includes phases A1–A4, B2 and B4 with the following building elements: Foundation, construction system, exterior walls (including finishes), interior walls (including finishes), floor slabs and roof systems (including green roof). In addition the building integrated photovoltaic panels on the southern walls and roof above the lobby have been included in the calculations as they are integral parts of the building elements in which they are mounted. However the energy generated has not been included in the calculations of the Global Warming Potential (GWP), as the overall energy use has not been taken into account. The courtyard and outdoor facilities as well as the excavation, site preparation and roadwork has also been excluded from the calculations.

The results of the calculation are compared to the DFØ Benchmark set for Retirement Homes and the GWP of the recently built psychiatric hospital in Kristiansand.

The project has achieved the goal of a 40% reduction compared to the DFØ Benchmark primarily through the use of low emission materials. The design was planned with the CLT construction system's restrictions in mind, aiming to reduce the need for columns and beams to support the slabs. The use of concrete and plastic materials has been kept to a minimum, and local manufacturers and products have been taken into accounting when developing the solutions.

Reuse has not been taken into account within the LCA, although the construction system is suited for deconstruction.





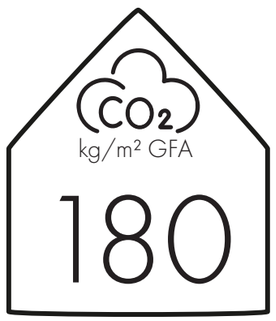


Figure No. 4.9: Diagrams sumamrizing the LCA calculations

Conclusion

Trade offs and learning

Sustainable Design is a holistic process, that encompasses more than low emissions, resource and energy use for the building itself. The design should take both present day and future users into account, ensuring the main function of the building can be carried out and developed as needs change.

This thesis dives deeply into the realm of environmental psychology and designing for people with mental health challenges. At first glance, one might wonder why these topics are given this much attention in a Master of Science in Sustainable Architecture.

These topics may seem to be outside of the scope of the study program, but are incredibly important in order to develop a well functioning design that answers to the design brief and goals set within this thesis. Although the main focus of the thesis is to use Biophilic Design as a philosophy for developing a Psychiatric Hospital, one cannot ignore the Evidence Based Design Principles that cater to people with mental illnesses. These principles must be present in order to offer the users the facilities they need.

By designing a Psychiatric Institution with the patients experience and recovery in mind the facilities will be better suited to offer quality care, and may in turn provide more efficient care and recovery. This could in turn lead to economic savings and increased social sustainability. To design a sustainable building without offering proper attention to the functions and user experience is nearly impossible. The building may achieve Zero Emission certification, but if it doesn't fulfill its purpose then why build it in the first place?

The patients needs and experience has been the first priority for the development of the design, and when there has been a conflict between the biophilic principles and psychiatric design the patients needs and security has been prioritized. This choice has led to an overall building shape that is less effective in terms of compactness and energy use, but instead offers the patients increased privacy and a feeling of domesticity. The design also includes large windows that enables a connection to the outside and offers views of the surrounding landscape as well as good daylight conditions, despite this leading to increased heat loads and emissions.

Another trade off was made during the initial phase of the project, when placing the building on the site. Instead of placing a building on top of the sloped site, the building cuts into the landscape in order to appear smaller and less intimidating to the patients that approach it. This choice requires increased interventions on the site, excavating part of the hillside, but avoids inflicting an imposing feelings upon the patients. Digging into the landscape also helps the building maintain a more compact form, limiting the number of floors and allowing for an accessible courtyard. This does however mean that the project will further disturb the existing environment, although it could be argued that any intervention upon the site will disturb the conditions and whether one digs 2m down or 4m down matters little. By placing the building this way one may also take advantage of the higher temperatures of the soil during the winter in order to reduce the heating loads.

The economic aspect of the project should also be discussed. Several design solutions are more expensive than the current day practice, including increased hallway width accessible bathrooms within all bedroom units, increased levels of glazing, designated activity and visitors areas, as well as an extensive outdoor area. These are all elements that elevate the patients' experience of the facility and facilitate their recovery. It is difficult to put a price tag on the effects of the design, but it is reasonable to assume that an increased quality of the surroundings will motivate patients and staff, leading to more successful treatment and recovery.

The main take-away from the project is the importance of post-occupancy evaluations and implementation of these within the project. Environmental Psychology supports the theory that Biophilic Design enables environments within which patients will thrive, but the lack of evaluation of the patient's' actual experiences has led to a design approach that instead focus on the staff's ability to provide "efficient" treatment. The environments effect on the patients recovery must be further investigated and implemented within design guidelines and project briefs.

Although Sykehusbygg and other public institutions carry out and implement some post occupancy evaluation today, most publicly available research on mental health and treatment focus on the patients health and experiences with treatment, such as Helsedirektoratets general evaluation forms and surveys where subjects answer leading questions on a pregenerated scale. These may provide some guidelines for the design, but are insufficient for the purpose of creating quality spaces.

Another problem is that a lot of the information that exists is not publicly available. As a result most architects will get their information regarding the patients needs and experiences from the project brief and some meetings with the building owner or institution that will inhabit it. In many cases this means that a person with little experience within the field of architectural design has to translate the results of evaluations and experiences into design requirements, leaving the architects that design the buildings with little actual insight into the users situations.

Another take-away is the difficulty of creating a design that stimulates all users, provides the patients with sufficient levels of freedom and trust while maintaining the staff's need for structure and everyone's safety and security. It is easy to understand why so many psychiatric hospitals are designed as a low maintenance box with a central atrium, as this is cost efficient and functional, facilitating the staff's work-life. The gains from shifting the focus towards the patient's experiences are less tangible, and difficult to assess, but a change of focus is without a doubt necessary in order to implement more socially sustainable solutions.

Figure No. 4.10: Social Sustainability Icon

References

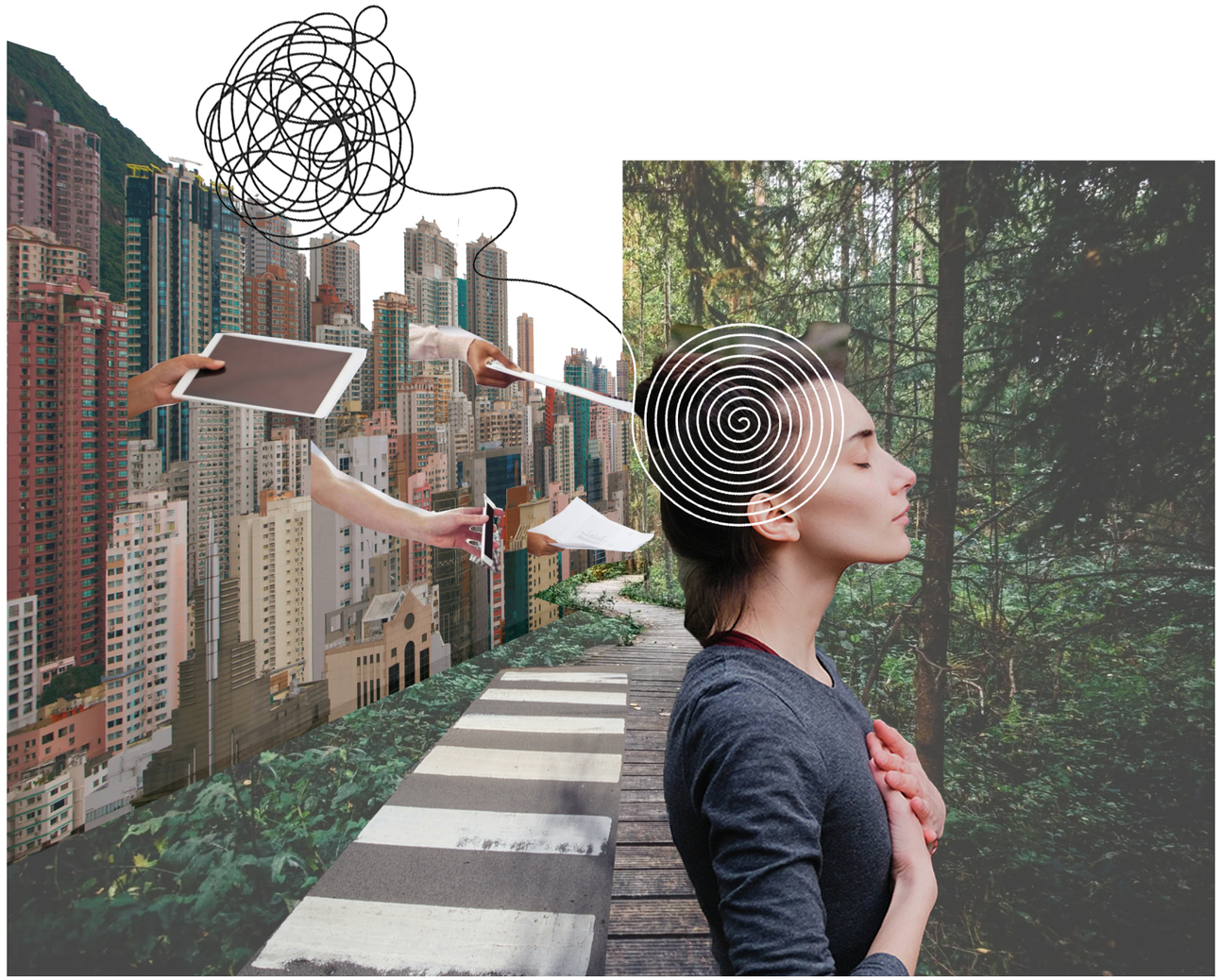
References to theory can be found within the Theory Booklet.

Figures

Figure No. 1.5: Fjellseter Sanatorium, c. 1910. Unknown. https://www.flickr.com/photos/trondheim_byarkiv/3322848945
Figure No. 1.7: Location of project. Kommunekart

Figure No. 1.17: *Graph Depiction Average Rainfall in Trøndelag from 1991 to 2020*, 2024. Meterologisk Institutt. https://www.met.no/vaer-og-klima/klima-siste-150-ar
Figure No. 1.18: *Graph Depiction Average Temperaturesl in Trøndelag from 1991 to 2020*, 2024. Meterologisk Institutt. https://www.met.no/vaer-og-klima/klima-siste-150-ar

Next page - Figure No. 4.11: Illustration of Project Aim



'Human Nurture' - *Designing For Sustainable Mental Health Treatment*

Maren Lovise Øby, Miriam Kinck Kolstad

June, 2024

Contents

Chapter 1

Preface

Nurture; *"to take care of, feed, and protect someone or something, especially young children or plants, and help him, her, or it to develop" - Cambridge Dictionary*

This master thesis in Sustainable Architecture marks the end of a two-year master programme at Norges Teknisk-vitenskapelige Universitet. The thesis corresponds to 30 study points, and was developed over the spring semester of 2024.

This thesis differs from the general themes within the Master in Sustainable Architecture by shifting the focus from primarily emissions- and energy-reducing architecture, towards sociocultural sustainability. The main goal is to create a facility that treats patients both patients, staff and the immediate surroundings with respect and dignity, achieving a holistic form of sustainable design.

We hope that this project can serve as inspiration for future mental health institutions in Norway, and help steer the development of these in a direction that will result in better treatment and well-being for the patients.

We would like to thank our supervisors at NTNU, Pasi Aalto and Patricia Marin-Schneider for guiding us through this project, even when we were headed in directions beyond their fields of expertise. We would also like to thank Knut H. Bergsland for guidance on architecture for mental health, as well as Sykehusbygg, particularly Marte Lauvsnes, for insight into current practice within institutional architecture. A special thanks also to our "informants" that were willing to share their experiences with Mental Health Institutions in Norway. These experiences were invaluable help for the development of our design.

Chapter 2

Introduction

2.1 Abstract

Research shows that exposure to nature and natural elements has a positive effect on well-being, physical and psychological health, as well as rehabilitation. This led to an interest in exploring biophilic design thinking within the architectural design of a mental health institution. The Psykiatrisk Døgnenhet was chosen as a design typology due to its nature as a low-security, low-risk facility, allowing for alternative design solutions and less rigid security measures.

The project was initiated by a deep dive into existing research, and a summary of existing literature within the fields of mental health treatment, biophilic design, environmental psychology and institutional architecture is collected within this booklet.

Additionally, through meetings and discussions with Sykehusbygg HF, former SINTEF-employees, psychiatric nurses and psychologists, as well as former patients, insight into the needs, wants and experiences of the people using these buildings was gained. Along with case studies, this forms the basis for the design decisions

The project uses biophilic and evidence-based sustainable principles, but the goals and results of the design are difficult to measure. It's impossible to know the exact effect the design will have on the users of the building, and the theory booklet therefore discusses different ways of quantifying and measuring the project's success.

The main goal of the thesis is to explore the themes of Biophilic Architecture, Mental Health, and the Connection between Nature and Well-being. The final result is a design proposal for a new Mental Health Hospital within the forest outside of Trondheim, as well as a theory booklet that summarises the research and overall values regarding sustainability, mental health and dignity that have influenced the final design choices.

Research Question

Can Biophilic Design Philosophy create a Mental Health Facility where users experience quicker recovery rates and greater success of therapy?

Due to the nature of the project, a set of overarching design goals were chosen in the initial phase of the project, rather than a specific research question.

- *Create an environment where patients thrive and recover*
- *Create a building with little negative impact on the immediate environment*
- *Create a functional and welcoming psychiatric hospital*

The design brief in Chapter 11 provides a set of detailed, measurable goals for the project. Chapter 3 - Quantification also discusses how the design may be assessed in order to determine whether the overarching goals have been met.

2.2 Why Design A Mental Health Institution?

Research finds that 80% of the Norwegian population will suffer from mental health conditions at one point in their life [Jackobsen and Spilde, 2023], and according to the SHoT-survey from 2022, 20 percent of all students have some sort of mental illness [Studenthelse, 2023]. Today, the yearly cost of mental illness is 330 billion NOK. This equals the cost of building a thousand school buildings each year. The public healthcare industry lacks funding, which results in short-term treatment rather than prevention [Jackobsen and Spilde, 2023]. Studies conducted by *'Riksrevisjonen'* [*Riksrevisjonen is the Norwegian parliament's audit agency that serves to conduct auditing, monitoring and guidance of different services.*] also reveal that people who suffer from mental illness do not receive adequate treatment or help when needed [Riksrevisjonen, 2021].

The Mental Health-care system is in need of more treatment facilities as well as more effective ways of treatment. With the rapid development of technology and social media, young people especially are exposed to significant threats to mental health, which in turn has led to a rise in 'less severe' mental health diagnoses. Most of these cases are treated at out-patient wards, with a varying degree of success [Riksrevisjonen, 2021]. The introduction of another in-patient mental health facility in Trondheim can lead to more preventive work by treating a bigger portion of the 'less severe' cases. This in turn may avoid the development of more severe problems for a number of patients by providing them with a break from their current situations within an environment designed to foster self-development, making them more equipped to handle their lives as part of today's society.

2.3 Why Apply a Biophilic Design Philosophy?

The positive effects that exposure to nature and natural elements has on well-being, physical and psychological health, as well as rehabilitation, has been the topic of a number of research articles (see [Ulrich, 1986], [Alam, 2023], [Naboni and Havinga, 2019] among others). The documented effects prove that Biophilic Design is especially suited for the design of low-risk psychiatric facilities.

See Chapter 7 - Biophilia, and Chapter 8 - Physical Environment & Health for a further explanation of the particular benefits of Biophilic Design.

2.4 Why Is This Sustainable Architecture?

Sustainable Architecture often invokes association to Zero Emission Architecture, Plushouses and Local Renewable Energy Production. Green Building Rating Tools and Certifications drive the industry in a direction focusing on benchmarks and technical achievements. Biophilic Design has more diffuse, overarching goals of including natural elements and creating designs that are in line with local ecology. However, it's an integral design philosophy in order to create holistically sustainable buildings. Through the use of renewable energy, and choice of materials (low emission, carbon storage and reused/recycled) the building's carbon footprint may be reduced, while the usage of plants, animals and insects can reduce the building's negative impact on the local ecosystem as well as improve the indoor environment.

Another part of sustainable development that's often overlooked in architecture is Social Sustainability. This involves providing all people with equal opportunities to live stable, healthy lives, without discrimination, where they can get educated and acquire jobs where they earn living wages. More than half of the UN's Sustainability Goals relate to social sustainability, yet it's often neglected when assessing sustainable architecture. In countries such as Norway, a lot of the work to ensure social sustainability revolves around breaking down stigmas to reduce discrimination and distributing money in ways that maintain the social security services offered by the government. Working to reduce the costs and needs of these services is also an important part of social sustainability.

Since Norway is unable to provide adequate mental health treatment to everyone needing it today, there's been a focus on making the treatment more effective. This has led to understaffed facilities, with cheap, effective design, and a treatment plan that leaves the patients feeling like livestock instead of people. By designing a mental health facility that through its design treats the patients with respect, they're given a greater sense of self-worth and provides them with a sense of normalcy in a difficult situation. Better facilities will facilitate better treatment and personal development, in turn speeding up the recovery process and lowering economical costs.

2.5 Challenges in Biophilic Design

One of the major challenges with both Biophilic and Sustainable Design is the added cost. Public projects especially have tight economic boundaries, and it can be difficult to argue for added costs without having exact knowledge of the gains. Although there is research detailing the benefits of incorporating nature, many stakeholders still perceive them as non-tangible. Exact, quantified values that can be measured against each other are preferred as they provide predictability.

Biophilic elements also tend to require regular maintenance, such as gardening or repair to avoid degeneration. Although they may last through the entire lifetime of the building, the costs of maintaining these elements may be hard to predict as opposed to the costs of replacing "no-maintenance" elements. In addition, many biophilic elements add risk to the design as they involve the use of water and living materials. I. e. green roofs may have defects related to waterproofing, leakage and mould growth.

Another challenge is that Biophilic Design requires a holistic approach, and applying isolated biophilic elements isn't enough. As most Green Building Rating Tools (GBRTs) and Certifications don't reward biophilic design, it can be difficult to convince stakeholders to apply this design philosophy.

The biggest challenge regarding Biophilic Design is the lack of specific frameworks. Design guidelines tend to be broad and non-specific, describing principles, but lacking instruction on how to achieve the framework's goals. Without descriptions of how to apply these strategies within architecture, it proves difficult for both architects and other stakeholders to implement them as part of the project.

Chapter 3

Quantification & Assessment

The thesis has several technical and theoretical limitations, the most prominent of which being the quantification of architectural quality and the projects overall sustainability. This chapter discusses ways of measuring the effects of the projects design, in both quantifiable and subjective ways. Due to the nature of the project, there will not be time to do all the different types of simulations or assessments of the final design. Economical aspects of the project will not be calculated or assessed further than what was stated in chapter 2.4.

3.1 Environmental Qualities

The effects weather and local climate has on the building can be simulated using Rhino and Grasshopper with the Ladybug tool set. Using local weather data sunlight, wind and radiation can be measured, and the design can be adapted accordingly. The interaction between the building and local climate will also have an impact on the building's total energy use.

3.1.1 Solar Irradience

The solar irradience that hits the surfaces of the project can be calculated using local climate data. The result may be used both to identify suitable locations for and calculate the potential energy production from photovoltaic panels, It can also help identifying surfaces with potential for heat gains, thus affecting the heating and cooling loads of the building.

Ladybug-simulations will be used for the solar irradiance calculations for the design project. Initial analysis will influence the shape of the building and courtyard, as well as identify which locations are suitable for PVs. An estimate of the yearly energy production will be calculated based on the results of the final simulation.

3.1.2 Daylight

Daylight Factor

The architectural concept of daylight factor (DF) is the ratio of light level inside a room compared to the levels of light outside of it. A DF under 2 is generally considered to be inadequate, and artificial lighting is required. If the DF is over 5 the room will generally only need artificial lighting between dusk and dawn.

Daylight simulations using Ladybug will document the daylight factors of the rooms within the design. Living rooms, or social zones, and bedrooms are particularly important to simulate in order to document adequate daylight. Simulations will also document glare risk.

Proper daylighting will reduce the need for artificial lighting, and thus the energy usage. Research also shows that daylight has several health benefits, such as stabilising the circadian rythm [Mead, 2008].

Many design guidelines and framework gives an average daylight factor as the recommended target. BREEAM for example states that "... at least 80 % of the floor area in occupied spaces has an average daylight factor of 2 % or more." [BREEAM-NOR V6.1, 2023]. It should however be noted that operating with average values for daylight distribution can be quite misleading, as the area closest to the window tends to have very high DFs and will significantly influence the average value.

Daylight Hours

The hours that certain areas or planes receive daylight are known as daylight hours. Courtyards and enclosed areas will have varying levels of shadow and light based on the shape of the walls surrounding them. In order to ensure that the courtyards receive daylight throughout the day, the daylighting hours will be simulated using Rhino and Ladybug.

The total annual daylight hours will be simulated for the both courtyard/outdoor areas and areas with PVs. In order to assure adequate daylight in winter the daylight hours for summer and winter solstice will also be simulated.

3.2 Architectural Qualities

3.2.1 Views & Privacy

Isovists

An isovist is a geometrical concept describing the volume of space seen from a given point [Wikipedia, 2024a]. The method can be used to geometrically represent the both the view

out of a room (through doors or windows), and within interior spaces. Isovists may also be used to simulate light and shadow from a point source of light.

The use of isovists in architecture is prescribed to Michael Benedikt, who in his paper *To take hold of space: isovists and isovist fields* described how isovist fields could be used to describe spatial properties [Benedikt, 1979]. The concept has later been used in combination with architectural psychology to analyse the experience and qualities of buildings [Franz et al., 2005], and Dawes and Ostwald used the concept to investigate and predict human responses to buildings [Dawes and Ostwald, 2013].

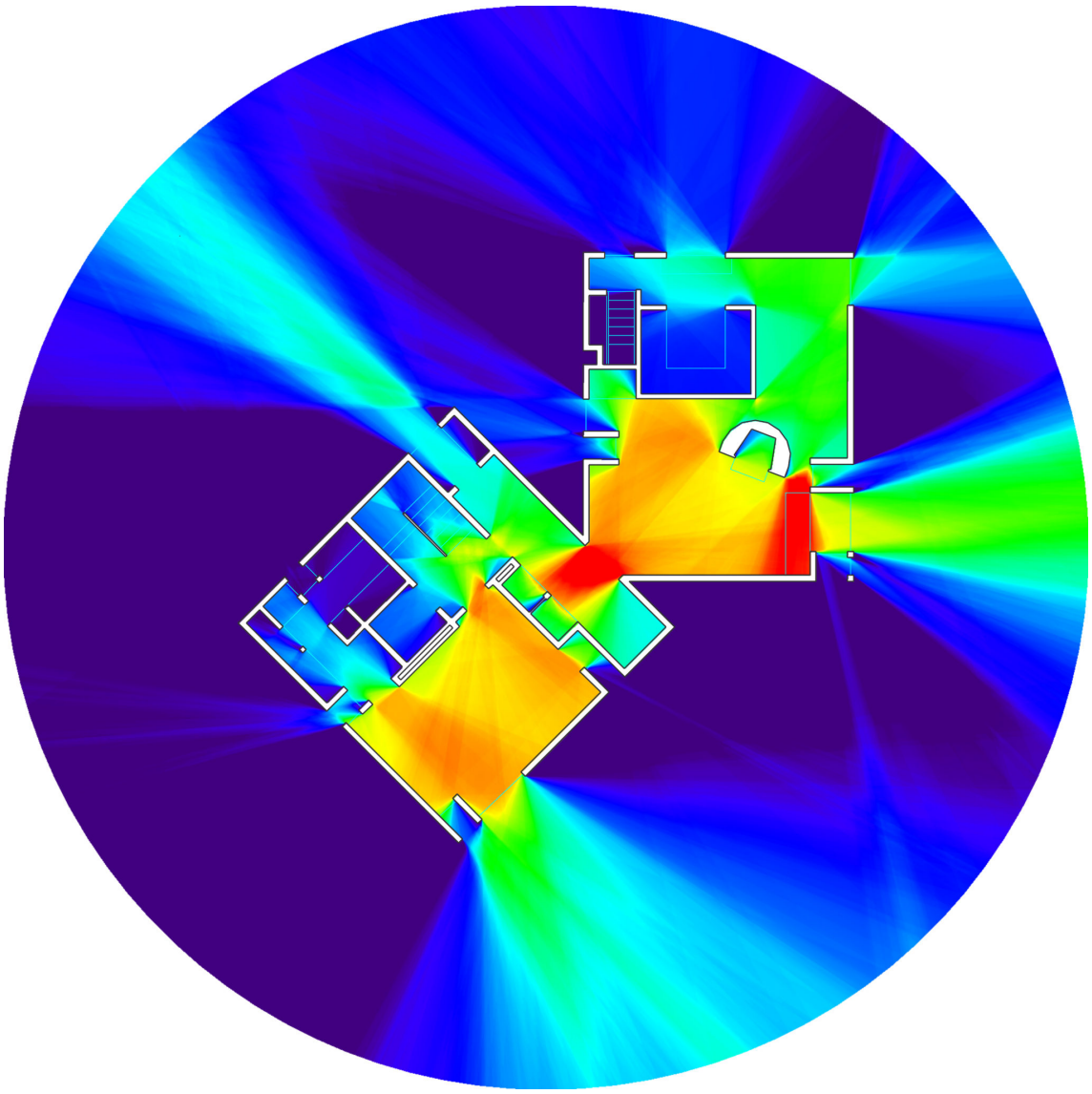


Figure 3.1: *Expanded visibility fields within Louis Kahn's Fisher House* [Isovist App, 2024]

The analysis method can be used in combination with prospect-refuge theory (described in chapter 8.2) to assess concealed and open spaces within the interior of the building, finding the most visible and hidden locations within the plan, as well as where within the interior you have a visual connection to the outdoors. Lonergan & Hedley (2016)

devised a method of analysing the visibility between two buildings by creating a set of isovists along the windows of the facades and using a classification scheme to represent cumulative visibility and privacy for each floor [Lonergan and Hedley, 2016].

Several software solutions may help calculate and draw isovists. Through the use of the Isovist-App, or Rhinoceros and Grasshopper the plans of the project may be analysed, and the spatial qualities of the interior can be graphically represented.

A problem with using isovists to analyse views outside of the buildings is to define where the view ends. Open spaces generate near infinite isovists, and different borders have been proposed. Davies et al (2006) proposed setting the "visibility limit" to 200m, while Weitkamp et al (2007) proposed a view distance of 1200m when studying landscape [Davies et al., 2006], [Weitkamp et al., 2007].

Visual Privacy

Visual privacy refers to the ability to perform tasks within a private space, such as a home, without being seen by outsiders. A psychiatric hospital requires a carefully designed balance between visual privacy and open, clear view of the interior and exterior environment. The employees must be able to see as much of the spaces as possible, in order to catch unwanted incidents (such as acts of violence or despair), and the patients will also seek control of their surroundings in order to avoid surprises or unwanted interactions. At the same time, the patients should not feel like they're under constant surveillance (see Prospect, p. 63, and Refuge, p. 64.) . The private rooms especially must have a high degree of privacy.

Mathematical methods for determining quantitative values for visual privacy exists, such as the Potential Visual Exposure Index (PVEI) developed by Zheng et al ([Zheng et al., 2022]), but making the calculations manually for an entire building would be extremely time consuming. The method can nevertheless be used to calculate the values for chosen locations.

HIPAT

McCartney & Rosenvasser developed the Hierarchy of Isolation and Privacy in Architecture Tool (HIPAT) in an attempt to measure and analyse the levels of privacy within student housing. The tool also analyses the impact control mechanisms within the built environment have on perceived levels of privacy. Interior spaces are divided into 6 levels of privacy:

- 1. Private
- 2. Semi-Private
- 3. Group

- 4. Floor
- 5. Building
- 6. Public

Spaces within levels 1-3 are primary territories, while those within level 4-5 are secondary territories, and level 6 contains public territories [McCartney and Rosenvasser, 2022a]. Each HIPAT level is assigned a color, thus enabling the privacy level to be graphically depicted on floor plans and visualise social configurations within the building. The tool may be used to gather quantitative data on the spatial distribution of the floor plans.

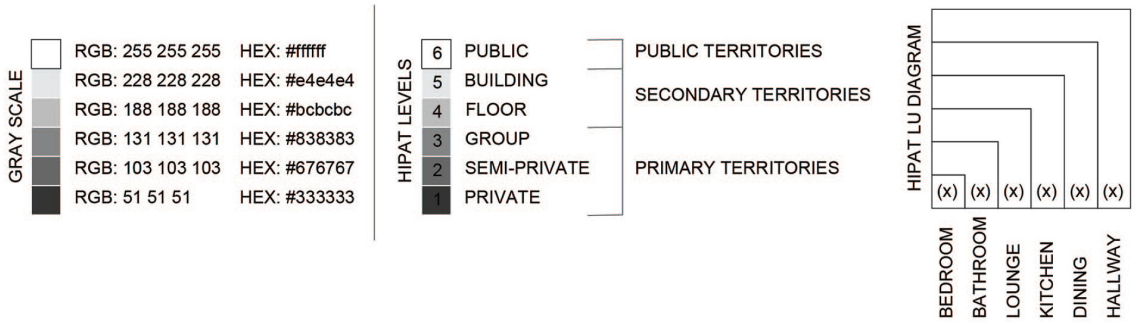


Figure 3.2: *Hierarchy of isolation and privacy in architecture tool (HIPAT) graphic tool.* [McCartney and Rosenvasser, 2022b]

One of the main purposes of HIPAT is to identify the levels of negotiation within the living arrangements, and showing how much control each user has within the building. The tool merges theories about isolation and crowding with territoriality in a way that allows planners to analyse socialisation and understand the users experiences.

In order to adapt the HIPAT to the psychiatric hospital typology that this thesis is concerned with, the levels of privacy are changed to:

- 1. Private
- 2. Patients
- 3. Staff
- 4. Building
- 5. Public
- 6. Outdoor Areas

A downside to the tool is that it defines privacy through the level of influence the user has on their environment. It does not account for visual privacy or acoustic privacy, something that is also of great importance within public areas. This means that all public areas are

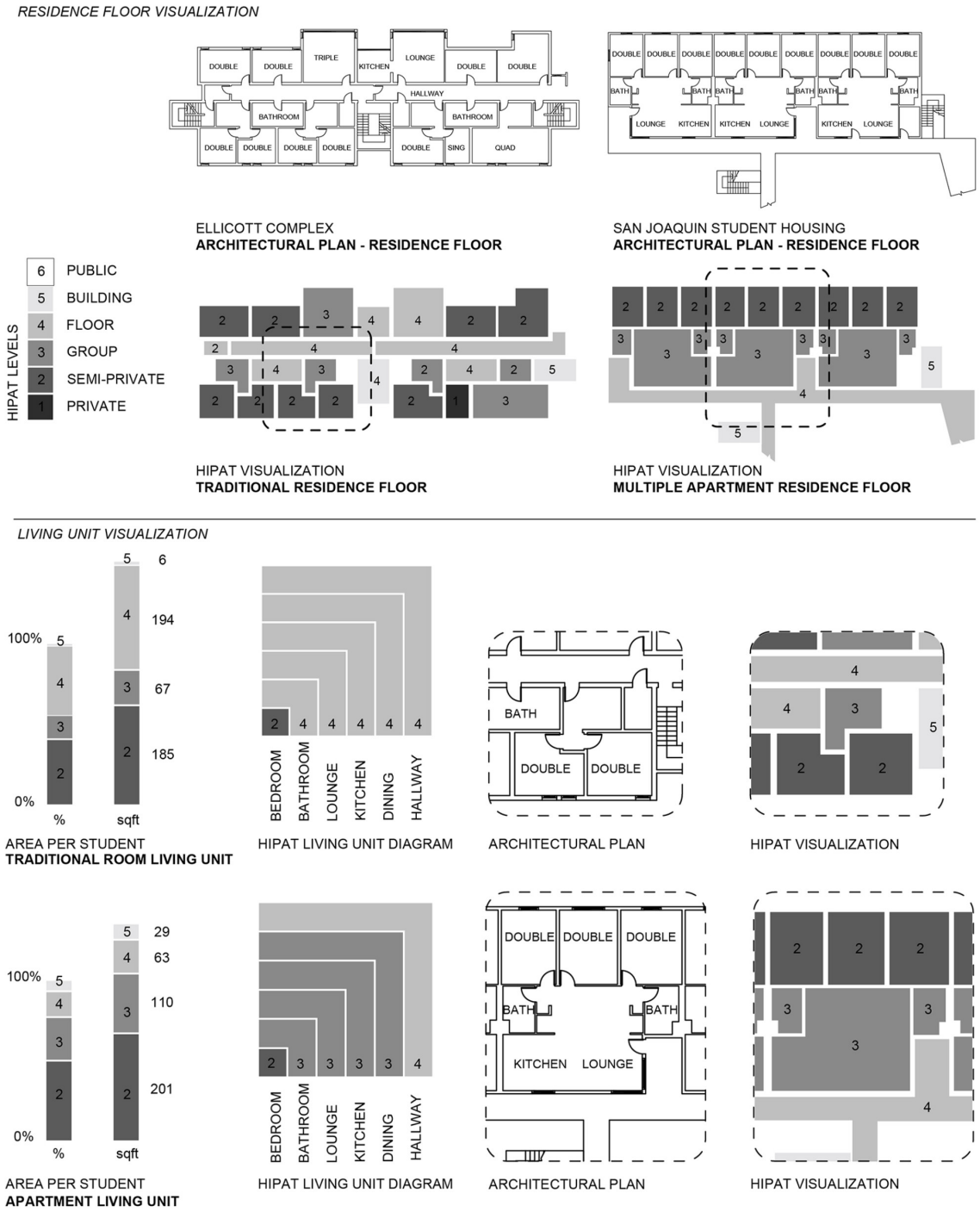


Figure 3.3: *HIPAT visualization of typical residence floors and living units of a traditional units floor and an apartment unit floor.* [McCartney and Rosenvasser, 2022b]

described the same way, although there might be spaces within that area that has greater or lower sense of privacy (visual and acoustic) and surveillance.

Assessing the quality of views

Quantifying the quality of a view through a window is a difficult process. Nearly all research within this area relies on subjective ratings only, and although general tendencies are found within the studies (view of nature is preferred over urban settings, daylight is preferred over artificial lighting, the number of layers and depth of the view affect the viewers satisfaction) there is no comprehensive assessment method for quantifying view perception. The quality of views may be assessed by measuring physiological reactions in users of the building, but no quantifiable assessment method existing for a design stage other than having user groups assess a VR model. Abd-Alhamid et al. did however summarises common trends among preferred views [Abd-Alhamid et al., 2023]. These can be used as guidelines in the design process.

Abd-Alhamid et al.'s findings regarding view quality parameters

- Rectangular window with horizontal alignment is preferred
- Satisfaction with window size changes by the observer location.
- Dark-coloured shadings with high opening factor and high visible transmittance were preferred.
- Flat or gently curved slat shapes showed better results for external view exposure.
- Switchable ETFE cushion was less preferred for view perception compared to clear glazing.
- A complete view is preferred over a fragmented one, even when the same window to wall ratio is provided.
- Mullion preference depends on the view distance, i.e. distant views were less preferred when increasing mullions number and width.
- 50–60% relative view size.
- Larger view angular size from working cubicle is preferred.
- Satisfaction with window size changes by the observer location as measured subjectively and objectively.

[Abd-Alhamid et al., 2023]

Some sustainable building analysis tools, such as *cove.tool* uses LEED's view requirements to measure quality views in four different assessments using a grid based analysis:

- Type 1 - 90° Sight Lines: Multiple lines of sight to vision glazing in different directions at least 90 degrees apart.

- Type 2 - Sky and Context: Views that include at least a view of the sky and objects at least 25 feet (7.5 meters) from the exterior of the glazing.

- Type 3 - Unobstructed View: Unobstructed views located within a distance of three times the head height of vision glazing.

- Total Quality Views: Total percentage of floor area that has at least two of the aforementioned three kinds of views.

[cove.tool,]

Nevertheless the tools has it's shortcomings, as it does follows very technical and quantified definitions of quality views, but does not account for preferred human environments and views in any way. Similarly Ladybug and Rhino can calculate the LEED V4 criteria for quality views, as well as quantify the visual connection to the outdoors as a percent of the full 360 field of view, and visual access to particular landmarks or scenery. However, a full assessment of the quality of view requires several considerations and will never be fully quantifiable.

Characteristics of preferred views and environments are discussed further in chapter 8.

3.2.2 Spatial Configuration

Space Syntax

Space Syntax theory is used to analyse spatial configurations, by describing the connectivity and integration of these spaces [Wikipedia, 2024b]. The method was introduced by Bill Hillier & Julienne Hanson as a way of gain insight into the relationship between society and space, and is now among other things used to predict the effect architectural and urban spaces have on the users.

In addition to showing how the different spaces are connected, a Space Syntax can be used to identify the most central, or well-connected spaces within a building or urban setting. It can also be used to calculate the number of choices that must be made in order to reach a space. This makes it useful for assessing the way-finding qualities within the project.

Criticism towards the use of space syntax analysis includes the fact that it does not account for metric distances, and thus will portray rooms divided by a 5m long hallway and divided by a 50m long hallway the same way. The analysis also does not take spatial qualities such as daylight, views, depth of space or general atmosphere into account, thus not considering whether the connection is a preferred place of stay or not.

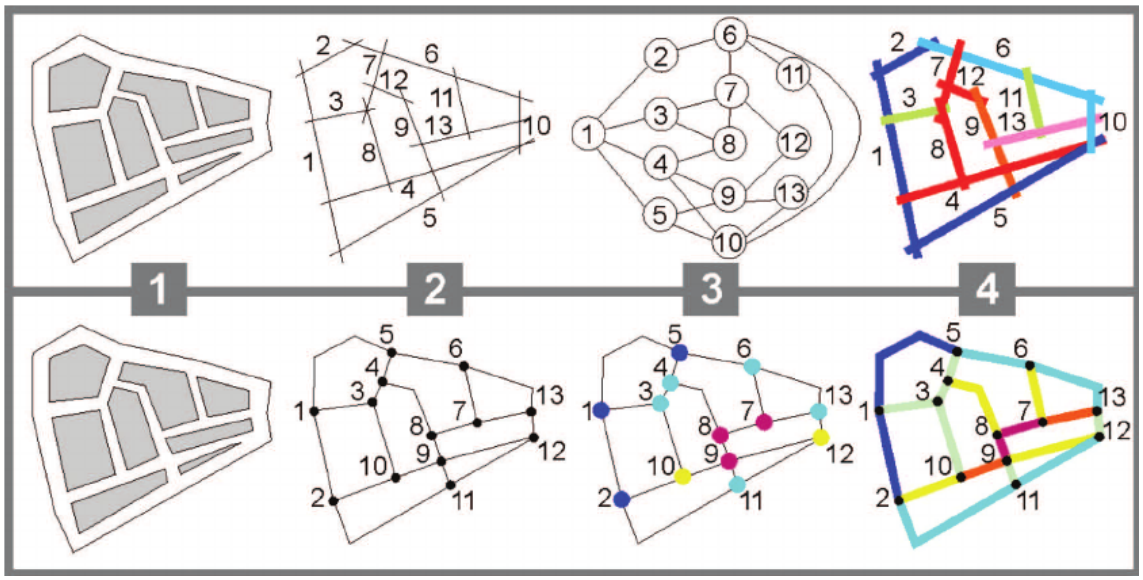


Figure 3.4: *The basic steps in a space syntax analysis* [Crucitti et al., 2006]

3.2.3 Architecture and satisfaction

Human Scale Development Approach

Human Scale Development is a term defined by Manfred Max-Neef and colleagues as an approach to community development. The term was coined after the team worked with improving the living conditions in Latin-America in the 1980s, and is based around human needs, self-reliance and organic articulations [Max-Neef et al., 1989]. The work identified that the fundamental needs are the same for all human beings, no matter where or when they live. The satisfiers, on the other hand, vary depending on culture or location. Max-Neef developed a matrix listing these fundamental needs, as well as satisfiers for these needs.

[Max-Neef et al., 1989]

[Max-Neef et al., 1989] The horizontal categories listed at the top of the matrix make up the existential needs, while the axiological needs are listed vertically. Satisfiers are listed in the intersections between the horizontal and vertical needs. The satisfiers listed within the **Being** column are individual, while the **Having** column lists institutions, laws and norms. **Doing** lists actions, while the **Interaction** column is made up of locations and environments. The matrix is a tool for analysis and may be adapted to specific user groups or cultures.

The *Needs & Satisfiers Matrix* is often used to plan and assess sustainable development programs, but it can also be used when developing guidelines for architectural designs. The design must account for as many of the needs as possible (preferably all), without inhibiting the possibility of fulfilling other needs. When assessing the quality of the design, one can then analyse how well it answers to the users' fundamental needs.

Matrix of needs and satisfiers	**Being**	**Having**	**Doing**	**Interacting**
Subsistence	physical health, mental health, equilibrium, sense of humour, adaptability	food, shelter, work	feed, procreate, rest, work	living environment, social setting
Protection	care, adaptability, autonomy, equilibrium, solidarity	insurance systems, savings, social security, health systems, rights, family, work	cooperate, prevent, plan, take care of, cure, help	living space, social environment, dwelling
Affection	self-esteem, solidarity, respect, tolerance, generosity, receptiveness, passion, determination, sensuality, sense of humour	friendships, family, partnerships, pets, relationships with nature	make love, caress, express emotions, share, take care of, cultivate, appreciate	privacy, intimacy, home, space of togetherness
Understanding	critical conscience, receptiveness, curiosity, astonishment, discipline, intuition, rationality	literature, teachers, method, educational policies, communication policies	investigate, study, experiment, educate, analyze, meditate	settings of formative interaction, schools, universities, academies, groups, communities, family
Participation	adaptability, receptiveness, solidarity, willingness, determination, dedication, respect, passion, sense of humour	rights, responsibilities, duties, privileges, work	become affiliated, cooperate, propose, share, dissent, obey, interact, agree on, express opinions	settings of participative interaction, parties, associations, churches, communities, neighbourhoods, family
Idleness	curiosity, receptiveness, imagination, recklessness, sense of humour, tranquillity, sensuality	games, spectacles, clubs, parties, peace of mind	daydream, brood, dream, recall old times, give way to fantasies, remember, relax, have fun, play	privacy, intimacy, spaces of closeness, free time, surroundings, landscapes

Table 3.1: Max-Neef's Needs & Satisfiers

Creation	passion, determination, intuition, imagination, boldness, rationality, autonomy, inventiveness, curiosity	abilities, skills, method, work	work, invent, build, design, compose, interpret	productive and feedback settings, workshops, cultural groups, audiences, spaces for expression, temporal freedom
Identity	sense of belonging, consistency, differentiation, self-esteem, assertiveness	symbols, language, religion, habits, customs, reference groups, sexuality, values, norms, historical memory, work	commit oneself, integrate oneself, confront, decide on, get to know oneself, recognize oneself, actualize oneself, grow	social rhythms, everyday settings, settings which one belongs to, maturation stages
Freedom	autonomy, self-esteem, determination, passion, assertiveness, open-mindedness, boldness, rebelliousness, tolerance	equal rights	dissent, choose, be different from, run risks, develop awareness, commit oneself, disobey	temporal/spatial plasticity

Table 3.2: Max-Neef's Needs & Satisfiers - continued

3.2.4 Post-occupancy Evaluation

Post Occupancy Evaluation (POE) is a method used to assess how effectively a building satisfies the needs of its clients and occupants [MacDonald, 2020]. Through careful evaluation of aspects of the building such as use and occupancy, energy and water usage, maintenance costs and user satisfaction, to measure whether the building meets the intended outcome[MacDonald, 2020]. The gathered data is used to learn from existing projects to improve and ensure high-quality buildings and a sustainable construction industry for future generations [MacDonald, 2020].

The benefits of implementing post-occupancy evaluation in projects are [MacDonald, 2020]:

1. Provide healthier, greener buildings
2. Compare intended use to the actual use
3. Cost reduction
4. Ensure quality and improvement in future projects
5. Prevent delays and budget blows in future projects

6. Increase user satisfaction

Additionally, the cost of implementing POE as part of the building process will only add an additional cost of 0.1-0.25% of the total building costs.

Despite POE being a highly valuable tool for all parties involved, it is still rarely implemented as part of projects or within the industry, in general, [MacDonald, 2020, Connellan et al., 2013]. The reason is likely the substantial cultural changes needed within the industry to successfully implement the method as standard practice [MacDonald, 2020, Connellan et al., 2013]. The Royal Institute of British Architects (RIBA) therefore proposes a top-down approach through government regulations to ensure widespread application of the tool especially whenever public funding is part of the project's financial plan [MacDonald, 2020].

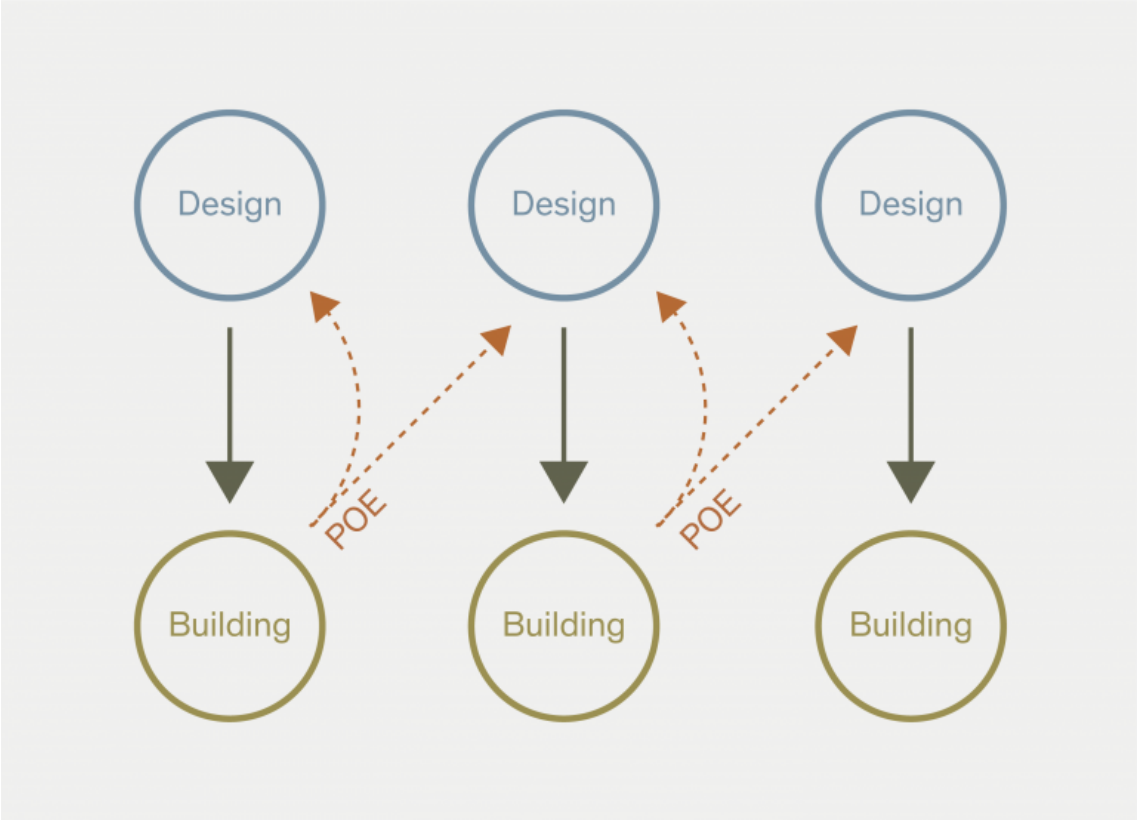


Figure 3.5: *Post occupancy evaluation provides important feedback on past projects results that should be used to improve quality of future projects* [MacDonald, 2020] Illustration by Morrow + Lorraine Ltd.

Different levels of measuring POE can be implemented depending on project type and size [MacDonald, 2020]:

- **Light touch POE:** Quick, simple evaluation before the final handover of the building.
- **Diagnostic POE:** Further evaluation conducted based on results from light touch

POE.

- **Detailed (forensic) POE:** Detailed analysis conducted by external surveyors to identify, improve and identify significant and persistent performance issues.

POE on sustainability and health: POE could play a critical part in ensuring a sustainable future, especially in terms of net Zero Energy Buildings (nZEB) [MacDonald, 2020]. Through the use of POE it is possible to measure whether a project complies with their intended building and/or energy performance as today, most buildings are not being measured on whether they *actually* meet the promised benchmarks [MacDonald, 2020]. RIBA further criticise how the quality control within the building industry is rather poor compared to that of other industries in terms of project costs [MacDonald, 2020]

POE on building use compared to design intentions:

Some buildings might be designed around complex systems that need to be operated in a certain manner to achieve optimal performance [MacDonald, 2020]. Systems like this could be natural or hybrid ventilation, which operates on different schedules that can either be designed to adjust to user interference or need to be fully automatic [MacDonald, 2020]. By conducting a POE on complex building design one can identify if anything is interfering with the systems, causing higher operational costs and emissions and from there provide the necessary changes to improve the building performance[MacDonald, 2020].

A common area for complex buildings or systems is lack of instructions or information. This could be anything from information on wall mounting capacity, control panels to building performance and design [MacDonald, 2020]. This could cause the user or client unnecessary stress and frustration which reduces their overall experience or satisfaction with the building [MacDonald, 2020].

POE is a tool that promotes a sustainable industry that values quality in building design[MacDonald, 2020]. It provides valuable insight and lessons for designers and construction workers who can use the provided insight to improve their projects, service and income [MacDonald, 2020]. POE benefits all parts involved in a project and are not limited to the investor, client or entrepreneur [MacDonald, 2020].

POE can also be applied to the user experience of the building. Conducting surveys and questionnaires on occupant experience in the building can provide architects with important information on user behaviour[MacDonald, 2020]. The gathered information can then be implemented in future projects and is perhaps particularly important in buildings where users spend major parts of their day such as institutions, residential units or offices [MacDonald, 2020].

In terms of psychiatric patients POE could be particularly valuable as one can identify areas of risks or perceived risk and measure the impact of the design decision based on user behaviour [Connellan et al., 2013]. One can also learn more about patient behaviour in

relevance to certain spaces and gain insight into what areas are successful or need further investigation or improvement [Connellan et al., 2013]. Psychiatric patients are a complex patient group as different diagnosis affects the use and perception of space differently. Measuring the effectiveness or ineffectiveness of space is therefore a crucial part in their path towards rehabilitation [Chrysikou, 2014, Shepley et al., 2016, Connellan et al., 2013].

The SCP Model

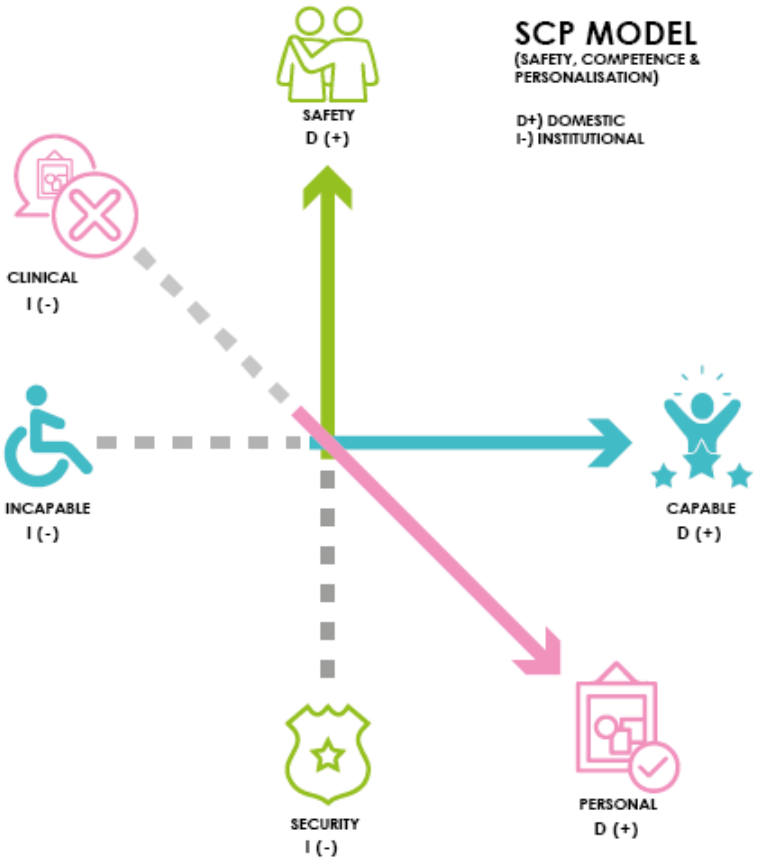


Figure 3.6: *SCP model based on concept and illustration by Evangelia Chrysikou. Competence is changed to Capability and personalisation and choice are changed to personal as it were easier terms to work with in terms of polar opposites* [Chrysikou, 2019a]

The SCP model (Figure 3.6) (safety and security, competence, personalisation and choice) offers a three-dimensional tool that organises concepts related to the spatial programming of psychiatric facilities/design [Chrysikou, 2019a]. The S.C.P variables read as a three-dimensional graph that serves as a scale to depict environmental quality and its effect on the users [Chrysikou, 2019a].. The scale further presents an opposite dimension to each concept variable [Chrysikou, 2019a].

Safety / Security: Tracks whether the environment is being viewed as safe (caring) or secure (intrusive/invasive/surveillance)

Incapable / Capable: Does the environment reflect incapability or does it encourage independence/self-care?

Clinical / Personal: Does the environment enable choice and personalisation or does it follow strict routines and pose a 'clinical' environment with little space for personal preference?

Further Chrysikou shows that the psychiatric rehabilitation model can be divided into three main categories which correspond to the axis of the SCP model and which combined construct the *'pyramid of needs'* which the model is built on (Figure 3.7).

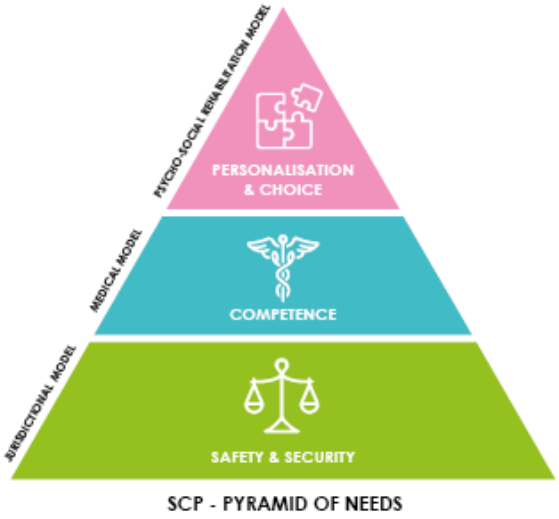


Figure 3.7: *SCP - Pyramid of Needs show how the psychiatric rehabilitation model can be applied to the SCP model. Illustration based on concept and figure by Evangelia Chrysikou* [Chrysikou, 2019a]

- **Harm/self-harm prevention & Safety and Security:** Preventing patients from hurting themselves or imposing harm on others
- **Rehabilitation & Competence/capability:** Restore or increase the feeling of competence/ capability
- **Social re-integration & Personalisation and choice:** Practice social skills and improve self-worth

The tool has been tested in ten facilities over two countries, involving 115 staff and patients. In later studies, Space syntax analysis has also become a critical part of the model, especially in terms of measuring the relationship between user and space [Chrysikou, 2019b].

The SCP-model is supplied with semi-structured questionnaires for both staff and patients and a building trait checklist. If applying space syntax on needs to analyse the building floor plan using software such as Depthmap and JASS-Tools [Chrysikou, 2019b].

Building check-list: The building trait checklist (Figure 3.8) needs to be adjusted to reflect traits defining the institutional 'normal' of existing psychiatric facilities in an area as institutional/building features vary greatly depending on the country and cultural context [Chrysikou, 2019b].

Staff and patient questionnaires: The questionnaires consist of semi-structured interviews which includes 23 primary questions targeting staff and 30 primary questions targeting patients. Further the questionnaire is divided into three subsets, targeting each branch of the SPC-model parameters [Chrysikou, 2019b, Chrysikou, 2019a].

The staff and patient questionnaires are not publicly available out of patient confidentiality

[Chrysikou, 2019b], Chrysikou has however presented an example from the building trait checklist (Figure 3.8that can help provide insight into the mechanics of the model (The full list of traits obtained from Chrysikou's 2014 book is available in the appendix of this booklet).

NUMBER	PARAMETER	FEATURE	INSTITUTIONAL	DOMESTIC
181	Safety and Security	Front doors open to public		
182		Open stairs within residences (vs enclosed or between fire doors)		
183		Lounges with windows or doors to the outside operable by service users		
184		Doors opening inwards		
185		Glass mirrors in bathrooms and WCs and weight bearing fittings		
186	Competence	No handles by toilets		
187		Microwaves in kitchens		
188	Personalisation and choice	Signs or notices on lounge walls		
189		Table cloths		
190		Stainless steel kitchen counters		
191		Provision for some en suite accommodation		
192		Neighbouring to houses		
193		Either integrated to general housing schemes or stand alone		
194		Window size similar to adjacent housing		
195		Designated waiting area such as a recess/portico outside the entrance		
196		Stair surfaces built from materials such as wood, carpet, marble or mosaic		
197		Laundry area located near kitchens or bedrooms		
198		Single room accommodation		
199		Variety in lighting (vs fluorescent only)		
200		Variety in style and colour of curtains and bedspreads		
201		Curtains around the shower		
202		Decorative elements in bathrooms		

Figure 3.8: *SCP-building trait checklist example extracted from the book 'Architecture for Psychiatric Environments and Therapeutic Spaces' by Evangelia Chrysikou* [Chrysikou, 2014]

SPC-model in Practice

The following example shows Chrysikou's comparison of two wards through the SCP-model and space syntax.

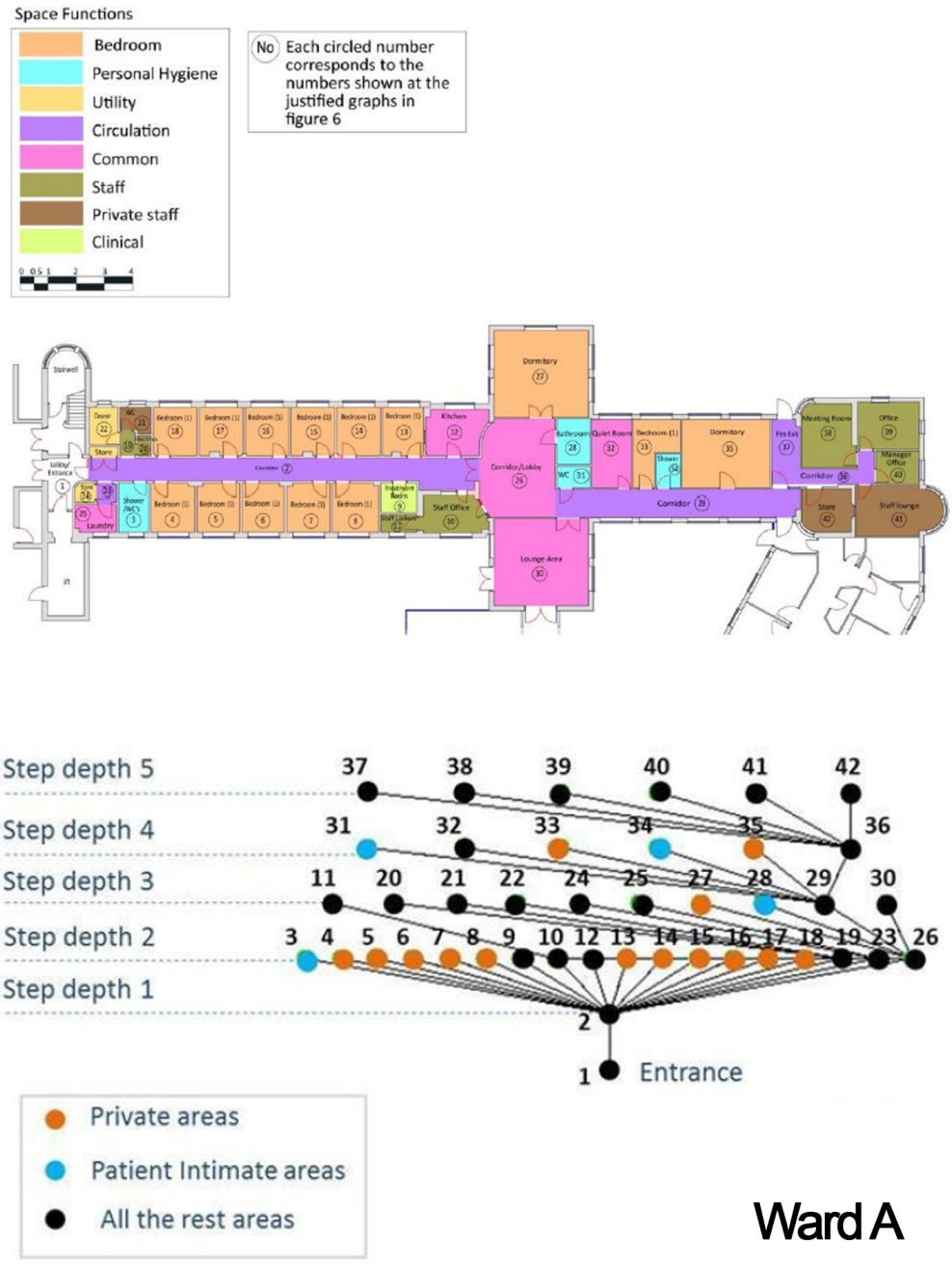


Figure 3.9: *Floor plan room programme analysis of ward A and Space syntax depth analysis of ward area types. Figures by Evangelia Chrysikou* [Chrysikou, 2019a]

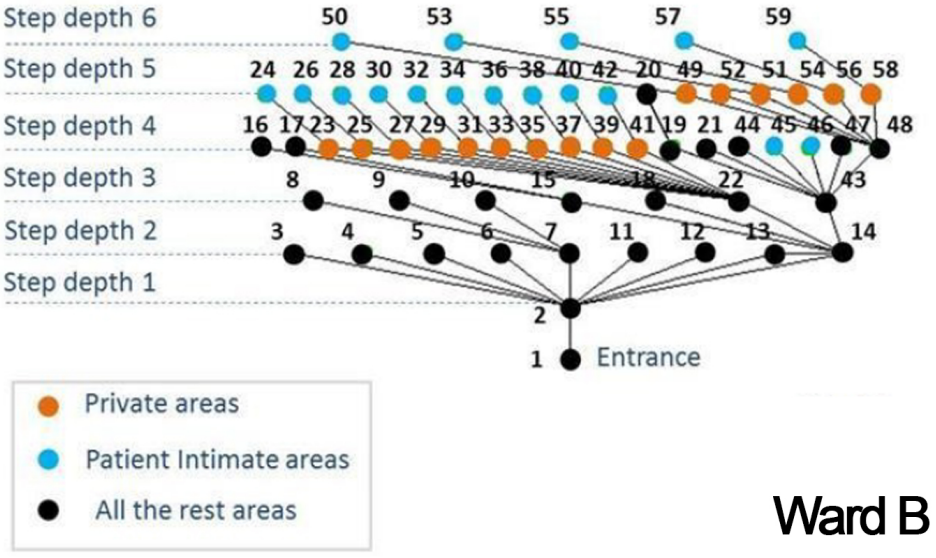


Figure 3.10: *Floor plan room programme analysis of ward B and Space syntax depth analysis of ward area types. Figures by Evangelia Chrysikou* [Chrysikou, 2019a]

Table 2: Institutional features for Wards A and B according to the institutional vs domestic features checklist.

Feature	Ward A		Ward B	
Context and site features	16/22	72.73%	14/22	63.64%
Building features	24/40	60%	24/40	60%
Space and room features	89/150	59.33%	78/150	52%
Total	129/212	60.85%	116/212	54.72%

Table 3: Layout similarities and differences for Wards A and B.

	Description	Ward A	Ward B
Similarities	Ground floor	+	+
	Single storey	+	+
	Access to fully protected courtyard	+	+
	Centrally positioned nurse station	+	+
	Centrally positioned clinics	+	+
	Double loaded corridors	(+)	+
Differences	Office area: offices integrated (as opposed to segregation or at the far end)	−	+
	Self-contained ward (vs dependent)	−	+
	Single bedrooms (vs sharing)	−	+
	Toilets: individual (vs shared)	−	+
	Gender segregation: single gendered ward (vs female only area)	−	+

"(+)" signifies that the relevant spatial trait is present but not everywhere. "+" signifies that the specific spatial trait is met and "(−)" that this is not the case.

Figure 3.11: *Building trait results between ward A and B. Figure by Evangelia Chrysikou* [Chrysikou, 2019b]

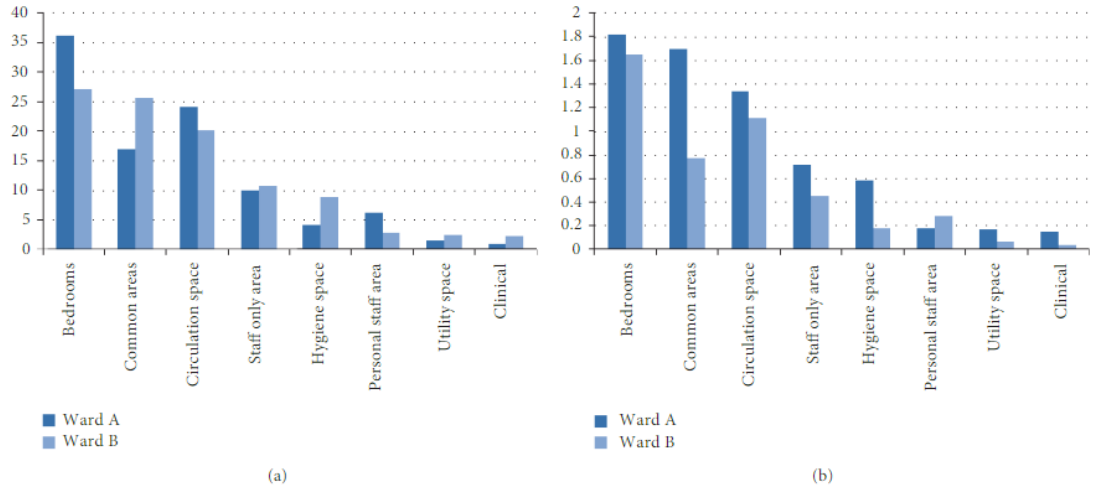


Figure 3.12: *Chart comparing the ratio of room types per ward (left) ratio of room types per patient (right). Figure by Evangelia Chrysikou* [Chrysikou, 2019b]

In Figure 3.14 and 3.10 The building floor plans are analysed and scored based on room programme and their architectural features [Chrysikou, 2019b]. The results (3.11) from each ward's score sheet are then compared in a set of charts (Figure 3.12) and further transferred to a radar graph (Figure 3.13 [Chrysikou, 2019b]. The final results are then combined and applied to the SCP model which shows each ward's total performance in comparison to other (types of) wards in the area.

**Detailed information on applying results to the radar chart and transferal to the SCP-Model is not clearly instructed/provided by the author and the final results section therefore may contain errors.*

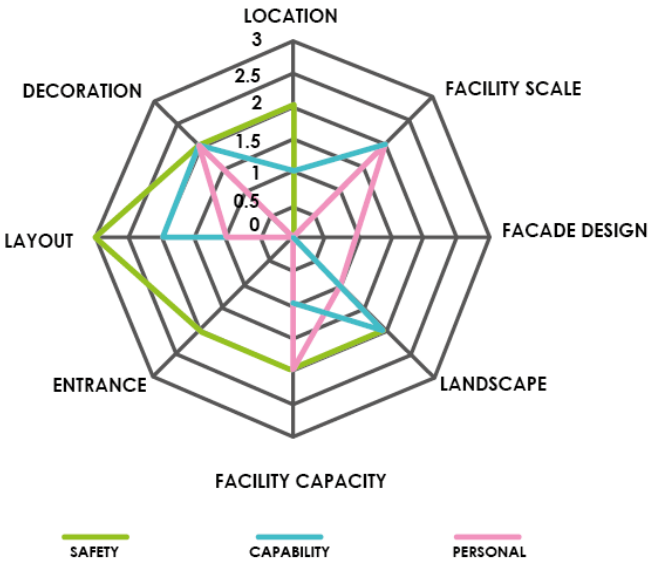


Figure 3.13: *SCP-model representation presenting ward results based on building trait score. Graphic based on figure by Evangelia Chrysikou* [Chrysikou, 2019a]

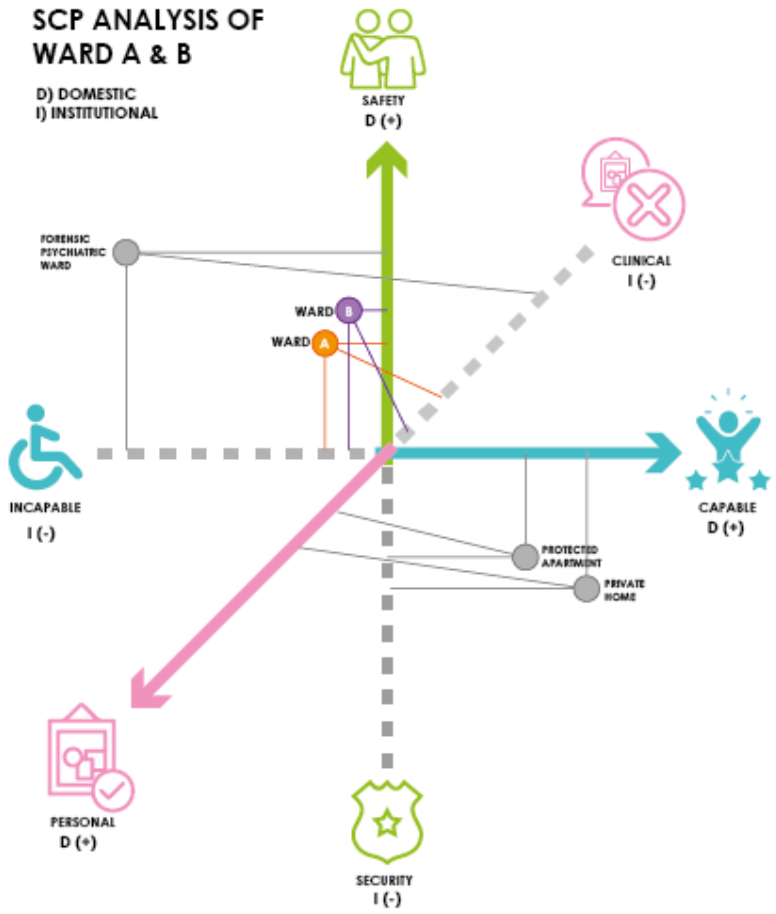


Figure 3.14: *SCP-Analysis of Ward A & B building performance compared to other (types of) wards in the area.* [Chrysikou, 2019a]

3.3 Biophilia

3.3.1 Measuring against definitions of Biophilic Design

Several attempts of defining biophilic design and creating frameworks for biophilic architectural design haver been made. The most well-known definitions of biophilic design are Kellert & Calabrese's Attributes of Biophilic Design and Terrapin Bright Green's 14 Patterns of Biophilic Design (described in chapter 7.3).

Kellert & Calabrese's Experiences and Attributes of Biophilic Design

Kellert divides the experiences and attributes of biophilic design in 3 categories; Direct Experiences of Nature, Indirect Experiences of Nature, and Experience of Space and Place [Kellert and Calabrese, 2015]. A biophilic design must include several of these experiences, through several different design elements.

Direct Experiences of Nature:

- Light
- Air
- Water
- Plants
- Weather
- Natural landscapes and ecosystems
- Fire

Indirect Experiences of Nature:

- Images of Nature
- Natural Materials
- Natural colors
- Simulating natural light and air
- Naturalistic shapes and form
- Evoking nature
- Information richness
- Age, change and the patina of time
- Natural geometries

- Biomimicry

Experience of Space and Place:

- Prospect and refuge
- Organized complexity
- Integration of parts to wholes
- Transitional spaces
- Mobility and wayfinding
- cultural and ecological attachment to space

The success of the design in terms of biophilia may be assessed through the integration of Kellert & Calabrese's experiences and attributes of biophilic design, as well as the 5 conditions for effective design presented by Kellert in an article in Metropolis Magazine (see chapter 7.2).

Terrapin Bright Green's 14 Patterns of Biophilic Design

The 14 Patterns of Biophilic Design described by the sustainability consultants in Terrapin Bright Green are described in depth in chapter 7.3. The design may be assessed by how successfully the patterns are represented within the design.

The Biophilic Interior Design Matrix

The Biophilic Interior Design Matrix was developed by McGee et al. (2019), based on McGee and Marshall-Baker's Biophilic Design Matrix (2015). The interior design matrix has a total of 52 attributes, based on the 72 attributes of biophilic design listed by Kellert (2008). The matrix is organised in 6 elements, each with corresponding attributes [McGee et al., 2019]. In addition to Kellert's attributes, five attributes from the Color Planning Framework [Portillo, 2009] are also included. Composition refers to how color can shape the interior spaces, communication refers to the meaning created through use of color, engagement is the feelings, thoughts and responses people have to color, preference reflects individual preference and market trends, and pragmatics are related to color driven by resource parameters.

McGee et al. used the Biophilic Interior Design Matrix in combination with a questionnaire, where practising architects were assessing the presence of the listed attributes within interior environments. A 4 point scale was used for the assessment of presence (None, Weak, Moderate, Strong), giving a final score based on the overall presence of biophilic elements.

Figure 3.15: *The Biophilic Interior Design Matrix.* Source [McGee et al., 2019]

Andreucci et al. used the Biophilic Interior Design Matrix developed by McGee et al. as an assessment tool to identify the integration of biophilic design in buildings and urban projects [Andreucci et al., 2021].

3.4 Environmental Sustainability

The overall sustainability of the project may be discussed in relation to the UN's Sustainability Goals, economic savings, social effects, energy savings or emissions. In terms of comparing the project with other works of architecture, the latter two impacts are the

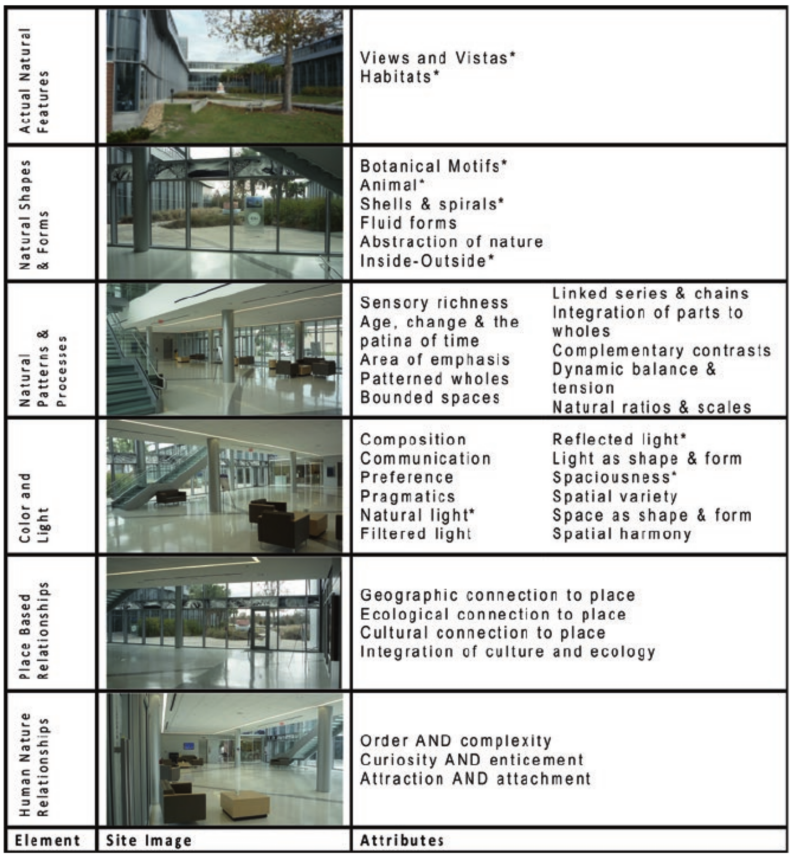


Figure 3.16: *Andreucci et al.'s elements and attributes of biophilic interior design included in the lobby of The University of Florida Clinical and Translational Research Building, based on the Biophilic Interior Design Matrix. Starred items are strongly present. Images are shown to help illustrate the overall context. Photos by [McGee et al., 2019]* Source [Andreucci et al., 2021]

most interesting as they are the easiest to calculate and measure. Assessing the social and economic effects of the project is possible, but the work load would most likely amount to a master thesis in sociology and economics.

Life Cycle Assessment

The Whole Building Life Cycle Assessment (wbLCA) is a good way of quantifying, and comparing, a building's environmental impact. The result of the calculations may be used to assess the designs overall sustainability through a comparison with benchmarks and other projects. The method can also help identify emission drivers, specific materials and building components that have a particularly large global warming potential.

The Norwegian standard for calculating LCA (NS-EN 15978) includes the production stage (modules A1-A3), construction (A4-A5), use (B1-7), and end-of-life (C1-C4). Reuse, recycling, energy productions and similar processes (stage D) are considered outside of the system boundary, and are thus regarded as optional calculations [Standard Norge, 2018].

The LCA calculator program Reduzer will be used to calculate the global warming potential (GWP) of the final design. This will be compared to the benchmark for care homes in Norway (see chapter 11.1.5), as no benchmark exist for psychiatric institutions. The LCA will have a study period of 60 years, and follow the NS3720 scheme for calculations, using gross area (BTA) as the functional unit. Both building materials, groundwork, construction and interior and exterior finishes will be considered, but furniture, equipment and infrastructure for plumbing and electrical systems will not be included in the calculation.

LCA, GWP and embodied carbon have become the main ways of assessing a building's sustainability today, because it allows stakeholders to see the total environmental impact of their building. However, an LCA of a building design requires several assumptions and might vary greatly from the final building's actual emissions. The results depends on the data available, and quite often products included in the design and calculations ends up being swapped in the construction stage (either because of availability or change of heart). The LCA also fails to account for several other aspects of sustainability, such as biodiversity, microplastics and waste generation.

Energy Use

A rough estimate of the energy use of the building is often included in LCA's and Reduzer can calculate the CO2 equivalents of the total energy use in the use phase. A more detailed energy calculation can predict the actual energy use related to heating and cooling, which can be used as another way of assessing the building's environmental sustainability.

The simulation program Simien can be used to calculate energy used for heating, cooling and ventilation within the building. However, calculating the total energy use is a time consuming process, and will not be done as a part of this master thesis. Instead an estimated calculation based on the building parameters will be included in the discussion of the solar panels.

3.5 Summary

The methods of quantifying the result of the design along with biophilic design principles, design for mental health, environmental psychology and sustainable design frameworks helped refine the design goals presented in the Project Brief. The following assessments were performed on the final design: Biophilic Design assessment using the Biophilic Interior Design Matrix, Daylight conditions within selected rooms and the courtyard, Solar radiation and PV performance, HIPAT assessment of levels of privacy, Isovists from selected points within the project, and LCA. The trade-offs and assessment are discussed in part 4 of the Design booklet.

Chapter 4

Mental Health Treatment in Norway

This chapter provides background information about mental health treatment in Norway. It contains an introduction to the Norwegian healthcare system as well as the services they offer, and the current challenges and shortcomings.

4.1 Base Structure of the Norwegian Healthcare System

General Heath Practitioner (GP) | Fastlege

Mental health treatment in Norway usually starts with your general practitioner. The general practitioner is responsible for the patient receiving adequate help, whether it is physical or psychological. After they have established the needs of the patient they provide the necessary treatment or referrals to the relevant institution and/or services such as hospitals, psychiatric care, rehabilitation or other treatment facilities with medical specialisations. These are also known as *'Spesialisthelsetjenesten'* (The specialist health care services) [Regjeringen, 2023]. There is also the option to apply directly to a private facilities whereby referrals are not required and which often provides a shorter waiting time. The prices, however, reflect the availability and are often more than twice the amount of the public service fee.

Urgent Care | Legevakt

Urgent care is a medical unit open 24h with an assigned GP, located at the hospital. Urgent care is primarily used for acute medical attention that does not require the need of an ambulance team but which is severe enough to require immediate care. The patients are prioritised based on the severity of the injury and do not have an assigned time spot [Regjeringen, 2023].

District Psychiatric Hospital | Distriktpsykriatisk Sykehus (DPS)

District psychiatric hospitals (DPS) are polyclinics specialised in the treatment of patients suffering from minor to major psychological disorders and consists of several treatment services based on severity.

Facilities within DPS

- Short-time polyclinics (Korttidspoliklinikken)
- Psychiatric daycare centre (Psycriatisk døgnenhet)
- Acute psychiatric care (Akuttpost/PAM)
- Psykriatisk akuttmottak (PAM)

A referral is usually needed from your GP to access treatment from these facilities [Regjeringen, 2023].

Child and Youth Psychiatric Policlinic | Barne- og Ungdomspsykriatrisk Poliklinikk (BUP)

BUP is a psychiatric treatment programme/service for children and youths from the age of 0-18. BUP works in collaboration with the child protective services (CPS) and the educational psychology services (PP-Tjenesten). This service operates primarily through polyclinics and offers no or few possibilities to get admitted to wards and greatly involves the patient's family and educational institution. This service typically involves a diverse team of healthcare workers with variation in educational background.

Ambulance Service

The ambulance service is a part of the special health services (spesialisthelsetjenesten) whereby the treatment usually starts before the patient reaches the hospital [Regjeringen, 2023].

Hospitals

Hospitals are short- and long term treatment facilities for both somatic and psychological conditions. The patient has the freedom to choose at which hospital they want hospitalisation. However, certain hospitals have different specialisations within certain medical

treatments. Hospitals can be both public and private [Regjeringen, 2023].

Rehabilitation

Addiction and physical rehabilitation can be provided at rehabilitation facilities or as a service provided by the local council [Regjeringen, 2023].

4.2 Psykiatrisk Døgnenhet

The Norwegian Psykiatrisk Døgnenhet is an inpatient ward where the patients are usually admitted voluntarily [Regjeringen, 2023]. This means that the patients generally will have less severe mental health issues than at other inpatient wards, and thus require fewer security measures [Regjeringen, 2023]. The goal of the Psykiatrisk Døgnenhet is to provide intensive care and a break from society where you have the best facilitation for healing.

4.3 Challenges Within Psychiatric Healthcare Today

The psychiatric unit DPS has the main responsibility for treating mental illness in patients [Riksrevisjonen, 2021]. To gain access to this service the patient requires a referral from their GP. If, however, the psychiatric unit evaluates the need for treatment as 'not urgent' or treatment is being prioritised for more 'acute' patients, the application will be declined and the local council will be further responsible for the patient care [Riksrevisjonen, 2021].

1 of 5 referrals for mental health treatment, gets declined with up to half of the received applications [Riksrevisjonen, 2021]. It is discussed whether the high declination rate is a result of miscommunication on responsibility between the psychiatric care and local council [Riksrevisjonen, 2021].

The waiting time for successfully referred patients is also showing inadequate/insufficient. The average waiting time for adults was an average of 27-77 days of the estimated 45 days. For children and teenagers, it is an average of 28 days of the estimated 40 days, while in the most critical regions, the average is 77 days [Riksrevisjonen, 2021].

Today's goal for psychiatric help is that the primary treatment for mental illness is to be moved from daycare units (døgnenhet) to policlinics and treatment of patients outside medical facilities, as this shows beneficial for certain patient groups as well as being more economically efficient [Riksrevisjonen, 2021].

Despite the current goals, *Riksrevisjonen's* (The national revision of Norway) survey from 2021 *'Undersøkelse av psykiske helsetjenester'* (Survey of psychiatric healthcare services), reveals that people who suffer from mental illness do not receive adequate treatment or help when needed. The results further showed that;

- The amount of treatment differs between the regional health facilities

- Access to mental health treatment varies between city councils
- Teens suffering from both mental illness and addiction do not receive adequate help/treatment
- 'The Golden Rule' that mental health and addiction should be prioritised before somatic health care, is not fulfilled
- The required work to increase and establish new knowledge in mental health care is not fulfilled
- Many local councils and polyclinics do not provide adequate user participation or involvement of next of kin in mental health treatment
- Many leaders do not actively try to systematically improve workplace quality
- The funds received from the state could be better utilised to improve service

The report also found that the healthcare workers of mental health patients wished for more opportunities to provide treatment outside the polyclinics and hospital environment [Riksrevisjonen, 2021].

Riksrevisjonen is the Norwegian parliament's audit agency that serves to conduct auditing, monitoring and guidance of different services [Riksrevisjonen, 2021].

The Price of Mental Health

Compared to physical illnesses such as cancer, COPD/kols, diabetes and cardiovascular disorders, mental health prevention and treatment receive very little funding and priority[Jackobsen and Spilde, 2023, Shepley and Pasha, 2017]. This is critical as mental illness has an earlier debuted (average debut of age 15) with long-term effects on life quality [Jackobsen and Spilde, 2023]

Today, the main public services available without a referral target milder states of depression and anxiety, usually, the type experienced in response to a certain event or life situation [Trondheim kommune, 2024]. A person experiencing more moderate or complex symptoms will unlikely receive adequate help which may cause further distress [Trondheim kommune, 2024]. The more complex patients can in some cases be rejected due to the severity of the symptoms, again because of lacking capacity and priority [Trondheim kommune, 2024, Riksrevisjonen, 2021].

While the report conducted by Riksrevisjonen pointed to positive numbers in the reduction of bed posts, there is still a lack of feedback within the public healthcare system.

Lack of prevention measures increases the number of patients which fills up the health care capacity, causing many patients to either stop seeking treatment or receive inadequate help as treatment gets compromised. This contributes to another problem known as *'revolving door syndrome'*.

Revolving door syndrome

Revolving door syndrome is a phenomenon that is used to describe patients with long-term or complex mental health conditions, whereby the facility fails to provide treatment efficient enough for the patient to function or manage outside the treatment facility/with tools on their own. These patients have high levels of re-admission and discharge. The typical age group for these patients are between ages 16 to 45 and is primarily caused by lack of funding for the institutions

Revolving door syndrome appears to be a worldwide phenomenon/problem despite differences in healthcare systems and has been shown to increase after deinstitutionalisation which increased by the second half of the 20th century [Gobbicchi et al., 2021]

4.4 Research v.s Patient and Staff Experience

A larger project and study on revolving door patients - *'Svingdørprosjektet'* - by Øyane distriktpsykiatriske senter (DPS), Askøy kommune, Øygarden kommune and NAV Region Vest, showed that many patients felt distressed because of lack of resources available after working hours [Senneseth et al., 2022].

This were further reflected in the statistics on time of admittance, whereby 76% of the patients were admitted between 16 and 08 in the morning [Senneseth et al., 2022]. The reason being that most get an increase in symptoms after the day has 'ended' with a reduction in distractions and social interactions [Senneseth et al., 2022].

Patient and staff experiences were also documented as part of the report where some of the main areas of concern were [Senneseth et al., 2022]:

- High fear of rejection tend to result in suicide attempts or serious self-harm in order to get help, especially for frequently admitted patients [Senneseth et al., 2022].
- Patients express the desire for more control or involvement during hospitalisations both voluntarily and involuntarily [Senneseth et al., 2022].
- Break in treatment plan such as being discharged, lack of appointment availability and sudden change of therapist. This damages the relationship between the patient and the healthcare system and there are high requests for out-of-hours services [Senneseth et al., 2022].
- Generalised treatment plans [Senneseth et al., 2022].
- Patient history and journal affecting opportunities and doctor-patient relationship [Senneseth et al., 2022].

Feedback from users is severely lacking in public healthcare services

Public healthcare questionnaires are often conducted by larger organisations on behalf of

the government and target larger patient groups than individual user experience [Chrysikou, 2014, Riksrevisjonen, 2021]. The surveys often involve a limited study or targeted group while the questionnaire itself tends to operate with scales and provide few or no semi-structured questions [Chrysikou, 2014, Chrysikou, 2019a, Shepley and Pasha, 2017, Riksrevisjonen, 2021, Folkehelseinstituttet, 2023]. This is likely to cause patients and health-care workers to leave out important information on experiences, either because there are no areas to fill in such information or because they might not reflect thoroughly upon situations [Chrysikou, 2014].

4.5 Summary

The current psychiatric health care system in Norway faces challenges such as long waiting lists and inadequate treatments. Treatment facilities for mental illness generally receive less funding than those focusing on somatic illness. This results in a problem referred to *'revolving door syndrome'*, whereby patients are dismissed without adequate treatment and keep returning to the system. Feedback from users and providers of mental health services indicates that higher levels of control and agency from the patient's side and more holistic, personally adapted treatment plans must be implemented. However surveys and feedback of the patient's actual experience of the treatment facilities are lacking, and little information exists on how the patients perceive the surrounding environment within the treatment facility and how this affects their experience.

Chapter 5

Psychiatric Architecture - Past & Present

In order to understand the development of psychiatric architecture it seems necessary to include a summary of the history of psychiatric care and design, how it developed over the centuries based on motivations and existing values at the time.

5.1 A Brief History of Psychiatric Architecture in Western Societies

The first formal psychiatric ward or asylum was established in France in 1586, the hospital general also known as 'Hotel Dieu', was described as a hybrid between a prison and an isolation site [Chrysikou, 2014]. The facility mixed both criminals and different patient groups disregarding their diagnosis. The limits of patients that could be admitted were not restricted and it was documented at some point to be more than 8 people per bed [Chrysikou, 2014].

Psychiatric facilities were commonly located in rural areas and are still to this day, however, the reason for placement was different [Chrysikou, 2014]. Today the wards are located in rural areas because of the calming effects and natural environments while in the past the rural location was picked as a safety, measure to keep the general society safe - out of sight out of mind [Chrysikou, 2014]. Therefore, the earliest facilities rarely provided an outdoor space for patients to enjoy and the building typology would often reflect 'confinement' [Chrysikou, 2014]. In these confined buildings, the patients were treated as clutter in claustrophobic facilities lacking both spatial and social organisation. These architectural characteristics would dominate the majority of psychiatric wards from the 1650s up to the 19th century [Chrysikou, 2014].

Conditions gradually improved during the 1700s. Psychiatric wards developed into more

Figure 5.1: *Illustration of York Retreat from 1892 shows the rural location and residential characteristics of the building* [Wellcme Collection, 1892]

organised facilities and cell galleries were introduced, whereby the patients were located along both sides of a narrow corridor for easy supervision [Chrysikou, 2014]. Furthermore, different patient groups were split into separate buildings to reduce crowding and improve safety. Yet, chains and restraints were still widely used [Chrysikou, 2014].

Health and hygiene were also a growing concern within the facilities. This eventually led to the introduction of ventilated hallways and courtyards in the late 1700s [Chrysikou, 2014]. The new arrangements made sure that fresh air could access the patient rooms and improved the general health of the patients [Chrysikou, 2014]. The introduction of the courtyards also allowed the patients to get a sense of freedom as they now had a confined outdoor area with some access to nature [Chrysikou, 2014].

5.2 William Tuke - the Founder of the Modern Asylum

One of the most significant changes in the history of psychiatric treatment facilities began with Quaker William Tuke in 1796 [Chrysikou, 2014, Kibria and Metcalfe, 2014]. Tuke established *'York Retreat'* which became the pioneer project of the modern psychiatric ward [Chrysikou, 2014, Kibria and Metcalfe, 2014].

York Retreat was established as a result of the unexpected death of fellow friend and Quaker Hannah Mills who was admitted to York Asylum, suffering from melancholy

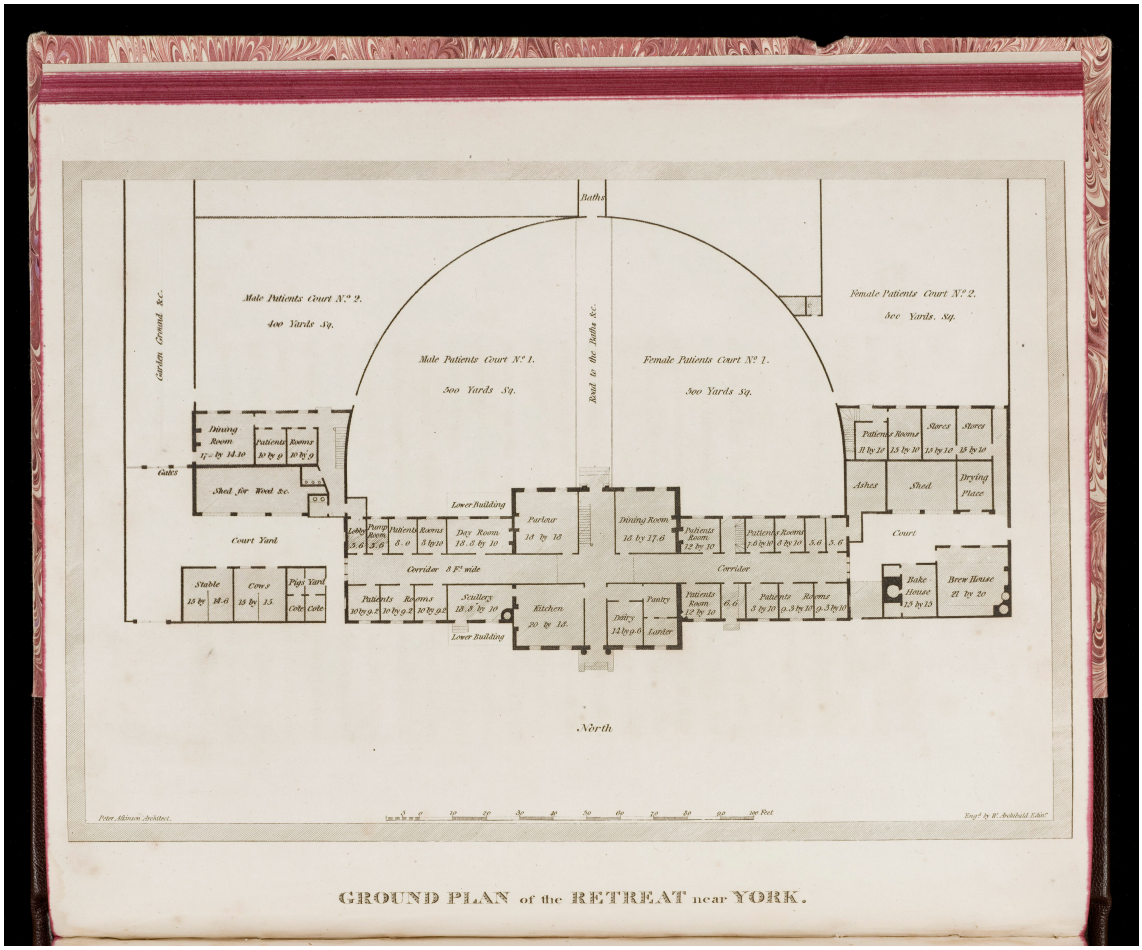


Figure 5.2: *The York Retreat Ground Floor Plan as of 1813* [Wellcome Collection, 1813]

[Chrysikou, 2014, Kibria and Metcalfe, 2014]. Mills was denied any visitors at the asylum while alive, which led fellow Quakers to decide to investigate the conditions of the asylum following her sudden death as they deemed it suspicious [Kibria and Metcalfe, 2014]. The group was shocked as they were met with horrible conditions and the dehumanising treatment of patients. As a result, the Quakers decided to establish their own facility based on Quaker values which led to the planning and construction of York Retreat [Chrysikou, 2014, Kibria and Metcalfe, 2014].

Together, Tuke and architect John Bevans carefully planned York Retreat resulting in a facility that was groundbreaking in its approach at the time both in terms of patient treatment as well as architectural qualities [Kibria and Metcalfe, 2014, Chrysikou, 2014]. In many ways, the retreat was organised in a similar matter to that of a modern psychiatric ward [Chrysikou, 2014],

The site and building were located in the countryside and had a farm-like resemblance with a more residential appearance [Kibria and Metcalfe, 2014, Chrysikou, 2014]. The layout of the building ensured a view to the outside from each patient room and was organised in a manner that attempted to provide more dynamic spaces than traditional asylums [Kibria

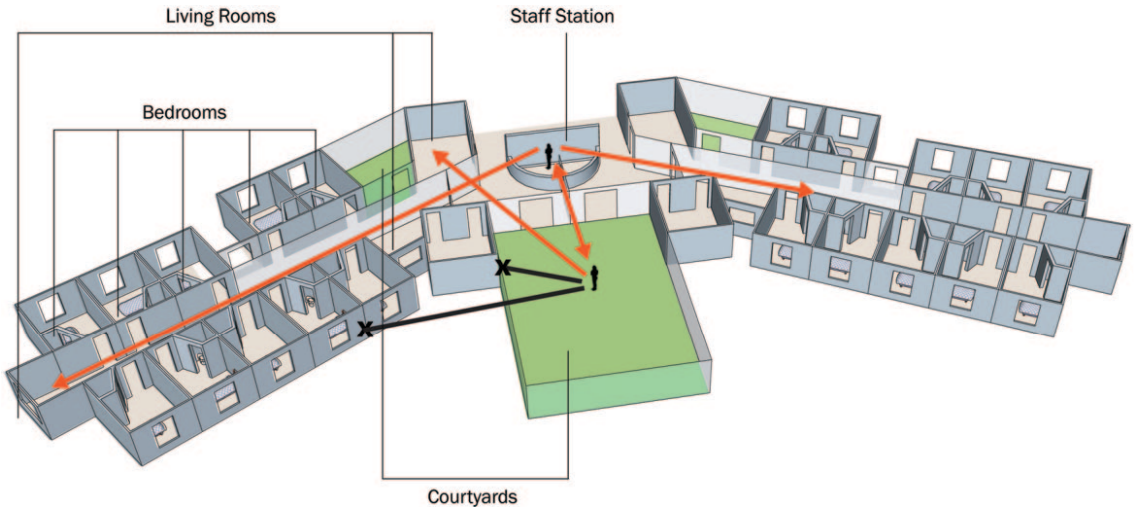


Figure 5.3: *This broad arrowhead floor plan as here presented by Golembiewsky often creates a 'fish bowl' environment, whereby the patients are stationed around a centralised staff facility. This clearly reflects the intentions of control and surveillance and can increase chances of conflict between staff and patients* [Golembiewski, 2015]

and Metcalfe, 2014, Chrysikou, 2014]. Tuke believed a more engaging environment would have a positive impact on the patients[Chrysikou, 2014, Kibria and Metcalfe, 2014].

The social organisation of the retreat were built on the Quaker social system which operates as a family [Kibria and Metcalfe, 2014, Chrysikou, 2014]. This meant taking care of each other both as carers and as patients, depending on the patient's level of functionality [Kibria and Metcalfe, 2014, Chrysikou, 2014]. They divided the patients into smaller groups based on gender and state of mind and it was observed that this had a significant impact on the patient welfare [Chrysikou, 2014, Kibria and Metcalfe, 2014]. Furthermore, Tuke established a supervision system that more actively prevented patient abuse and restraints were forbidden except for that of extreme situations [Kibria and Metcalfe, 2014].

The retreat was ahead of its time with its increased focus on patient treatment and dignity as well as the environmental features of the building [Kibria and Metcalfe, 2014, Chrysikou, 2014] . Because of the importance of Tuke's advocation and engagement in moral treatment, he is often referred to as 'the Founder of the Modern Mental Asylum'[Kibria and Metcalfe, 2014, Chrysikou, 2014].

During the 19th century, the architecture of psychiatric wards prioritised optimising exposure to daylight and control [Chrysikou, 2014]. This led to the development of the broad arrowhead building layout as well as buildings being highly symmetrical and monumental in their design to allow a centralised administration that could easily surveil the patients [Chrysikou, 2014].

5.3 Psychiatric institutions in Norway

Like most countries during the 18th and 19th century, Norway primarily kept 'madhouses' as a way to isolate the mentally ill from the general society [Kringlen, 2004, Chrysikou, 2014]. The practice took a turn in Norway after Frederik Holst and later Herman Wedel Major took a special interest in the matter after witnessing the horrible conditions at the madhouse [Kringlen, 2004]. Major travelled through Norway and Europe to document and create a report on facilities and patient treatments. This led to further changes in Norway's psychiatric treatment and later the opening of Gaustad Asyl in 1855, Norway's first state asylum. The asylum kept 250 patient and prioritised more humane treatments such as baths, ointments and music therapy rather than restraints and opiates [Kringlen, 2004].

After asylums became a public service the challenges of economics and capacity grew as a problem and peaked during the 1950's with 50% overcapacity [Kringlen, 2004]. Overcapacity continued as a problem for psychiatric hospitals in Norway until the 1970's, when outpatient clinics became developed as well as the integration of psychiatric wards as part of the general hospital [Kringlen, 2004].

5.4 Psychiatric Care Today

Throughout the 20th century until today, the focus has gradually changed from in-patient care to outpatient- or ambulant care community-based care [Riksrevisjonen, 2021, Shepley et al., 2016]. This means that the treatment of patients is moved to dedicated residential facilities [Shepley et al., 2016, Chrysikou, 2014]. This allows for more self-sufficiency and autonomy among patients and provides a more efficient model in terms of care [Riksrevisjonen, 2021, Shepley et al., 2016]

As for Norway, the characteristics of mental health institutions seem to follow the same as the rest of Europe [Kringlen, 2004]. The major differences between the Scandinavian countries and most of Europe were their early and extended interest in normalcy starting in the 1970's as part of the treatment plan and still holds a strong position today [Chrysikou, 2014, Kringlen, 2004].

Design-wise the architecture of psychiatric wards has changed very little up until recent years [Kringlen, 2004, Chrysikou, 2014]. Despite the negative associations found in traditional psychiatric wards, newer wards have been criticised for their lack of bigger common spaces and lack of accessible outdoor spaces, especially in confined wards and where the patient is exposed to a high number of strangers[Chrysikou, 2014, Shepley et al., 2016, Batrakova, 2019]. There are however signs that the times are changing with the completion of the new psychiatric hospital in Kristiansand. The goal of the project is to provide a role model for future psychiatric facilities both in terms of design and patient treatment [Hennig Larsen, Sykehusbygg, Skanska, Sørlandet sykehus , 2024]. One can expect that

this will have a great impact on future hospital architecture. More information on the Kristiansand project can be found in the 'Case Study' chapter.

5.5 Summary

The first psychiatric hospitals were remote and closed off, removing patients from society. Modern-day hospitals are often located in the city, providing a location closer to the rest of society, but in some cases with an increase in perceived separation due to the patient's restrictions of movement within the building. Norway has since the 1970s had a focus on maintaining the patient's sense of normalcy within treatment, but modern-day facilities still lack quality outdoor and common areas, where patients can socialise and be involved in recreational activities during their stay.

Chapter 6

Design for Mental Health

This chapter focuses on the current design trends, recommendations, challenges and possibilities of psychiatric architecture.

Institutional and/or hospital spaces today are holistic, person-centred environments designed to heal patients in the best, most efficient ways possible. Through the use of advanced functions and methods, they are programmed to maximise patient capacity while keeping costs at their minimum [Schaumann et al., 2016, Berg, 2023, Brochmann and Wang, 2022]. In addition, the hospitals need to accommodate patients and staff with variable and often opposite needs. This combination of functions, people and services makes hospitals one of the most complex building types to design for architects[Schaumann et al., 2016, Batrakova, 2019].

With the increased focus on patient-centred care comes the advantage that patients are now more active contributors to their treatment plans [Schaumann et al., 2016]. For psychiatric care, this is an important step as patients often know what works for them in terms of de-stressing, triggers and motivators, but are often scared to voice their concerns or wishes due to feelings of inferiority [Batrakova, 2019, Schaumann et al., 2016, Berg, 2023].

Together with user experience, the change in approach is further reflected in the environment of the buildings. Patients who feel a higher sense of choice, control and dignity have proved to show lower levels of stress and agitation as well as having a shorter recovery time [Chrysikou, 2014, Shepley et al., 2016]

. The change in treatment plans has also impacted the design of psychiatric facilities. More attention is given in newer buildings to the concepts of normalcy and home-like environments, still, the majority of existing facilities are dominated by a 'clinical environment' [Chrysikou, 2014, Shepley et al., 2016].

Typical design features found in psychiatric environments are [Chrysikou, 2014]:

- (Common) spaces are being too smalls which increase the risk of crowding and feelings of vulnerability/unsafety amongst the patients. This heightens the risks of confrontations and aggressive behaviour
- Neutral colours (with white being the most common colour for walls and ceilings).
- Long straight corridors that are hard to navigate due to lack of characteristics or 'landmarks'.
- furniture is often fixed or practical with 'public' features (easy to clean, short lifespan, low level of comfort (discourage long periods of sitting) etc.
- overly tidy, while tidiness is good,

6.1 Design Recommendations

While the domestic environment has proved beneficial, there are also studies that an institution with too many domestic features creates a new set of problems [Shepley et al., 2016, Batrakova, 2019, Chrysikou, 2014, Connellan et al., 2013]. There is therefore a need for fine balance between the two, which is what make the design process so intricate [Schaumann et al., 2016]. Too many domestic features can prohibit the recovery time of the patient as they might feel too comfortable in their environment, while too many institutional features are likely to foster feelings of alienation and restlessness [Shepley et al., 2016, Batrakova, 2019, Chrysikou, 2014, Connellan et al., 2013]. Therefore balancing the two is essential to create the optional healing environment. Ways to measure domestic vs clinical features in architectural design are further investigated in the 'Quantification' chapter in this booklet.

Design Recommendations for Psychologist Offices and Therapeutic Spaces

In 1998 architect and professor Kathryn H. Anthony surveyed the environment of therapy psychologist offices as it has been criticised that most research on therapeutic environments is lacking insight on the effect of psychologist offices in terms of design and client consideration [Anthony and Watkins, 2007].

What further distinguishes a psychologist's office from primarily therapeutic spaces is the more medical transactional relationship between psychologist and client [Anthony and Watkins, 2007]. A successfully combined office and therapeutic environment increases feelings of credibility as well as feelings of safety and comfort [Anthony and Watkins, 2007, Batrakova, 2019]. The majority of psychologist offices were careful to present a seating situation that presented the client and carer as equals, which in most cases showed a positive impact on patients. Still, there would be scenarios whereby the client would feel

the 'need' to pick the less comfortable arrangements as a result of inferiority which could negatively impact the session and relationship between the two [Anthony and Watkins, 2007].

Results from the study showed that the layout and features of the therapy room play an important part in how the patients responded, behaved and experienced the psychology sessions[Anthony and Watkins, 2007]. It was important for the psychologist to feel in control of the environment and to allow the primary focus to be on the session [Anthony and Watkins, 2007, Batrakova, 2019]. Therefore they would carefully plan the environment in such a way that most personal items were facing the psychologist while the more therapeutic and professional items were directed towards the client, providing a balanced environment between formal and informal [Anthony and Watkins, 2007]. Lastly, the report gathers twelve key criteria to consider when designing a therapy room.

Anthony's 12 design considerations for therapy rooms [2007]

- **Location:** Convenience of getting there. Surrounding environment, safe/unsafe, high traffic (increased stress)
- **Building Typology:** Does the building display a homely or institutional image?
- **Degree of Visibility:** Patient requirements; do they feel the need to hide or be less visible? Do they require a full overview of the therapy room and the therapist?
- **Restroom Distance:** A nearby restroom can provide patients with a location to 'hide' or receive a necessary break from therapy, reducing the stress of having to search for or walk long distances to decompress the potential buildup of stress
- **Privacy (critical):** Can the discussions in therapy be heard from outside of the office, e.g in the hallway? Can noise or sessions be heard from adjacent rooms? (noise barrier)
- **Visible Clocks:** Not knowing how long they have been attending the session can cause some patients to feel stressed about the pace of the session, whether they were suddenly out of time or if they rushed through it and thereby left important details behind.
- **Exits & Access Points:** Does the number of entrances and exits provide a sense of security or harm to the patient or therapist? A therapist in the survey previously mentioned expressed a desire for a direct exit from her therapy room whereby the patient would not have to cross through the waiting/common areas in an emotional or fragile state in the presence of strangers.
- **Furnishing:** How are the therapist and patient located in relation to one another? Facing each other? Next to each other? What organisation would be most beneficial

for the type of patient in treatment? Choice of furniture and impact on/desired behaviour

- **Lighting:** Light conditions within the therapy room; Too bright? Too dim? Certain patients are likely to desire different types of lighting levels depending on their condition. Who will be in control of the lighting and where are the lights located?
- **Views:** What views are available to the patient? View towards nature shows healing effects
- **Plants:** Are there plants in the office? What condition are the plants in? Plants in poor condition can reflect negatively on the therapist (How can you care for me if you cannot care for your plants?)
- **Artwork:** Colour, theme, texture and subject are all likely to affect the patient in certain ways.

There have been studies of the psychiatric environments in Norway as well. Architect Knut H. Bergsland specialised in psychiatric design [Bergsland, 2020]. Through his research, Bergsland emphasises the importance of first impressions for patients; being admitted and arriving at a psychiatric hospital plays a major part in the future expectations and experiences of the patient during their stay [Bergsland, 1991, Chrysikou, 2014]. It was crucial to the patients, not to be treated as second-rate people;

"...the patients must be met with a sense of status and mastery" [Bergsland, 1991].

This means that the materials and the design should be of a quality that does not remind the patients that they're locked in or tucked away somewhere outside of the rest of society [Bergsland, 2024, Shepley and Pasha, 2017]. High-quality interiors provide a greater sense of dignity than materials end furniture that looks like they could easily be replaced, a critical lesson on symbolic importance in the psychiatric environment [Burns et al., 1998, Barrera et al., 2019, Chrysikou, 2014].

"Et opphold i en psykiatrisk enhet bør, i den grad det er mulig, bidra til at pasienten, uansett diagnose og funksjonsevne, gjenvinner mest mulig av sin realitetssans og normalitet og forberedes på ny uavhengighet. Dette gjelder døgnplasser så vel som poliklinikker og andre aktuelle enheter. Både bygninger og personale må bygge oppunder normaliteten" - Knut H. Bergsland, "Arkitektur I psykiatriske sykehus", Journalen Nr 1 2020.

"A stay in a psychiatric ward should, as far as possible, contribute to the patient, no matter the diagnosis or ability to function, regaining as much as possible of their sense of reality and normalcy and preparing for new independence. This goes for inpatient as well as outpatient wards and all other relevant wards. Both buildings and personnel must build up this sense of normalcy." – Knut H. Bergsland, "Arkitektur I psykiatriske sykehus", Journalen Nr 1 2020. Translated by Maren Lovise Øby.

To get a deeper understanding of the patient experience, Bergsland got himself admitted to acute psychiatric care [Bergsland, 1991]. During his stay, Bergsland had interactions with (unaware) staff and patients [Bergsland, 2024]. During his stay, Bergsland learned about how a patient had 'escaped' from their room, claimed over the roof and entered through the main entrance (to prove that he could escape if he wanted to) as a way to establish a sense of control [Bergsland, 2024]. Another person turned parts of his room into a small performance stage, emphasising the importance of personalisation during their stay. Both these examples show the importance of experienced environmental control for patients[Bergsland, 2024]

These studies show that a greater sense of freedom and safety through physical distance and expanded personal zones is crucial for patients suffering from different types of mental illnesses [Bergsland, 2024, Batrakova, 2019, Chrysikou, 2014].

One way to accommodate different patient needs could be to design common areas that allow multiple conversations and activities to take place at the same time while allowing staff to maintain a certain overview of the patients in a way that limits the feeling of surveillance [Bergsland, 2000, Batrakova, 2019, Chrysikou, 2014]. Equally, the same areas *must* offer an opportunity for anxious or agitated patients to retreat and maintain overviews of stressful situations. Spaces should be designed in a way that prevents, diverts, and shelters restless behaviour and disturbances [Bergsland, 2024, Shepley et al., 2016]. Further, having bedrooms and social spaces that allow for flexible layouts of furniture helps increase this feeling, as well as making them feel more at home by increasing the use of domestic-like features [Bergsland, 2024, Batrakova, 2019].

Additionally, Bergsland highlights the importance of a set of criteria named the five S's of psychiatric design [Bergsland, 2020]. The points provide a short list of crucial elements to consider when designing a psychiatric unit.

The Five S's of Psychiatric Design;[Bergsland, 2020]

- **Size** - The sizes must be manageable both for patients and for staff. Patients likely have different size requirements based on conditions, e.g. a schizophrenic might require more space as a result of hallucinations (both visual and auditory), while staff requires a space that can easily be overviewed and which allows for "gentle" intervening in case a situation arises.
- **Structure** – Organisation and orientation within the facility.
- **Siting** – building context and location. Patient wards should preferably be on the first floor of the building to allow close contact with the external environment
- **Safety and security** – Critical to implement, but not to the extent whereby it begins to feel alienating. Homely furniture and material choices as well as providing the patients with trust and a sense of control are an important part of the path to

recovery

- **Staff** – Enough staff but also a building/floor plan that allows easy access and navigation both day and at night, it is, however, important to avoid the feeling of surveillance.

These criteria provide the fundamental guidelines for psychiatric design.

A comprehensive literature review on ward environments *'Stressed Spaces: Mental Health and Architecture'*[2013] was carried out by PhD candidate and lecturer in Arts & Social Sciences, Kathleen Connellan et.al. The literature review encapsulates the main key points of existing research on ward design and environments and results in the categorisation of 13 themes that seem to be the main consideration in psychiatric design [Connellan et al., 2013].

Conellans findings are also further supported by more extensive publications on the topic such as *'Design for Mental and Behavioral Health'* [2016] and *'Mental and Behavioral Health Environments: Measurement of Building Performance'* by Shepley et.al [2017]. as well as 'Architecture for Psychiatric Environment and Theraputic Spaces' by Chrysikou both conducting detailed research and rview on the field [Chrysikou, 2014, Shepley et al., 2016, Shepley and Pasha, 2017].

The 13 themes of psychiatric environments as presented by Connellan et.al [2016]; **Themes are expected to overlap*

1. **Security/privacy**
   targets patient, staff and visitor experiences in terms of security, violence, privacy, and overcrowding. Wards today are more condensed which can increase feelings of agitation as well as feeling unsafe. To improve the spatial quality without increasing the size It is necessary to provide clear distinctions between areas through furniture and to maximise natural light wherever possible. The level of autonomy and patient dignity is also crucial and needs to be carefully balanced. Measures need to be in place to prevent and secure patients from self-harm or destructive behaviour but it is equally important that the person feels a sense of control [Connellan et al., 2013]

   - Non-medical furniture
   - Foster personalisation (No uniforms, allow personal items/decor, moveable furniture in patient rooms etc.)
   - Crowding increases levels of stress and risks of aggressive behaviour
   - Provide distinct interior features to define use of area (e.g colours, types of furniture etc.)
   - Standard patient rooms (No difference in size or furniture design)

- Provide 'escape' routes from common areas to allow patients to retreat from stressful situations without trouble

2. **Light** Light and especially access to natural light play a key importance, not only for mental health patients but for people in general. Sun and natural light control our bodily clock or *circadian rhythm* and help the body regulate its functions as well as providing us with information about the environment. It has been proven in both somatic and psychiatric care to reduce the number of hospitalisation days. Daylight reduces the chances of errors in physical tasks (e.g. medication) and provides us with visual information about the environment. Benefits:

   - Reduces the number of errors
   - Positive effects on depression
   - Increase feelings of safety
   - Pain and stress relief
   - visual stimuli (change of day, change in colours, weather, seasons etc.)
   - Impacts sleep patterns and regulates hunger
   - Risks of glare

3. **Theraputic Milieu** The therapeutic milieu targets features that overlap between architecture, environmental psychology and rehabilitation and practice. So primarily how the building design and its operational functions work together [Connellan et al., 2013].

   - Calm/simple textures and colours in materials and decorations
   - Comfortably sized bedroom
   - Views to nature either directly or indirectly through photos and art
   - Noise reduction, especially repetitive or unnatural sounds
   - Encourage everyday tasks
   - Thermal comfort and thermal control
   - Lighting control

4. **Gardens** One of the most desired and valued features amongst both staff and patients. Allow both to decompress and relax from stressful situations. Staff with access to nature express higher satisfaction and mood at work. Outdoor spaces were primarily used for walking, sitting and eating as well as for alone time [Connellan et al., 2013]. The topic of nature, plants and greenery will be further elaborated on

in the two following chapters. Summary of some of the garden priorities to consider in design;

- Open space
- Therapeutic/sensory garden
- Stress relief
- Sensory stimuli (sight, smell, sound, texture)
- Accessible gardens
- Potential for gardening
- Should provide for different types of seating
- Provide outdoor activities
- Multiple access points
- Provides some level of privacy (trees, bushes etc)
- Provide different levels of landscaping complexity and variety

5. **Architectural Impact on Mental Health Outcomes**
   With its big overlap with research on therapeutic milieu, architectural impact on mental health overlaps with all 13 themes. The primary characteristic of this theme however will therefore primarily target the more general sense of space, stimuli and environmental aesthetics and build upon the corresponding principles and theories from environmental psychology which will be further elaborated on in the next chapter [Connellan et al., 2013]. Architectural impact on mental health targets;

   - Transactional spaces (spaces that make the patient feel equal to the healthcare workers)
   - Symbolism
   - Foster personalisation
   - Spaces that provide a level of complexity, order and carefully designed interior
   - Single rooms
   - Clean and organised spaces (but not to a clinical point!)
   - Provide sensory stimuli
   - Positioning and number of windows
   - Art

- Plants (highly priority)
- Avoid long corridors
- Enriched corridors
- Open or semi-open nursing stations are preferred by patients but staff feels less safe

6. **Interior Design**
   Interior design has been shown to play a significant part in patient behaviour. Wards featuring high-quality environments are documented to experience less agitation in patients as well as little to no vandalism when compared to older or dated wards. Symbolism is an important feature in institutional design and actively impact user experience and behaviour. Environments that reflect confinement generally experience more uneasiness among patients compared to those who experience environments that incorporate elements associated with home, calmness and normalcy [Connellan et al., 2013]. Further it is encouraged to include:

   - High-quality environment and furniture
   - Domestic furniture over institutional and office-like furniture
   - Way-finding (use colours, textures and 'landmarks' to help navigate the building)
   - Allow semi-private zoning (wooden slats, Japanese shoji screens, (light) curtains, etc.)
   - colour psychology

7. **Psycho-geriatric Design** Psycho-geriatric design has primarily been studied in relation to the growing elderly wave that we are facing. As many elderly experience Alzheimer's and dementia as well as a reduction in both cognitive and physical function, the psycho-geriatric design tends to prioritise security and safety but also areas that target other problematic areas experienced by the elderly such as loneliness, anxiety and depression. This does not mean that it is limited to the elderly population and it provides features that are as relevant for all age groups [Connellan et al., 2013]. These favoured environmental features are;

   - Recreational spaces
   - Easy observation of patients without the sense of surveillance
   - Limit number and use of seclusion units
   - Provide easy routes of patient retreat and allow quick removal of patients in an agitated situation

- Separate bathrooms and bathrooms secluded from areas with high occupation (feels unsafe and uncomfortable having people 'right outside' the door)
- provides good access to public transport
- optimise nurse station location (easy to access and good overview)
- Separate living and treatment spaces
- Allow patients to use and access laundry and kitchen areas
- Encourage zoning that increase risk of social interactions (activity rooms, games rooms, etc.)
- allows for different seating and engagement arrangements (seating that allows patients to just observe, interact or something in between)

8. **Post-occupancy Evaluation**
   Post-occupancy evaluations (POE) are rarely carried out despite being a tool that benefits the patients and the community. POE are also a tool to ensure and improve architectural design and would therefore further benefit the industry if incorporated as part of a firm's routine. It is encouraged to incorporate POE especially wherever evidence-based design is actively used as part of the design process as one can document the user's experience from past and present and work on areas of improvement [Connellan et al., 2013] POE can be further useful in terms of:
   - Document user experience
   - Testing before and after refurbishment or remodelling of a building
   - Combine with evidence-based design (EDB)
   - Semi-structured questions before and after
   - Engage interdisciplinary teams

9. **Design of Nursing Stations**
   Nursing stations are one of the key elements in successful psychiatric design. The nursing station is often centralised and provides the main overview of the patients and ward. Nursing stations tend to increase levels of conflict as patients are often located nearby. Many patients also dislike the obvious privacy of staff. Open nursing stations, however, have provided a positive experience for both staff and patients as long as the staff are provided with other units they can seek out privacy. The open nursing station encourages and improves the patient and staff relationship and interaction as well as increases the sense of respect and improves the transactional relationships between healthcare workers and patients [Connellan et al., 2013].

- Semi-open nursing stations are preferred by patients and decrease patients disrespecting the space
- Provide more private areas for nurses and staff outside of the nursing station to work and relax
- Closed nursing stations prevent social interactions between staff and patients (negative)
- Open or semi-opened nurse stations decreased the number of requests from patients (positive)
- Decentralised stations provide increased feelings of equality between staff and patients, but should still be in close proximity to patient rooms and encourage the desired transactional relationship between nurses and patients

10. **Model of Care**
    Model of care targets the more therapeutic or treatment-oriented aspects of patient stay and design and is the primary challenge in terms of constraint in architectural design for psychiatric wards. It requires intricate design decisions to navigate and negotiate the right balance between safety and security for both staff and patients, as well as it needs to encourage rehabilitation and socialising among patients [Connellan et al., 2013].

    - Provide equally balanced connections between public and private zones
    - Provide or be located near a retail space to serve as an area to practice interactions between the ward community and the wider community
    - Architecture that blends within the urban or local environment
    - interactive walkways
    - Building layout should support and encourage social interactions

11. **Art**
    Few studies on the effects of art in psychiatric environments, however studies where combined patient groups with and without accessibility to art showed a positive effect on stress levels in patients who engaged in creative activities. For decorations, research shows that realistic art is preferred amongst patients as abstract or stylised types of art can increase stress levels and can feel like a real-life manifestation of the patient's symptoms and experiences [Connellan et al., 2013].

    - Creative activities have a positive effect on patients suffering from depression and/or anxiety

- Avoid abstract types of art and stick realism as more abstract or stylized imagery increase stress
- Provide artistic therapy rooms for e.g painting, music or arts and crafts

12. **Designing for the Adolescent**
    Many wards houses patients of a mixed age group. While this could be effective, it can pose negative impacts on the younger or older patients where preferred environments perhaps vary the most. Therefore adequate interior and environmental features should be provided in different areas of the ward to attract and respond to different user needs without the need of too much compromising amongst patients [Connellan et al., 2013].
    - Provide environments targeting different age groups
    - Gyms or opportunities for exercise are favourable
    - Increased need for privacy (e.g single bedrooms and bathrooms)
    - Preference for views towards medium vegetation
    - Housing is preferred over facility stay
    - Increased need for connection and accessibility to the wider community
13. **Forensic Psychiatric Facilities**
    Forensic psychiatric facilities favour privacy, safety and security. It has been shown that there is a correlation between architectural quality and design and a number of patient escapes. Therefore, these types of units focus on keeping smaller facilities with fewer patients. There is a high focus on normalisation and providing enough activities to actively engage patients both as treatment as a security measure. The facilities still offer high levels of privacy but with compromised features[Connellan et al., 2013].
    - Domestic scale
    - Good lighting conditions
    - Encourages skill building
    - Allows for privacy and observation
    - A layout and environment that compromise therapeutic milieu and staff efficiency
    - Provide smaller units/facilities
    - Avoid structures and fittings that can encourage escapes (e.g climbability, breakability and positioning)

6.2 Constraints and Challenges

Figure 6.1: *Design for Domesticity (left) and safety (right) [Batrakova, 2019]*

Mental health services and design have historically been based on risk assessments, often affected by sociocultural context and expectations instead of addressing the needs of the patients [Schaumann et al., 2016, Connellan et al., 2013, Chrysikou, 2014]. While patients today are not viewed as dangerous individuals in the same way as before, there is still a stigma surrounding patients and safety [Chrysikou, 2019a, Connellan et al., 2013].

For architects, the primary challenge in all hospital design is the complex building programme, tight budgets and focus on economic and operational efficiency [Schaumann et al., 2016]. This means prioritising shorter transits and effective layouts for observation rather than providing a dynamic environment for staff and patients [Schaumann et al., 2016, Connellan et al., 2013]. This often results in dense and dark buildings.

While costs, energy and structural performance can be calculated through simulations or models, the behavioural or qualitative aspects are primarily the responsibility of the designer [Schaumann et al., 2016]. However, there is a lack of methods and tools to help predict the outcome of the design process as people's interactions with their surroundings are complex and change over time. Few projects actively involve patients, healthcare workers and staff as part of the design process [Connellan et al., 2013, Chrysikou, 2019a, Chrysikou, 2014]. Therefore, most design decisions are primarily based on assumptions, past experience and commonly known concepts [Schaumann et al., 2016, Chrysikou, 2014]. To further complicate the process, there are no 'quantitative' tools of measurement to help justify the increased costs often following more spacious and dynamic environments that would be favourable to the patients. This often causes the design to prioritise the interests of the staff, taking us back to the question of whose safety or interests are most valued.

While quick access to patients is crucial in psychiatric design, the close location between staff and patients can also be a contributor to increased distress and aggressive behaviour as the patients can quickly feel trapped or surveilled [Connellan et al., 2013, Chrysikou, 2014]. Multiple papers further raise the questions on whether the priority of the design

favours security for staff or safety for patients [Connellan et al., 2013, Brickell and McLean, 2011].

However, designing a larger facility comes with the challenge of increased construction and operational costs. A bigger building requires more staff to effectively keep track of the patients. As there is a general shortage of healthcare workers, this could potentially affect patients as they may not be able to access desired locations or activities as there are none to accompany them [Shepley et al., 2016, Connellan et al., 2013]. Yet, the majority of papers highlight the increased issues of physical and/or experienced crowding amongst patients as one of the biggest concerns in psychiatric design.

6.2.1 Bueaurocratic Challenges

In Norway, all public hospitals are required to put aside 30% of their income to fund future projects or refurbishing while the state provides the remaining 70% [Berg, 2023]. While 30% might not sound like much, the report shows that the majority of hospitals do not have the economy to put off 30%. This is further impacted by the state's expectations of efficiency, both in terms of the building, patients and healthcare workers in general [Brochmann and Wang, 2022, Berg, 2023].

Whenever a new hospital is built, the budget is easily blown and there will have to be cuts and compromises in the design during the construction process [Berg, 2023]. Without the involvement of staff and patients in these decisions, this will likely affect what is perceived as the least (medically) important [Berg, 2023, Brochmann and Wang, 2022].

The financial concerns are further elaborated in the report *'Utredning av finansieringsmodeller for sykehusbygg'* (Survey on financial models for healthcare facilities) carried out by Akademikerne In 2022. Akademikerne is a large collaborative organisation consisting of different Norwegian trade unions [Akademikerne, 2023].

The report investigates the existing challenges and proposes possible solutions for the existing financial and investment models for hospitals [Brochmann and Wang, 2022]. The report points to the main challenges being the hospital enterprise (helseforetakene) is provided with limited financial flexibility which prevents them from sufficiently prioritising long-term goals [Brochmann and Wang, 2022].

"Kuttene kan gå utover både arbeidsmiljø og produktivitet, fordi sykehuset blir lite og uhensiktsmessig, sier Lise Lyngsnes Randeberg, leder i Akademikerne" [Berg, 2023]. Quote translated by Miriam K. Kolstad.

"The cost of cuts can impact both work environment and productivity, as the hospital becomes smaller and more impractical" - Lise Lyngsnes Randeberg, leader of Akademikerne [Berg, 2023].

The report concludes in a proposal of six financial models that could greatly improve exist-

ing financial models without posing negative impacts on existing motivators and liability within the health sector. The main proposals suggest:

- - Extended access to loans that allows for longer payback period and lower down-payments.
- - A national investment plan with supplemental funding
- - Access to allocated quality funds depending on objective criteria

Whenever cuts needs to be made in the healthcare sector, psychiatry is one of the primary departments affected. They have the most stable and predictable budgets and number of patients [Berg, 2023]. The psychiatric patients are also the quietest ones, meaning there will be fewer protests in response to cuts [Berg, 2023].

6.3 Summary

Patients suffering from mental illness may require different physical conditions than "healthy" persons. Particular attention must be paid regarding social interactions and personal space, as well as balancing openness and sight-lines with feelings of surveillance, as well as personal freedom, safety and security. The design should accommodate both therapy and recreational activities, as well as make sure that the patients don't experience a lack of social status while admitted. Instead, the environments must be dignified and offer a sense of freedom that helps facilitate the patient's sense of self-worth and self-esteem. This requires more patient-focused design and in many cases more expensive solutions than what is the current practice. Due to the lack of evaluation of user experience and involvement within the planning process, these requirements are often offered less priority than "medical" requirements.

Chapter 7

Biophilia

This chapter contains a description of Biophilic Design within the architectural discipline, and the main design strategies applied.

7.1 The Biophilia Hypothesis

The term *Biophilia* was first introduced by German-American psychoanalyst Erich S. Fromm in his book *'The Anatomy of Human Destructiveness'* in which he defines the term as *"...the passionate love of life and of all that is alive; it is the wish to further growth, whether in a person, a plant, an idea, or a social group"* - Erich Fromm, 1973 [Fromm, 1973]. Later the term was popularised through biologist Edward O. Wilson's book *'Biophilia'*, whereby Wilson further elaborates on the idea of human's inherited gravitation, connectedness, and love towards nature [Kellert et al., 2008]

7.2 Biophilic Design in Architecture

Biophilic Architecture focuses on sustainable development and a union between nature and architecture. In short, it is a field within sustainable architecture that uses principles found within nature, as well as nature itself, to create buildings that are good for both the humans using them, and the local ecosystem [Kellert, 2015].

In a modern society, where the built and natural environments are kept separate, it is increasingly necessary to reunite the two. Doing this requires the paradigm shift that Kellert refers to as *"restorative environmental design"* [Kellert et al., 2008]. Through design solutions inspired by nature, we can achieve good indoor environmental quality, in addition to the many health benefits from being in nature (as well as a reduction of the negative symptoms one finds among people who tend to stay within modern architecture, such as stress and headaches).

The practice of Biophilic Design consists of *'Direct Experiences' of Nature*, *'Indirect Experiences' of Nature* together with Experiences of Space and Place [Kellert and Calabrese, 2015]. *Direct experiences of nature* refer to the natural light, air, water, plants, weather, natural landscapes, and ecosystems that are incorporated into the spaces designed. *Indirect experiences of nature* on the other hand are images of nature, refined natural materials, colors typically found in nature, mobility and way-finding, cultural and ecological attachment to space, simulating natural light and air, naturalistic shapes and form, evoking nature, information richness, natural geometries, biomimicry, and age, change and patina of time.

Kellert defines 5 conditions for the effective practice of Biophilic Design [Kellert, 2015]:

1. Biophilic design emphasizes human adaptations to the natural world that over evolutionary time have proven instrumental in advancing people's health, fitness, and well-being. Exposures to nature irrelevant to human productivity and survival exert little impact on human well-being and are not effective instances of biophilic design.

2. Biophilic design depends on repeated and sustained engagement with nature. An occasional, transient, or isolated experience of nature exerts only superficial and fleeting effects on people, and can even, at times, be at variance with fostering beneficial outcomes.

3. Biophilic design requires reinforcing and integrating design interventions that connect with the overall setting or space. The optimal functioning of all organisms depends on immersion within habitats where the various elements comprise a complementary, reinforcing, and interconnected whole. Exposures to nature within a disconnected space – such as an isolated plant or an out-of-context picture or a natural material at variance with other dominant spatial features – is NOT effective biophilic design.

4. Biophilic design fosters emotional attachments to settings and places. By satisfying our inherent inclination to affiliate with nature, biophilic design engenders an emotional attachment to particular spaces and places. These emotional attachments motivate people's performance and productivity and prompt us to identify with and sustain the places we inhabit.

5. Biophilic design fosters positive and sustained interactions and relationships among people and the natural environment. Humans are a deeply social species whose security and productivity depend on positive interactions within a spatial context. Effective biophilic design fosters connections between people and their environment, enhancing feelings of relationship, and a sense of membership in a meaningful community.

To summarise; biophilic design aims to utilize the patterns and functions found in nature which further can be translated into an architectural language [Kellert et al., 2008]. In the book *'Biophilic Design the Theory Science and Practice of Bringing Buildings to Life'*, Kellert presents two dimensions and six design element categories that can serve as a framework for biophilic design

Dimension 1: Organic/Naturalistic dimension

The first dimension describes objects or structures within the built environment that reflect or represent the relationship between humans and nature whether direct, indirect or symbolic.

Dimension 2: Place-based/Vernacular dimension

The second dimension defines the connection between the built enviornment and the local context, culture and ecology. Whether it responds and contributes to the identtity of the people and space that it is located in.

Design Element Categories

- Environmental features
- Natural shapes and forms
- Natural patterns and processes
- Light and space
- Place-based relationships
- Evolved human-nature relationships

7.3 Terrapin Bright Green's 14 Patterns of Biophilic Design

The sustainability consultant firm Terrapin Bright Green published a report in 2014 where they summarised 14 patterns of Biophilic Design, as a way of defining Biophilic Architecture. The report also discusses their effects on stress, cognitive functions, and emotions. The design patterns, or elements are placed within three categories: Nature in the Space, Nature Analogues and Nature of the Space [Browning et al., 2014]. The patterns effects on physical and mental well-being is described in Chapter 8.4, while their definitions are presented here.

Nature In the Space

Nature In the Space refers to physical, natural objects within a space. This is typically plants, animals and water, but also refers to breezes, sounds, scents and other elements that cannot be touched, but are nonetheless present within the space.

- *Visual Connection With Nature.* A view to elements of nature, living systems and natural processes.
- *Non-visual Connection With Nature.* Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.
- *Non-Rhythmic Sensory Stimuli.* Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.
- *Thermal and Airflow Variability.* Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.
- *Presence of Water.* A condition that enhances the experience of a place through seeing, hearing or touching water.
- *Dynamic and Diffuse Light.* Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature.
- *Connection with Natural Systems.* Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.

Natural Analogues

Natural Analogues are indirect presence of nature, such as artworks, furniture or ornamentation that include, objects, patterns, colors or shapes found in nature.

- *Biomorphic Forms and Patterns.* Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.
- *Material Connection with Nature.* Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.
- *Complexity and Order.* Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.

Nature of the Space

Nature of the Space refers to spatial configurations in nature and the views within the spaces.

- *Prospect.* An unimpeded view over a distance, for surveillance and planning.
- *Refuge.* A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.

- *Mystery.* The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.

- *Risk/Peril.* An identifiable threat coupled with a reliable safeguard.

The list is adapted from [Browning et al., 2014]

The exact biophilic design interventions should always be adapted to the specific needs and conditions of the project and its users. The scale of the project will also affect which patterns may be implemented.

7.4 Biophilic Design and Sustainable Architecture

While the focus on sustainability in the construction industry has increased, the targets are primarily focusing on limiting the environmental impact of the building, little effort is put into restoring people's relationship with nature within an urban environment [Kellert et al., 2008]. Sustainable buildings today are also very practical in their design and therefore lack qualities one might look for in the desire for building preservation. The desire to preserve a building is greater when there is a stronger connection and identity connected to its design.

7.5 Regenerative Design

While Biophilic Design is often viewed as a less technical and quantified direction within sustainable architecture, Regenerative Design tends to combine ideas from the Biophilia paradigm with technical solutions in an effort to give back to nature. The goal is to not only balance the negative impact of the building, but ending up on the plus side, either through producing a surplus of energy, accommodating for local plants and wildlife or designing for social interactions. Because of the need for change within the construction industry and society as a whole, it's no longer enough to apply isolated measures to reduce a building's footprint. In order to ensure a truly sustainable development more holistic measures must be taken.

"*The sustainability of a living system is tied directly to its beneficial integration into a larger system. The smaller system contributes to the larger systems development and, in turn, receives nourishment for its own.*" – [RegenesisGroup, 2016]. Regenerative development and design – A framework for evolving sustainability.

There are two main approaches to regenerative architecture. Pamela Mang and Bill Reed define regenerative architecture as the "*reconnection of human aspirations and activities with the evolution of natural systems – essentially coevolution*" [Mang and Reed, 2012], and Christina du Plessis formulate two questions that make up the regenerative worldview,

"*how can we learn to live in harmony with nature?*" and "*how can our efforts make the world a healthy and life-enhancing place?*" [Du Plessis, 2012]. Shady Attia, on the other hand, states that the aim of regenerative design should be to "*create a virtuous circle, in which the consumption of resources (materials, water, air and energy) in a process is balanced by the creation of products (or by-products) and resources identical in quantity and quality [...] Applied to the field of architecture, the challenge of designing positive impact buildings is to integrate a number of constraints to ensure that the project as a whole will be able, on the scale of its own life, to reproduce and recreate all of its components and the resources it consumed to be built, to perform and to function.*" [Attia, 2018].

Mang and Reeds approach to Regenerative Design has clear references to Biophilic Design. Their design approach is based on three phases: Understanding of place, Designing for Harmony and Co-evolution. Understanding place goes deeper than just contextual factors such as topography, climate, light, and tectonic form [Hes and du Plessis, 2014]. It highlights the importance of a shared connection to place and belonging through questions such as "*What patterns, dynamics, and relationships between physical, human, and natural systems characterize this place? Do they add positive value to the whole system?*" The second phase, designing for harmony, works towards the end goal: a harmonious society and symbiotic relationship with nature. Co-evolution aims to create a balance or mutually beneficial integration (symbiosis) of human society and natural systems [RegenesisGroup, 2016].

Several principles within the Regenerative Design framework presented by Mang, Reed, Hes and duPlessis resemble those found in Kellert and Terrapin's frameworks for Biophilic Design, including:

- Support human and natural co-habitation
  - Shared spaces incorporating nature to provide social interaction opportunities.
  - Increased visual and physical connection to nature.
  - Indigenous wildlife habitats to increase biodiversity.
  - Local food production.
- Building envelope to improve indoor environment and restore local ecosystems.
  - Natural systems in roof/façade to improve IEQ and reduce heating and cooling loads.
  - Surrounding micro-climate mitigation.
  - Building envelope to facilitate habitat connectivity.
- Positive energy exchange with the surrounding built environment.

  - Effective energy management and storage systems.
  - Exchange with other buildings, infrastructure, and the grid.
  - Energy-sharing strategies and initiatives.

- Retrofit for resilient buildings.
  - Building and building components are durable, reversible, demountable, and adaptable where possible to account for changing technologies and climatic conditions.

7.6 Summary

Biophilic Design seeks to implement a love for nature, and integration of natural elements within architectural design. This includes direct and indirect experiences of nature, as well as the experience of the local space and place. The main definitions of Biophilic Design and the elements within it are developed by Kellert and the Think-Tank Terrapin Bright Green. As a sustainable design strategy, biophilic design implements a larger focus on local impact than an emissions-based design approach.

Chapter 8

Physical Environment and Health

This chapter investigates how humans experience and respond to different types of environment.

In order to design a successful psychiatric unit it is important to understand how humans interact and respond to their surrounding environment and how these responses might change when faced with mental illness.

8.1 Environmental Psychology and Architecture

Environmental psychology looks at the relationships between humans and their surroundings. It investigates how we interpret and experience the natural and built environment, how we perceive it as well as our relationship and understanding of space. This further includes social aspects like personal space, crowding, isolation and how we respond to different levels of human interaction. Furthermore, it relates to the places we live and work, how they affect us and how these places can be designed to be better for people and the planet [Gifford, 2012].

The study of how we view space (proxemics), is highly relevant when designing a mental health institution. All humans have a certain requirement of personal space and is what one would consider "my space". The need for personal space might differentiate between culture, mental state and context, personal preferences and health [Bechtel and Churchman, 2002].

American anthropologist Edward T. Hall introduced the theory on proxemics in the 50s after studying people's personal territories during World War II. In his theory, Hall introduced four zones of personal territory [Hall, 1966];

1. Public zone (25 to 12 feet in diameter / 4m-8m),
2. Social zone (12 feet to 4 feet / 1m-4m),

3. Personal zone (4 feet to 1 foot / 0.5-1m)

4. Intimate zone (1 foot to contact / 0-50cm) **Measurements are approximate conversions from feet and inches to metres and centimetres.*

When suffering from mental illness, the sizes of these zones may change as one relates space differently based on diagnosis, triggers and situations. Patients within a mental health facility may feel the need to keep a bigger distance from other patients or staff, often related to an increased need for control [Bechtel and Churchman, 2002, Chrysikou, 2014, Bergsland, 2024]. In the '*Handbook of Environmental Design*' by Bechtel and Churchman, they also describe social relationships that are more situation-specific and revolve around territory. The concepts originate from zoology and are more focused on the physical territory than the individual personal space [Bechtel and Churchman, 2002]. The concepts include;

- **Territory:** A visibly marked area defended by an individual to feel in control of a situation that could pose a threat (non-visual territory). Personal space differs as personal space centres around the body and has invisible boundaries, while territory centres around the home or nest [Bechtel and Churchman, 2002].

- **Individual Distance:** The space between an organism and its kind, helps analyse natural spacing manners [Bechtel and Churchman, 2002].

- **Flight Distance:** Distance between the individual and a potential threat. The distance needed to flee a potentially harmful situation (space invasion) [Bechtel and Churchman, 2002].

- **Distancing:** Increasing the physical distance between individuals to increase the level of privacy [Bechtel and Churchman, 2002].

- **Defend Space:** Physically marked and/or surveilled territory that increases the feeling of safety to its inhabitants (e.g. surveillance cameras, fencing etc.)[Bechtel and Churchman, 2002].

Invasion of personal space or lack of control in an environment often manifests as a type of stress and is a major contributor to both physiological and psychological distress and a key component in many mental health issues [Bechtel and Churchman, 2002, Kaplan and Kaplan, 1989].

In his paper *'Human Adaptation to Levels of Environmental Stimulation'*, Joachim F. Wholwill discuss levels of stress or stressors, primarily through responses to different types of stimuli or stimulus [Wohlwill, 1974]. *Stimulus* can be defined as any internal or external factor, situation or episode that triggers any type of response in a being [Wohlwill, 1974].

Types of under- and over-stimulation [Wohlwill, 1974]

Under-stimulation

- Deprivation of Sensory Stimulation
- Isolation (Deprivation of Social Interaction)
- Confinement (Deprivation or Restriction of Movement)

Over-stimulation

- Sensory overload
- Informative
- Hyperdynamic

'Deprivation of sensory stimulation' (under-stimulation) is the lack of one or multiple sensory inputs whether visual, tactile, auditory or through smell. [Wohlwill, 1974] These are all senses humans use to navigate and collect information about an environment. If enough of these senses are limited we are likely to feel a type of distress and 'insecurity' whether consciously or subconsciously. [Wohlwill, 1974]

A common feeling could be *'Isolation'* which is the lack of human interaction that would normally provide the individual with responses to actions and behaviour and in a way that cause a type of 'arousal' or stimuli [Wohlwill, 1974]. *'Confinement'* could be defined as a restriction in environment, whether physical or social. The under-stimulants mentioned are frequently co-ocurring and are often found in environments such as prisons [Wohlwill, 1974].

While under-stimulation is a lack of sensory input, over-stimulation is the result of *sensory overload* is when noise, visual or physical stimulation is over-activated and typically when ones personal space is being compromised, such as experienced in big crowds, loud environments, rapidly changing visual stimulation and [Wohlwill, 1974, Bechtel and Churchman, 2002].

In 'Attention Restoration- and Stress Recovery Theory' it is discussed that people who experience prolonged exposure to stress will likely have trouble performing cognitive tasks, have a limited capacity to ward off distractions, and would benefit from a stay in an environment where they do not require directed attention [Kaplan and Kaplan, 1989]. This provides a chance to rest and recover the ability to direct attention.

The rest relies on 4 principles:

1. Being away from unwanted distractions and routines that require directed attention, fascination, or effortless engagement of attention (exploring the environment)
2. A sense of extent (coherence in the experience of the environment)

3. Compatibility (correspondence with what the person wants to do, must do, and can do within the environment) [Kaplan and Kaplan, 1989]

Nature provides an excellent environment for Attention Restoration. The great number of people who engage in hikes, expeditions, or other forms of long-term exposure to nature as a way of taking a break from everyday life seems to confirm this. Several articles [Hartig et al., 1997, Laumann et al., 2001]also state that natural environments have greater restorative qualities than urban and other built environments. Ulrich et al. proposed their *'Stress Recovery Theory'* in 1991, which states that exposure to non-threatening natural environments fosters greater restoration from stress than urban environments [Ulrich et al., 1991].

This could be further supported by the *prospect refuge theory* that proposes that humans prefer landscapes and architecture that offer both prospect (view) and refuge (shelter). In other words, we prefer to have the opportunity to "see without being seen" [Appleton, 1975].

Lee and Park emphasized the importance of including accessible hideout spaces in library design, which can increase the feeling of tranquillity and safety in an unfamiliar environment [Lee and Park, 2018]. Mental health institutions, where the users often feel the need to withdraw from social interaction should follow some of the same principles.

Another theory that builds on both attention restoration and prospect and refuge is the *'savannah theory'*. The savannah theory was presented by Orians and Heerwagen in 1992 and suggested that the *'natural habitat of humans'* was the African savanna which offers a mix of wood- and grassland. The landscape provides trees for shelter and refuge, open views and an abundance of resources. According to the hypothesis, human beings still prefer these types of environments due to our history of origin[Orians and Heerwagen, 1992]. Hildebrand has elaborated on this in *'The Aesthetics of Survival'*, identifying five characteristics of preferred environments: *prospect and refuge, enticement, peril, and complex order* [Hildebrand, 1999, Kellert et al., 2008] which will be elaborated on later in section 8.4 *'Terrapin Bright Green's 14 Patterns of Biophilic Design and Their Impact on Health.*

8.2 Nature and Health

The effects nature has on both physical and psychological health and well-being have been the topic of several research papers through the years. In 1984, Roger Ulrich researched the recovery rate of patients recovering from gall bladder surgery, noting that patients with a view of nature recovered faster than those with a less stimulating view [Ulrich, 1984] Since then, other studies emphasizing the benefits of nature for health and well-being have emerged.

White et al. proposed that 120 minutes of contact with nature per week increases overall health and well-being [White et al., 2019], while Tsunestsugu et al. noticed a reduction of stress in patients who had a 5-20-minute visual connection to nature [Tsunetsugu et al., 2013]. Song et al. investigated the specific effects of natural environments and found that confronting natural environments helps reduce the chance of heart disease, balances pulse rate and blood pressure, reduces the secretion of cortisol and enhances the parasympathetic nervous system [Song et al., 2016].

During the pandemic, many people started visiting parks and green areas to get a break from their confinement within their own homes. Lopez et al. researched the use of urban parks before and during COVID-19, emphasizing how these green areas were a critical part of maintaining physical and mental health during the pandemic [Lopez et al., 2020].

Certain natural elements have a particularly calming effect, as stated by Van der Berg et al. Running water was found to have a stress-reducing effect [van den Berg et al., 2003], and this has been an important element in landscaping as made evident by numerous parks and garden facilities throughout history. Wooden interiors also provide a sense of restfulness, as well as comfort and naturalness [Tsunetsugu et al., 2007, Nyrud et al., 2014].

Additionally, air quality and natural light provide many well-known physical health benefits, among them stable circadian rhythm, reduction of headaches, increased concentration, and unobstructed intake of oxygen.

8.3 Terrapin Bright Green's 14 Patterns of Biophilic Design and Their Impact on Health

As a part of the development of their 14 Patterns of Biophilic Design, Terrapin Green looked at research documenting health benefits connected to the patterns. The summary is presented here:

- *Visual Connection With Nature.* This pattern aims to help individuals shift focus and relax both eyes and cognitive functions. Research shows that increased biodiversity has a better effect on cognitive relaxation than merely an increase of natural objects [Fuller et al., 2007]

  Benefits:

  - Lowered blood pressure and heart rate ([Brown et al., 2013]; [Van Den Berg et al., 2007]; [Tsunetsugu and Miyazaki, 2005]).
  - Improved mental engagement/attentiveness ([Biederman and Vessel, 2006]).
  - Positively impacted attitude and overall happiness ([Barton and Pretty, 2010]).

Design considerations include:

- Prioritize real nature over simulated nature; and simulated nature over no nature.
- Prioritize biodiversity over acreage, area or quantity.
- Prioritize or enable exercise opportunities that are in proximity to green space.
- Design to support a visual connection that can be experienced for at least 5-20 minutes per day.
- Design spatial layouts and furnishings to uphold desired view lines and avoid impeding the visual access when in a seated position.
- Visual connections to even small instances of nature can be restorative, and particularly relevant for temporary interventions, or spaces where real estate (floor/ground area, wall space) is limited.
- The benefits of viewing real nature may be attenuated by a digital medium, which may be of greatest value to spaces, due to the nature of its function (e.g., hospitals radiation unit) cannot easily incorporate real nature or views to the outdoors.

- *Non-visual Connection With Nature.* The pattern uses sensory input other than the visual (smell, sound, touch and taste) to improve physical and mental well-being.

  Benefits:

  - Reduced systolic blood pressure and stress hormones ([Park et al., 2009]; [Hartig et al., 2003]; [Orsega-Smith et al., 2004]; [Ulrich et al., 1991]).
  - Positively impacted cognitive performance ([Mehta et al., 2012]; [Ljungberg and Neely, 2004]).
  - Perceived improvements in mental health and tranquillity ([Li et al., 2012]; [Jahncke et al., 2011]; [Tsunetsugu et al., 2010]; [Kim et al., 2007]; [Stigsdotter and Grahn, 2003]).

  Design considerations include:

  - Prioritise nature sounds over urban sounds.
  - Design for non-visual connections that can be easily accessed from one or multiple locations, and in such a way that allows daily engagement for 5 to 20 minutes at a time.
  - Integrate non-visual connections with other aspects of the design program.

  - A single intervention that can be experienced in multiple ways can enhance the impacts.

  - Design for visual and non-visual connections to be experienced simultaneously to maximize potential positive health responses.

- *Non-Rhythmic Sensory Stimuli.* This pattern revolves around encouraging natural stimuli that attracts attention and allows for a break while working with focused tasks. These breaks help replenish the ability to focus, reducing mental fatigue and stressors.

  Benefits:

  - Positively impacted heart rate, systolic blood pressure and sympathetic nervous system activity ([Li, 2010]; [Kahn et al., 2008]; [Beauchamp et al., 2003]; [Ulrich et al., 1991]).

  - Observed and quantified behavioural measures of attention and exploration ([Windhager et al., 2011]).

  Design considerations include:

  - As a general guideline, non-rhythmic sensory experiences should occur approximately every 20 minutes for about 20 seconds and, for visual stimuli, from a distance of more than 20 feet away.

  - Many stimuli in nature are seasonal, so a strategy that is effective year-round, such as with multiple interventions that overlap with seasons, will help ensure that non-rhythmic sensory experiences can occur at any given time of the year.

  - The briefness and random quality of the intervention is of importance and separates it from other patterns.

  - An intervention that leverages simulation (rather than naturally occurring) natural stimuli will likely necessitate early collaboration with the mechanical engineer or facilities team.

  - A non-rhythmic stimuli strategy can be interwoven with almost any landscape or horticulture plan. For instance, one can select plant species for window boxes that will attract bees, butterflies and other pollinators.

  - Peripheral movement is perceived quicker than movement right in front of us. Mechanical and natural movement is also perceived differently. A repeating, rhythmic movement such as a pendulum or the ticking of a watch only holding our attention briefly until it's ignored ([Beauchamp et al., 2003]). Stochastic

movements such as the movements of animals catch our attention, leading to physiological benefits.

- *Thermal and Airflow Variability.* The intent of the pattern is to allow users to control thermal conditions and experience the sensory inputs of thermal and airflow variability.

  Benefits:

  - Positively impacted comfort, well-being and productivity ([Heerwagen, 2006]; [Tham and Willem, 2005]; [Wigö, 2005]).
  - Positively impacted concentration ([Hartig et al., 2003]; [Hartig et al., 1991]; [Kaplan and Kaplan, 1989]).
  - Improved perception of temporal and spatial pleasure (alliesthesia) ([Parkinson et al., 2012]; [Zhang et al., 2010]; [Arens et al., 2006]; [Zhang, 2003]; [de Dear and Brager, 2002]; [Heschong, 1979]).

  Design considerations include:

  - Incorporation of airflow and thermal conditions into materials, daylighting, mechanical ventilation and/or fenestration will help distribute variability over space and time.
  - Thermal comfort is a vital bridging component between biophilic design and sustainable design, especially in the face of climate change and rising energy costs. When thermal and airflow variability is implemented in a way that broadens people's perception of thermal comfort, it may also help reduce energy demands for air conditioning and heating.
  - Designing in features that allow users to easily adapt and modify their perceived thermal conditions of their environment will increase the range of acceptable temperatures by two degrees Celsius above and below the conventional parameters for thermal comfort ([Nicol and Humphreys, 2002]).
  - Coordination of design strategies among a project team (e.g., architect, lighting designer and MEP engineers) as early as the schematic design process will be particularly important for achieving design intent.

- *Presence of Water.* The pattern seeks to create a soothing environment that encourages conteplation, enhances mood and promotes restoration through the use of still or moving water elements.

  Benefits:

  - Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure ([Alvarsson et al., 2010]; [Robert J et al., 2010];[Biederman and Vessel, 2006]).
  - Improved concentration and memory restoration ([Alvarsson et al., 2010]; [Biederman and Vessel, 2006]).
  - Enhanced perception and psychological responsiveness ([Alvarsson et al., 2010]; [Hunter et al., 2010]).
  - Observed preferences and positive emotional responses ([Windhager et al., 2011]; [Barton and Pretty, 2010]; [White et al., 2010]; [Karmanov and Hamel, 2008]; [Biederman and Vessel, 2006]; [Karmanov and Hamel, 1993]; [Ruso, 2008]; [Ulrich, 1983]).

  Design considerations include:

  - Prioritise a multi-sensory water experience to achieve the most beneficial outcome.
  - Prioritise naturally fluctuating water movement over predictable movement or stagnancy.
  - High volume, high turbulence water features could create discomfort, impact humidity levels or decrease acoustic quality, so proximity may influence appropriateness.
  - Water features can be water and energy intensive and as such should be used sparingly, particularly in climates with little access to water. Shading the water, using high albedo surfaces, and minimizing the exposed water surface area will minimise water loss through evaporation, and possibly contribute to the biophilic experience.

- *Dynamic and Diffuse Light.* This pattern both seeks to ensure adequate lighting, as well as providing light conditions that may help hold attention and stimulate the eye and maintaining circadian rhythm. The goal should be to create diverse lighting, without extreme differences (glare and darkness). Movement of light and shadows may attract our attention, providing non-rhythmic visual stimuli.

  Benefits:

  - Positively impacted circadian system functioning ([Figueiro et al., 2011]; [Beckett and Roden, 2009]).
  - Increased visual comfort ([Elzeyadi, 2012]; [Kim et al., 2007]).

  Design considerations include:

  - Dynamic lighting conditions can help transition between indoor and outdoor spaces.
  - Drastically dynamic lighting conditions, such as with sustained movement, changing colors, direct sunlight penetration and high contrasts, may not be appropriate for spaces where directed attention activities are performed.
  - Circadian lighting will be especially important in spaces the people occupy for extended periods of time.

- *Connection with Natural Systems.* The goal of this pattern is both to heighten awareness of natural systems and properties, such as the seasonality and cycles of life, and invoke a sense of responsibility for the local ecosystem.

  Benefits:

  - Enhanced positive health responses; Shifted perception of environment ([Kellert et al., 2008]).

  Design considerations include:

  - Integration of rainwater capture and treatment into the landscape design that respond to rain events.
  - Let context decide whether visual access to existing natural systems, incorporation of responsive design tactics (e.g. use of materials that change form or expand function with exposure to solar heat gain, wind, rain/moisture, or shading), structures (e.g., steps wells), or land formations (e.g., bioswales, arroyos, dunes) are the right intervention to achieve the desired level of awareness.
  - Design for interactive opportunities, especially for children, patients, and the elderly (e.g., integrative educational curriculum; horticulture programs, community gardens; seasonal cooking/diet).

- *Biomorphic Forms and Patterns.* The pattern aims to provide design elements that allows the users to make connections to nature, and through the use of biomorphic forms and patterns create a visually preferred environment that improves cognitive performance and reduces stress. Examples range from the direct inspiration from nature found in Art Noveau architecture to more abstract patterns such as the use of Fibonacci-sequences.

  Benefits:

  - Observed view preference ([Joye, 2007]).

  Design considerations include:

  - For diversity and frequency of exposure biomorphic forms and Patterson should be applied on 2 or 3 planes or dimensions (e.g., floor and wall; furniture, windows and soffits).

  - Avoid the overuse of forms and patterns that may lead to visual toxicity.

  - More comprehensive interventions will be more cost effective when they are introduced early in the design process.

- *Material Connection with Nature.* The pattern's objective is to both establish a connection to the nature in general, as well as with local ecology. Natural materials have characteristics that may increase cognitive and physiological well-being (smell, acoustics, visual elements and associations).

  Benefits:

  - Decreased diastolic blood pressure ([Tsunetsugu et al., 2007]). Improved creative performance ([Lichtenfeld et al., 2012]).

  - Improved comfort ([Tsunetsugu et al., 2007]).

  Design considerations include:

  - Quantities of a (natural) material and colour should be specified based on intended function of the space (e.g., to restore versus stimulate). In the same vein, a degree of variability of materials and applications is recommended over high ratios of any one material or colour.

  - Real materials are preferred over synthetic variations because human receptors can tell the difference between real and synthetic, so minimally processed materials from real nature are preferred whenever possible.

  - Incorporating instances of the colour green may help enhance creative environments; however, scientific studies on the impact of the colour green have mostly been conducted in controlled lab environments, so dependence on colour to engender creativity should be considered experimental.

- *Complexity and Order.* The goal of the pattern is to establish a balance between boring spaces and an overwhelming amount of information and stimuli. Symmetries and fractals geometries configured within a coherent spatial hierarchy should create a visually stimulating environment, which in turn brings out positive psychological and cognitive responses.

  Benefits:

  - Positively impacted perceptual and physiological stress responses ([Salingaros and Xie, 2012]; [Joye, 2007]; [Taylor, 2006]; [Kaplan, 1988]).
  - Observed view preference ([Salingaros and Xie, 2012]; [Hägerhäll et al., 2008]; [Hägerhäll et al., 2004]; [Taylor, 2006]).

  Design considerations include:

  - Prioritize artwork and material selection, architectural expressions, and landscape and master planning schemes that reveal fractal geometries and hierarchies.
  - Fractal structures with iterations of three will be more impactful than a design limited to two iterations.
  - Computer technology using the algorithms of mathematical and geometric functions can produce fractal designs for architectural, design and planning applications with ease. If a fractal design is being created, consider using geometries with a mid-range dimensional ratio (broadly speaking, D=1.3-1.75).
  - Over-use of and/or extended exposure to high-fractal dimensions could instill discomfort or even fear, countering the intended response: to nourish and reduce stress. Avoidance or under-utilization of fractals in design could result in complete predictability and disinterest.
  - A new building or landscape design should take into account its impact on the fractal quality of the existing urban skyline.

- *Prospect.* The pattern provides users with conditions for visually surveying the environment, getting an overview of both opportunities and threats.

  Benefits:

  - Reduced stress ([Grahn and Stigsdotter, 2010]).
  - Reduced boredom, irritation, fatigue ([Clearwater and Coss, 1991]).
  - Improved comfort and perceived safety ([Herzog and Bryce, 2007]; [Wang and Taylor, 2006]; [Petherick, 2000]).

  Design considerations include:

  - Orienting building, fenestration, corridors and workstations will help optimise visual access to indoor or outdoor vistas, activity hubs or destinations.
  - Designing with or around an existing or planned savanna-like ecosystem, body of water, and evidence of human activity or habitation will help the information-richness of the prospect view.

  - Providing focal lengths of at least 6 meters, preferably 30 meters; when a space has sufficient depth, spatial properties can be leveraged to enhance the experience by removing visual barriers. Limiting partition heights to 42" will provide spatial barriers while allowing seated occupants to view across a space. Under-story vegetation or hedges should use a similar guide; preferred height limitations will depend on terrain and how the space is most experienced (e.g., while sitting, standing, on a bicycle)
  - Locating stairwells at building perimeter with glass façade and interior glass stairwell walls can form a dual prospect condition.
  - When high ceilings are present, perimeter or interior spaces elevated 12-18" will enhance the Prospect condition.
  - Often the view quality and the balance between Prospect and Refuge will be more important than the size or frequency of the experience.
  - The Prospect pattern may be combined with the Visual Connection with Nature pattern.

- *Refuge.* This pattern aims to provide an easily accessible, safe environment. The space should feel protective and support restoration. Visual connection into the space should be limited, and ideally one should be protected on three sides (including the back) as well as overhead. Refuge is often combined with prospect, providing a view to the outside.

  Benefits:

  - Improved concentration, attention and perception of safety ([Grahn and Stigsdotter, 2010]; [Ulrich et al., 1991]; [Wang and Taylor, 2006]; [Petherick, 2000]).

  Design considerations include:

  - Indoor refuge spaces are usually characterised by lowered ceiling conditions. For spaces with standard ceiling heights, this may equate to approximately 18-24 inches below the main ceiling, and is often achieved through treatments like a soffit, a drop-ceiling or acoustical panelling, or suspended fabric.
  - Outdoor or indoor spaces with particularly high ceilings (¿14 feet), a more drastic differential may be necessary to achieve the desired outcome; freestanding or vegetative alcoves and mezzanine-like structures are often effective.
  - When designing for larger populations or multiple activity types, providing more than one kind of refuge space can address varying needs, which can often be met through differing spatial dimensions, lighting conditions, and degree of concealment.

  - Light levels in refuge spaces should differ from adjacent spaces and user lighting controls will broaden functionality as a refuge space.

- *Mystery.* A sense of mystery invokes a persons curiosity and compels them to explore. The objective of the pattern is to provide a functional environment that provides stress reduction and cognitive restoration through encouraging natural exploration of the space.

  Benefits:

  - Induced strong pleasure response ([Salimpoor et al., 2011]; [Ikemi, 2005]; [Blood and Zatorre, 2001]).

  Design considerations include:

  - Curving edges that slowly reveal are more effective than sharp corners in drawing people through a space.
  - Dramatic shade and shadows can enhance the mystery experience.
  - Strategies that provide dark shadows or shallow depth of field could instill unappreciated surprise or fear.
  - The speed at which users are transiting through a space will influence both the size of the aperture and the size of the subject; faster typically means bigger.
  - Organically evolved mystery conditions (e.g., low maintenance gardens with winding paths) are expectedly going to change characteristics over time. These changes should be monitored as they may enhance the mystery condition, or otherwise degrade it as it evolved into a surprise condition (e.g., overgrowth of plantings leads to obscuring of depth of field).

- *Risk/Peril.* Much like the Mystery pattern, this pattern also aims to stimulate the users curiosity, as well as attention. It also refreshes memory and may activate problem solving skills. It's not necessarily about the feeling of danger, but should rather be intriguing, making the space worth exploring.

  Benefits:

  - Resulted in strong dopamine or pleasure responses ([Kohno et al., 2013]; [Wang and Tsien, 2011]; [Zald et al., 2009]).

  Design considerations include:

  - Risk/Peril design interventions are usually quite deliberate and as such will not be appropriate for all user groups or places.

- Design strategies that rely on spatial conditions will be easier to implement when incorporated as early as concept design and schematic phases of the design process.
- The element of safety must protect the user from harm while still permitting the experience of risk.

List adapted from [Browning et al., 2014]

8.4 Summary

Mental illness may affect a person's perception of their immediate environment and their preferred personal space. Both aspects must be taken into account when designing a Psychiatric Hospital. Personal territory, preferred distance and opportunities for flight from unwanted situations must be implemented into the design. '*Attention Restoration- and Stress Recovery Theory*' emphasise the positive effects of nature when recovering from stress, depression, anxiety and other psychological diagnoses. Several studies document further physical and psychological health benefits gained from exposure to nature and natural elements, leading to the conclusion that applying a Biophilic Design approach to a Psychiatric Hospital would be beneficial.

Chapter 9

Case Studies

This chapter primarily analyses psychiatric wards but also includes a rehabilitation centre for cancer patients that features qualities that are highly desired for healing environments. Analysing ward layouts are prioritised as they require a certain structure that heavily influences the overall design of the building. Therefore getting the ward environment right is crucial before further applying biophilic and other types of environmental decisions

9.1 Sikkerhetsbygget DPS Østmarka. Trondheim, Norway

The new high-risk psychiatric ward at Østmarka in Trondheim is designed with the principles of 'healing architecture' in mind, meaning the physical environment of the building itself is supposed to take an active part in the patient's healing process [Leistad and Dahl, 2024, Ratio,]. Staff and patients were heavily involved in the design and construction process, whereby they could be part of testing different rooms or parts of the facility before completion [Leistad and Dahl, 2024].

The layout of the building features dining, administration and acute reception are located along the main axis, whereas each patient ward is located alongside an inner courtyard [Leistad and Dahl, 2024]. The inner courtyards allow views to nature and provide good lighting in the deeper parts of the building as well. Further, there are wooden slats covering parts of the glazed areas to increase the feeling of privacy from both inside and outside [Leistad and Dahl, 2024, Ratio,].

For the patient units, the rooms are spacious (13-15m2) and all receive daylight and views towards nature. The ventilation and temperature are available for the patients to control to adapt to each individual's needs [Leistad and Dahl, 2024]. The building underwent post-occupancy evaluation before handover whereby faulty equipment or poor-performing finishes were replaced. Staff reported that they are especially happy about the use of colours in the building as well as the layout and design of the reception area [Leistad and Dahl, 2024]. [Leistad and Dahl, 2024].

Figure 9.1: *Akuttbygget Østmarka. [Leistad and Dahl, 2024, Ratio,]*

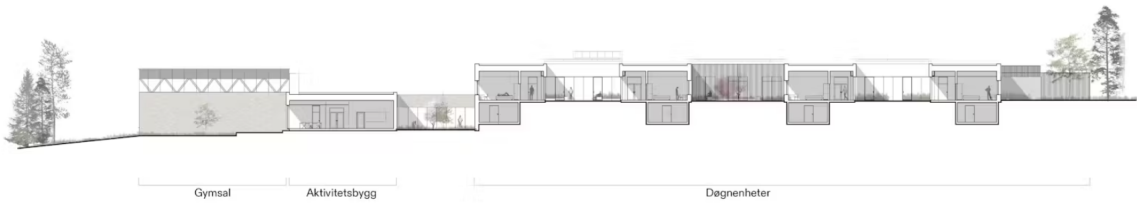


Figure 9.2: *Akuttbygget Østmarka - section. [Leistad and Dahl, 2024, Ratio,]*

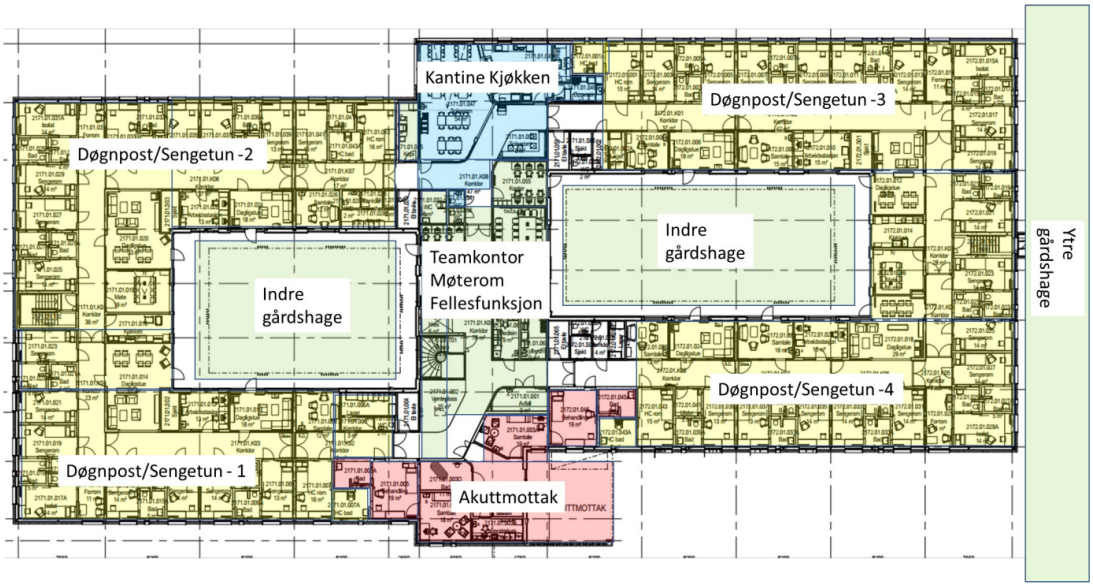


Figure 9.3: *Akuttbygget Østmarka 1st. Floor. [Leistad and Dahl, 2024]*

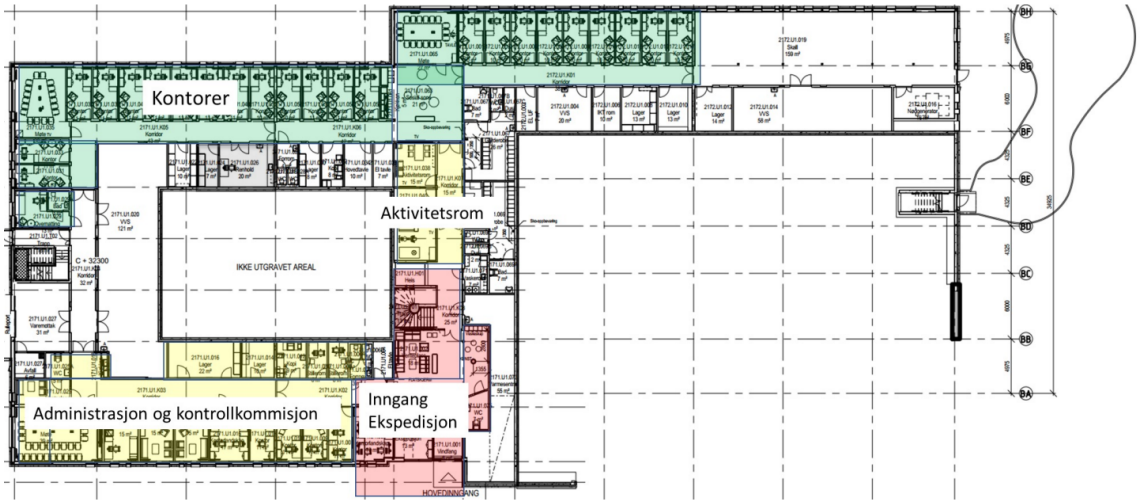


Figure 9.4: *Akuttbygget Østmarka 2. etg [Leistad and Dahl, 2024]*

9.2 Nybygg psykisk helse - Sørlandet sykehus. Kristiansand, Norway

Figure 9.5: *New psychiatric ward Kristiansand. [Hennig Larsen, Sykehusbygg, Skanska, Sørlandet sykehus , 2024]*

The new psychiatric unit at Sørlandet sykehus is also promoting 'healing architecture' and prioritises the use of nature within their project [Hennig Larsen, Sykehusbygg, Skanska, Sørlandet sykehus , 2024]. It is the first CLT built hospital and has a high feature of wood and colours as part of the building interior [Hennig Larsen, Sykehusbygg, Skanska, Sørlandet sykehus , 2024, NIL, 2023]. The layout of the building consists of multiple courtyards which ensures views of green spaces for both staff and patients. Users were heavily involved in the design phase of the building to talk the designers through their experience of what does and does not work for them [Hennig Larsen, Sykehusbygg, Skanska, Sørlandet sykehus , 2024]. The goal of the project is to serve as a new model and vision for psychiatric design and users were heavily involved in the process [Hennig Larsen, Sykehusbygg, Skanska, Sørlandet sykehus , 2024].

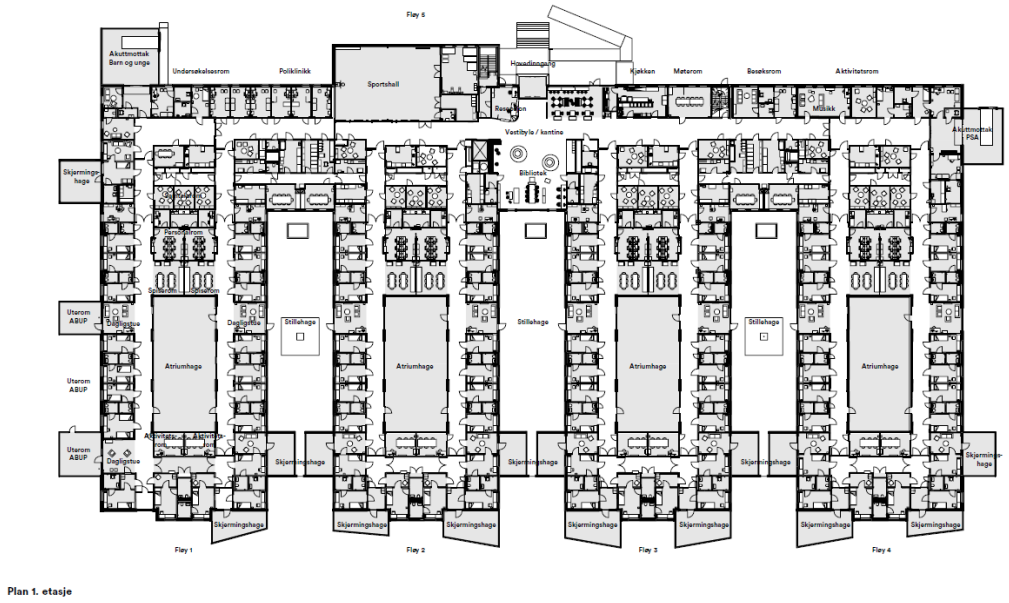


Figure 9.6: *1st. floor. [Hennig Larsen, Sykehusbygg, Skanska, Sørlandet sykehus , 2024]*

Figure 9.7: *Landscaping plan. [Hennig Larsen, Sykehusbygg, Skanska, Sørlandet sykehus , 2024]*

9.3 Gaustad Asyl

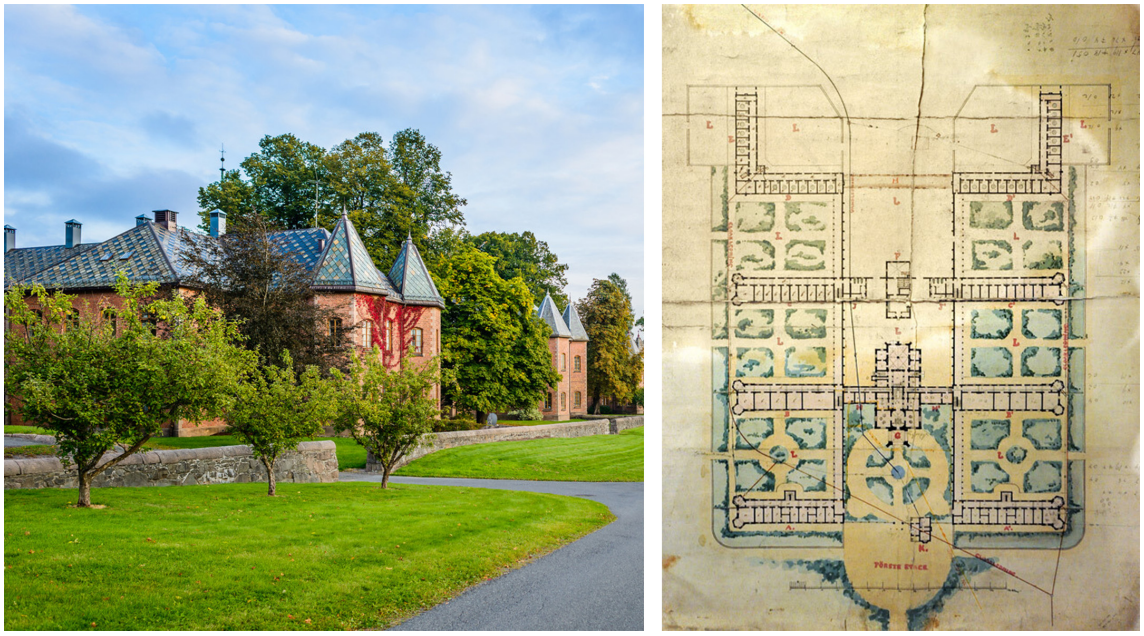


Figure 9.8: *Gaustad Asyl. Photo by Jon Henrik L. https://fokus.foto.no/i/1015030 and Floorplan provided by [Hvattum, 2016]*

This case study will look at the original idea and concept of Gaustad asylum as the facility was groundbreaking for its time due to the high architectural standard and treatment of patients [Hvattum, 2016, Kringlen, 2004].

Gaustad Asyl was Norway's first public asylum and was planned by psychiatrist Herman Wedel Major and architect Heinrich Ernst Schirmer. The planning of the building took place in parallel to the establishment of the Norwegian lunacy act[Hvattum, 2016]

The facility consists of three buildings (a, b and c block) that would all follow a linear floor plan that was becoming increasingly popular at the time as it allowed more light and fresh air into the as well as a more homely environment [Hvattum, 2016].

The facility ensured views of nearby landscapes and gardens and was organised in a way that allowed patients to be split based on social status, gender and severity of illness. The facility offered access to several courtyards of 50x30m which was a central part of the treatment plan, as the facility also featured a gardening school that provided work for the patients [Hvattum, 2016].

The technical instalments on site were very advanced and modern for its time and included floor heating, ventilation ducts and gas lights. Flush toilets were also installed but later removed as they were not functioning sufficiently [Hvattum, 2016].

9.4 Nybygg Psykisk helse og rus, Åsgård. Tromsø, Norway

Figure 9.9: *Proposed building programme* [Hansen and Fagerli, 2022]

Nybygg psykisk helse og rus (new psychiatric and rehabilitation facility) is a planned new extension for Universitetssykehuset i Nord-Norge (UNN). The concept prioritises a low-rise building mass and includes several larger courtyards that still allow an easy overview of the patients [Hansen and Fagerli, 2022]. The primary functions of the facility are located towards the east while the patient units are located towards the west with the high-risk unit towards the north [Hansen and Fagerli, 2022]. The atriums have ground heating to ensure access throughout the whole year. Building flexibility was a major priority of the concept[Hansen and Fagerli, 2022]. Therefore, the allocated room programme is spacious enough to allow a flexible floor plan in case the building or certain parts need to be repurposed, re-located or to fit future extensions. To further highlight the project's flexibility the layout is based on standardised units that allow for prefabrication and repetitive patterns [Hansen and Fagerli, 2022]. The project has gone through several planning processes due to the high project costs. However, a financial plan has been established and the project will be built in two terms and are now ready for construction.

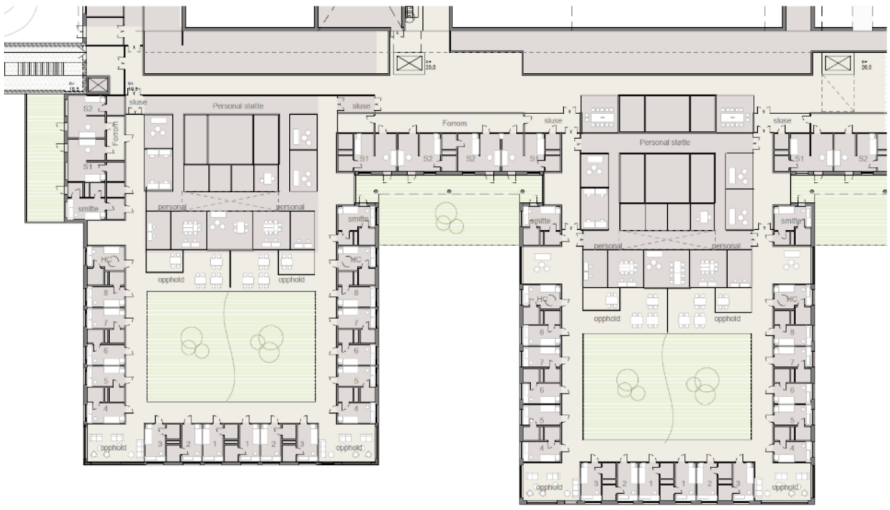


Figure 9.10: *Proposed layout for patient unit* [Hansen and Fagerli, 2022]

9.5 Maggie Centres, United Kingdom/Worldwide

Figure 9.11: *Maggie Centre by Reiach & Hall Architects. Airdrie, United Kingdom [Grandorge, 2014]*

The Maggie Centres are support facilities for cancer patients and their families, focusing on creating friendly spaces with a sense of dignity and normalcy[Jencks, 2015]. The centres arrange workshops, and financial and psychological services to help ease the patient's journey [Jencks, 2015]. The centres actively research and evaluate their services, patients and environments to ensure quality and maintain the centre's success[Jencks, 2015].

While not explicitly designed for psychiatric patients, there are many relevant overlaps between mentally ill and cancer patients as psychological distress is also commonly experienced among cancer patients as well as experiencing alienation and struggle with identity after receiving the diagnosis.

The Maggie centres were founded in the United Kingdom but are now established in other parts of the world.

9.6 Summary

These case studies all serve as inspiration for the final design of the project. While none of them have been designed using a biophilic approach, they all display elements of biophilic design, and/or design solutions adapted to psychiatric patients that may be implemented within the project.

Chapter 10

Design Framework Based on Research

Chapter 10 provides a summary and assessment of several Biophilic Design Frameworks and sustainable building certification systems, in order to develop a set of project-specific design guidelines with quantifiable goals.

The lack of emphasis of human-nature connection within Environmental Sustainable Design has been criticised by Kellert and Kayhan among others ([Kellert, 2016], [Kayıhan, 2018]). As most sustainable design frameworks, standards and certification systems are based on empirical systems that ensures that all projects are assessed on the same basis, they tend to result in rigid checkliststhat require specific solutions and leave little room for alternative solutions. Many of these also follow a narrow, high-tech, emissions-focused path that leave out other aspects of sustainability. They do however tend to have specific requirements, goals and demands, something Biophilic Design frameworks are often criticised for lacking. The Biophilic focus on sensory experiences comes off as vague and leads to less quantifiable criteria. In order to stake a course for the project that takes both the design philosophy, sustainability and program into account, we assessed some of the leading principles and frameworks within Sustainable Architecture and Biophilic Design, before using them as a starting point to develop a set of project-specific guidelines. These will then be used to help develop the final design, rather than just acting as a checklist where we tick off parameters.

10.1 Sustainable Architecture Frameworks and Green Building Rating Tools (GBRT)

Several attempts have been made to bridge the gap between Biophilic Design and Environmental Sustainable Design (ESD) through the development of new design framework. Wijesooriya et al. compared Biophilic Design Frameworks in an effort to examine the

comparability between biophilic criteria and typical sustainable design frameworks. Their analysis and findings have been taken into account when developing the framework for the project, and 4 of the frameworks they analysed have been considered in the research towards developing the project specific framework. Xue et al. did it the other way around, identifying criteria related to human health and well-being within GBRTs. 4 of the six GBRTs included in Xue et al.'s analysis also serve as a basis for the project design framework.

The frameworks assessed are briefly described in this section (section 9.1), and the resulting guidelines are presented in section 9.2. In addition the project specific framework has also been influenced by the "Gröna Punkter för grönare by" as presented by Persson in "Bo01 Hållbar framtidsstad - Lärdomar och erfarenheter" [Persson, 2005].

10.1.1 Biophilic Design Frameworks

Kellert's Biophilic Design Framework (2008)

Kellert's Biophilic Design Framework from 2008 helped define the architectural approach to Biophilia. The framework consists of two dimensions, the naturalistic or organic and the place-based or vernacular. Six biophilic elements are identified; Environmental features, natural shapes and forms, natural patterns and processes, light and space, place-based relationships and evolved human-nature relationships. Within these elements Kellert proposes 70 attributes guiding the development of biophilic architecture [Kellert et al., 2008].

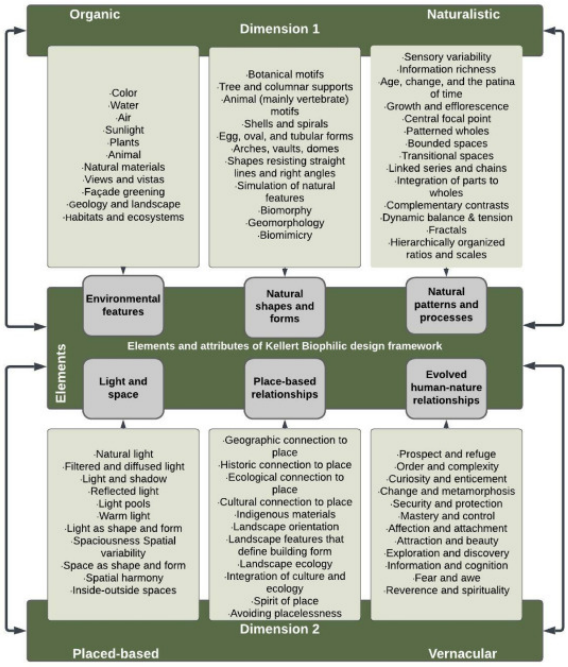


Figure 10.1: Kellerts Biophilic Design Framework as illustrated by Wijesooriya et al.

[Wijesooriya et al., 2023]

The framework offers broad guiding principles, that may be interpreted by the architect for the specific project. Kellerts book offers a varying degree of reasoning and explanation for each element, and few concrete design strategies. This means that the road to achieving a successful biophilic design is more or less up to the designer. While it's important that the design interventions are specifically adapted to the project at hand, doing so without any help as to how to tailor the strategies is difficult.

Terrapin Bright Green - 14 Patterns of Biophilic Design (2014)

The 14 Patterns of Biophilic Design has already been discussed, as a way of defining Biophilic Design and the connection between Biophilic Design and health and well-being. The framework also contains design strategies that can be used to achieve the patterns, using both natural and constructed methods. The benefits of implementing nature and natural systems within a project are also thoroughly described. A flaw of the framework is the lack of guidelines on how to assess whether or not the goals are reached. The connection between biophilia and environmentally sustainable design is also lacking [Browning et al., 2014].

Kellert and Calabrese - The Practice of Biophilic Design (2015)

The Practice of Biophilic Design is based upon Kellerts original design framework. Experiences and attributes of Biophilic Design are grouped in three categories: Direct experiences of nature, Indirect experiences of nature and Experience of Space and Place. The number of attributes have been reduced from 70 to 24. The framework highlights the importance of sustained contact with nature, emotional connection to places, social connections, as well as benefits of exposure to nature.

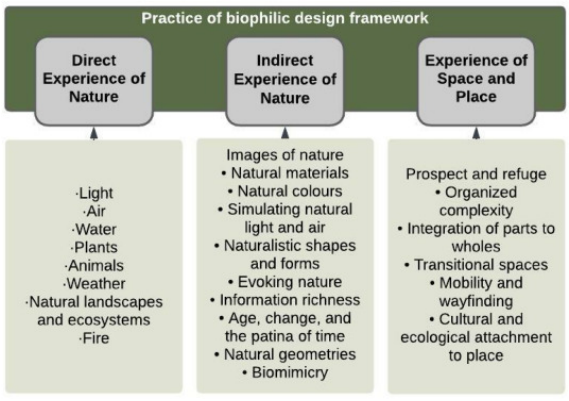


Figure 10.2: Kellert and Calabrese's The Practice of Biophilic Design Framework as illustrated by Wijesooriya et al.

[Wijesooriya et al., 2023]

The framework shares the same flaws as Kellerts original framework, lacking proper explanation of design strategies. No sustainability criterias are indicated, and overall the

sustainability aspect is not highlighted [Kellert and Calabrese, 2015].

Xue et al. - The Biophilic Framework for Sustainable Design (2019)

Xue et al. tried to develop a framework that merges criterias from GBRTs with biophilic philosophy. Six cathegories (Biophilic Infrastructure, Sensorial Design, Biophilic Setting and Performance, Transportation Connectivity, Work-Live-Play Integration and Green Space Place-Making) are further divided into 14 criteria and 42 strategies. This was then used to assess several GBRT's compatibility with Biophilic Design values.

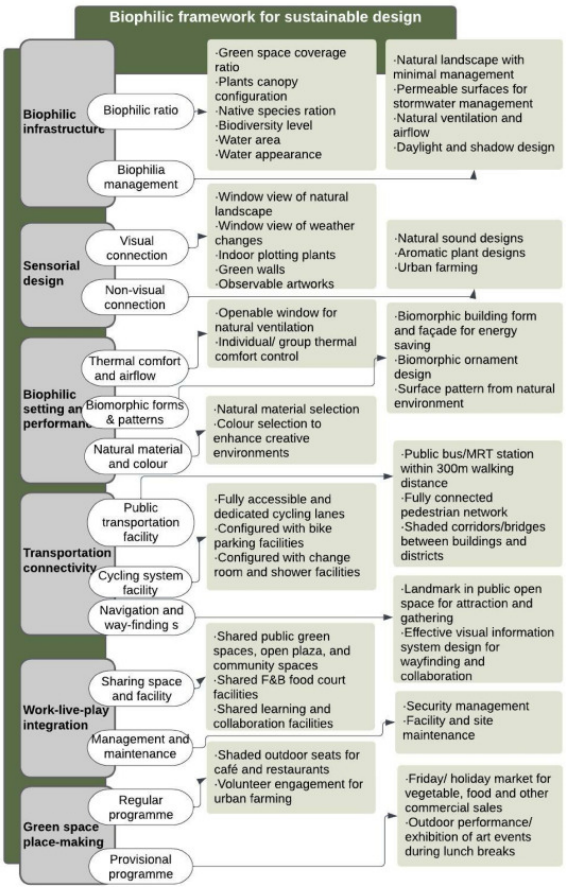


Figure 10.3: Xue et al.'s The Biophilic Framework for Sustainable Design as illustrated by Wijesooriya et al.

[Wijesooriya et al., 2023]

The credit awarding strategies resemble the structure of GBRTs, merging building performance and biophilic strategies, adapting the frameworks of Kellert and Terrapin Green. The framework describes specific building elements and functions that will aid in achieving the overarching goals.

Part of Xue et al.'s process for developing their biophilic design framework included identifying credits related to well-being and human preferences within existing framework. Six frameworks were analysed; LEED V4, BREEAM International NC 2016, Green Mark

Non-residential Building 2015, Green Building Label 2014, Well Building Standard V2 and Living Building Challenge V3.1. Their findings show that although not explicitly biophilic, a large percentage of the credits are related to human-oriented spatial design, even among the more "technically oriented" GBRTs [Xue et al., 2019].

Attia's Regenerative Framework (2018)

Attia has concerned himself mainly with "Regenerative Architecture", a design philosophy that shares many values with Biophilic Design. He places great value on the measures that "regenerate" the local environment, and seeks to create guidelines that ensures both energy and material efficiency. In "Regenerative and Positive Impact Architecture - *Learning from Case Studies*" he describes 5 major guiding principles, leading to a framework based on 3 main strategies, which Attia used as a basis for the assessment of 4 cases. The case study then resulted in 10 key take-aways [Attia, 2018].

Attia's Guiding Principles For Regenerative Architecture:

- Safe & Healthy Materials (*No hazardous materials.*)
- Materials Reuse (*All building products or materials must be able to biodegrade safely, or be recycled. Use of products with a goal of 100% recovery or re-use.*)
- Renewable Energy & Carbon Management (*Mandatory LCA, with a goal of 100% of the energy used within the building's lifetime to be renewable.*)
- Water Stewardship (*Water is treated as a valuable resource.*)
- Social Fairness (*All manufacturers are expected to carry out their activities while respecting health, safety and diversity of all living things.*)

Attia's 3 Design Strategies For Regenerative Design:

- Regenerative Construction Systems (*Flexible construction systems that allow for recovery, upgrading, modification and transformation of building elements and materials. Modular construction systems and design for disassembly are proposed as specific design strategies/elements, which should form the basis of the design. The building should also have a high-performance envelope.*)
- Regenerative Design Elements (*Choose architectural principles based on geographical and climatic situations. Proposed elements include atriums, courtyards, terraces, balconies, skylights, glazed facades, staircases, meeting rooms, open office spaces, common areas, foyer and roof gardens. The elements should aim to improve the quality of air and water, increase biodiversity, use healthy materials, enable cultural and social diversity, enable functionality, mobility and generate energy.*)
- Regenerative Building Materials & Products (*The project must use C2C-certified*

products, and include materials passports within a database in order to facilitate reuse.)

Attia's Lessons Learned from Case studies:

- Design for Reversibility & Modularity (*Enable easy assembly and disassembly for long building spans.*)
- Design for Circularity (*Select Components that can be properly reused and have and expanded lifespan.*)
- Apply for Green Building Certification & Use Multi-attribute Products (*Set measureable performance targets.*)
- Use Renewable Energy Sources (*Compensate for operational and embodied energy using renewables.*)
- Apply Sustainable Materials Sourcing &LCA (*Increase the share of bio-based materials.*)
- Design for Occupants Comfort and Well-being (*Enable user-control and acieve indoor environmental quality.*)
- Engage Integrative Design Process (*Get the right mindset for the Design & Build team.*)
- Apply Performance-base Contracting (*Design using KPI's for energy, materials, water and air.*)
- Enable Collaborative Consumption & Leasing Services (*Extend the suppliers & producers responsibility.*)
- Create a Database & Materials Passport (*Use BIM to create a 3D model and centralize building information.*)

The framework focus on choosing a flexible and regenerative construction system as a basis for design, but offer very few specific design interventions or even goals. It's left up to the architect to interpret the guiding principles and strategies, and figure out how to get there. The framework references the Passive and Active House Standards, for some specific requirements, and the key take-aways from the case studies in the book mentions that one should always follow GBRTs to achieve energy and carbon efficiency, but overall the framework only informs you of how you should think and weigh your decisions, rather than what to do.

Craft et al.'s Regenerative Design Model (2016)

In an attempt to create a design framework that focus on how to make building's do good, as opposed to just reducing their negative effects, Craft et al. developed a design model for regenerative retrofitting of existing buildings. They based their work on Mang & Reed's Regenerative Design Principles, as well as Birkeland's "Positive Development", and developed 4 "Reactive" and 4 "Proactive" regenerative design principles [Craft et al., 2016]. Although the framework focus on retrofit, the principles may also be applied to new buildings.

Proactive Principles (*Net-positive, restorative & regenerative*)

- Support Human & Natural Co-habitation
  - Shared spaces incorporating nature to provide social interaction opportunities.
  - Increased visual and physical connection to nature.
  - Indigenous wildlife habitats to increase biodiversity.
  - Local food production
- Building envelope to improve indoor environment and restore local ecosystems
  - Natural systems in roof/facade to improve IEQ and reduce heating/cooling load.
  - Surrounding climate mitigation.
  - Building envelope to facilitate wildlife habitat connectivity.
- Positive Energy Exchange with Surrounding Built Environment
  - Effective energy management and storage systems.
  - Exchange with other buildings, infrastructure and the grid.
  - Energy sharing strategies and initiatives.
- Retrofit for resilient buildings
  - Building and/or building components are durable, reversible, demount-able and adaptable where possible to account for changing technologies and climate conditions.

Reactive Principles (*Net-zero, green buildings & resource-efficiency*)

- Renewable energy potential
  - Building's context to determine the appropriate use and location of renewable energy generation.

- Upgrade Existing Energy Systems
  - Replace and/or upgrade building central plant.
  - Improve appliance and lighting efficiency.
  - Energy management systems.
- Material Compatibility with Surrounding Environment
  - Material choice and arrangement to reduce heating and cooling loads.
  - Climate, cultural and aesthetic compatibility with surroundings.
  -
- Improve construction quality and integrity
  - Existing structural systems.
  - Waterproofing and moisture management.
  - Air leakage and penetration.

[Craft et al., 2017]

Much like Attia's framework, Craft et al.'s Regenerative Design Model provides a stepping stone towards identifying specific design interventions by offering guiding principles. The framework is meant to be used in a wide array of cases, and therefore focus on the principles, avoiding specific design examples and quantified goals that might not work in the specific context.

10.1.2 Green Building Rating Tools

WELL Building Standard V2 (2023)

The International WELL Building Institute published the first WELL Building standard in 2014, aiming to increase the focus of human health and well-being within building standards [International WELL Building Institute, 2020]. The second version of WELL consists of ten concepts: Air, Water, Nourishment, Light, Movement, Thermal Comfort, Sound, Materials, Mind and Community. Within each of these categories there are both preconditions and optimisations. All together there are 124 features listed, broken down into specific demands and actions [International WELL Building Institute, 2020].

LEED V. 4.1 (2024)

LEED is a green building certification program developed by the US Green Building Council. The first version of the standard was released in 1994, and the current version is the fourth iteration. The tool consists of a credit library with 110 credits distributed across

the categories; Integrative Processes, Location & Transportation, Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, and Indoor Environmental Qualities [LEED V 4.1, 2024]. In addition there are 3 credits within Innovation and Regional Priority. Depending on the number of points achieved, the building will be awarded a Certified, Silver, Gold, or Platinum rating.

LEED is a commercialised building certification program, and focus on efficiency and reductions of emissions and energy use. The requirements that must be met in order to be awarded points within each credit are clear, and some biophilic principles such as protection of sensitive land, reduced parking footprint, protecting and restoring habitat, reduction of water use, quality views and daylight are considered. However the program puts little focus on reuse and circularity, There are also few guidelines for creating buildings where people thrive, other than through the requirements regarding interior environmental quality.

BREEAM-NOR

The leading GBRT in Norway is BREEAM-NOR, based on the certification tool developed by Building Research Establishment in Britan and adapted to Norwegian climate and laws by Grønn Byggallianse [BREEAM-NOR V6.1, 2023]. The certification aims to reflect "best practice". The tool covers the 10 sections; Management, Health and well-being, Energy, Transport, Water, Materials, Waste, Land use & Ecology, Pollution, and Innovation. A total of 135 credits are available, weighted differently, with Materials being awarded the highest value (17%), followed by Health & Well-being (16%), Land User & Ecology (15%), Energy (14%), Management (13%), Transport (10%), Waste (7%), Water (4%), and Pollution (4%). The sum of the weighted credits then result in the ranking; Pass, Good, Very Good, Excellent, or Outstanding.

BREEAM-NOR is often regarded as a rigid checkpoint rating tool for sustainability that focus on emissions, but omit social and economic sustainability. Newer iterations of the tool try to change that through a redistribution of the credit weighting (Energy and Pollution used to have higher weightings), as well as awarding points for implementing biophilic design elements, design for disassembly and circularity. Although the number of credits for these categories are fewer than what can be achieved by creating a thorough design brief within the planning stage.

DGNB

DGNB was developed in Germany, and puts more focus on the human experience than environmental aspects. The framework starts with listing all the human-centred criteria, and describing how they relate to people. It aims to cover all aspects of a sustainable building, and 38 criteria covers the topics Environmental Quality, Economic Quality, Sociocultural & Functional Quality, Technical Quality, Process Quality, and Site Quality. Each crite-

ria has a defined objective and is linked to relevant UN Sustainable Development Goals [DGNB System International, 2020].

DGNB parts from most other commercial sustainable building certification systems by not having emissions and energy as their primary focus. Environmental sustainability is weighted more or less equally to social and economic sustainability, and technical quality. As a result, the system presents as more holistic than for example BREEAM. The criteria each have a list of requirements that must be met in order to be awarded points, and the objective and benefits are both described. This way one can relate the criteria, and specific requirements, to their goals, making DGNB helpful when trying to develop project specific requirements based on broader design philisophical goals.

Living Building Challenge v 4.1 (2024)

The Living Building Challenge is design philosophy, programming tool and building certification program developed by the International Living Future Institute. It aims to implement biophilic and regenerative principles into current practices within the building sector, creating a holistic building standard.

The standard is divided in 7 categories, or petals; Place, Water, Energy, Health & Happiness, Materials, Equity, and Beauty. The petals are then divided into imperatives, that each have specific guidelines that must be imposed on the design. There are 20 imperatives altogether, which should all be considered when designing a new building. Several of the imperatives focus on social sustainability, bridging our built environment and local community [LIVING BUILDING CHALLENGE 4.1, 2024].

Version 4.1 has a clear requirements for nearly all imperatives, and with descriptions of how to get there, as well as case studies. The intent behind each requirement is also described, further clarifying the goals the framework is trying to achieve. Overall, the framework does a very good job at bridging the gap between the technical checklist frameworks, and the non-specific biophilic and regenerative frameworks.

10.2 Project Framework

Our research and assessment of several biophilic frameworks, as well as frameworks and guidelines for the design of psychological institutions, has lead to the development of a set of project specific guidelines that has acted as a guideline for the design phase of the project. Some goals are impossible to measure in the design part of the project, but are included because they should still be important, quantifiable goals for a project of this size and type, and should thus be guiding also within the design phase.

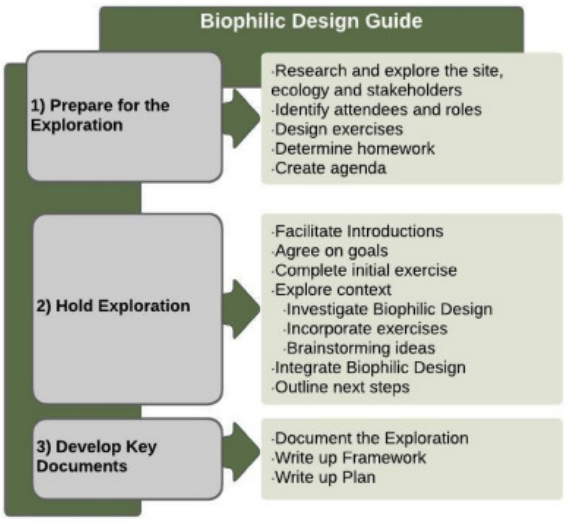


Figure 10.4: International Living Future Institute's Biophilic Design Guidebook as illustrated by Wijesooriya et al.

10.2.1 Project-Specific Biophilic Design Guidelines

The following list provides relevant attributes or goals that we aim to achieve within the categories Site and orientation, Materials, Energy, Thermal Comfort, Air, Water, Light, Nature, Spaces & Design, Human Well-being, Acoustics, Design for mental Health and Public Space. We have used several established frameworks in order to establish guidelines for the project, and have mainly focused on the attributes we can control and measure as architects at this preliminary stage, although some assumptions about the construction- and use-stages of the building's lifetime are made. As the design project is a facility for people in fragile conditions, the main priority must always be to create a place with a focus on the users well-being and comfort. We have therefore chosen to include goals from frameworks that are particularly concerned with peoples well-being, such as WELL.

The International Living Future Institute's Biophilic Design Guidebook (2018), which offers a detailed methodology for how to develop a biophilic framework and served as a guide for the development of the project's biophilic guidelines. The Biophilic Design Guidebook consists of 3 steps: Preparing to explore biophilic design considerations, Hold exploration and Develop Key Documents [International Living Future Institute, 2018].

[Wijesooriya et al., 2023]

Design Interventions and Examples

- **1. Site & Community**
- 1.1 Address the Ecology of Place
- 1.1.1 Conduct a Site Analysis: *A site assessment will initiate the planning process. This will document site and community conditions prior to the start of work, as*

well as identify risks, challenges and opportunities. The assessments should include: mapping of contours and topography, slope stability risks, hydrology, flood hazard areas, rainwater collection and reuse opportunities, landscape typology, impervious and pervious surfaces, local climate conditions such as average monthly precipitation, and temperature ranges, solar exposure and shading opportunities, seasonal sun angles, prevailing winds heat island effect potential, previous development, human use and views. Relevant questions to ask in order to get a deeper understanding of the area include: "Why is this place unique or typical of the area?" and "How do current residents react to both climate and weather?". [LIVING BUILDING CHALLENGE 4.1, 2024], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023]

- 1.1.2 Conduct an Ecological Survey: *The ecological survey addresses questions such as: "How does this ecosystem work? What is unique about it?", "How can people be connected to the climate and ecosystem in this place?", "What ecosystem services are available, and what other values do they provide (aesthetic, physical and auditory, etc.)?". The survey identifies the site and project's current and potential ecological qualities and conditions such as dominant biogeographical features, vegetation, threatened/endangered species, invasive plant species, soil type, hydrology and wildlife on site.* [BREEAM-NOR V6.1, 2023]

- 1.1.3 Preserve the Existing Ecological Conditions: *The project must preserve the current ecological conditions and existing habitats, and thus avoid building on pristine greenfields, wilderness, prime farmland or in a floodplain.* [LIVING BUILDING CHALLENGE 4.1, 2024], [Kellert et al., 2008], [LEED V 4.1, 2024]

- 1.1.4 Landscape Ecology: *A design that considers biodiversity, landscape structures, patterns, optimal scale and size, ecological connectivity, biological corridors, resource flows, and ecological boundaries will reinforce the landscape ecology on a long-term basis.* [Kellert et al., 2008]

- 1.1.5 Set Concrete Sustainability Goals: *The site assessment, as well as regulations and program needs, should result in both general goals for the project and concrete sustainability goals for the project.* [BREEAM-NOR V6.1, 2023]

- 1.2 Redice Negative Impacts

- 1.2.1 Reduce the local Heat Island Effect: *Large Buildings with extensive heat absorbing surfaces provide local heat island effect. Green roofs and plant materials that provide shade over paved areas will help reduce this. Plants and vegetation also reduce the heat island effect through evapotranspiration. Overall the following condition should be met: Area of nonroof measures/0,5 + Area of High-reflectance Roof/0,5 + Area of Vegetated Roof/0,5 = Total Paving Area + Total Roof Area.* [LEED V 4.1, 2024]

- 1.2.2 Ecological Restoration: *The project most contribute positively to the ecology of place through protecting and restoring the ecological conditions and local habitats. 40 percent of the greenfield area on site should be protected from all development and construction activity. A portion of 25% of the site should be restored to it's natural state. Plant a minimum of 6 plants species that are native to the local area, including a minimum of 2 out of the following plant categories: tree, shrub and ground cover. Minimum 5 m2 of the landscape area should be dedicated to pollinating local flowers, and a minimum of 5 m2 should have plants that produce fruits and berries that may serve as food sources for local animals. A minimum of 80% of the roof should be covered in vegetation in order to offset the footprint of the building. It should be ensured that animals can remain in the area by establishing hiding places and "residences" such as leaf and twig mounds, vegetation that is not managed, bird boxes, bat boxes, squirrel boxes, insect hotels, dead wood, sunny areas with fine-grained sand, etc.* [LIVING BUILDING CHALLENGE 4.1, 2024], [Kellert et al., 2008], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023]

- 1.3 Local Infrastructure

- 1.3.1 Conduct a Local Infrastructure Survey: *Assess the local functions and infrastructure, such as road network, public buildings and recreational opportunities.* [BREEAM-NOR V6.1, 2023], [International WELL Building Institute, 2020], [LIVING BUILDING CHALLENGE 4.1, 2024], [DGNB System International, 2020]

- 1.3.2 Access to Public Transport: *The project should be located within a 300m walk distance of an existing bus network.* [International WELL Building Institute, 2020]

- 1.3.3 Pedestrian and Biking Network: *The project should be fully connected to a pedestrian and biking network that connects it to all major community functions.* [Xue et al., 2019]

- 1.4 Connection to Place

- 1.4.1 Geographic Connection to Place: *Connections to the local geography may foster feelings of familiarity and predictability. Design elements emphasising prominent geological features, views of landscapes, architecture, local flora and fauna (e.g. local architecture, materials, flora, fauna, artists, landscape) can help create a geographic connection to place.* [Kellert et al., 2008], [International WELL Building Institute, 2020], [DGNB System International, 2020], [BREEAM-NOR V6.1, 2023]

- 1.4.2 Historic Connection to Place: *Historic connections to the place can be established through references to architecture, local materials and former use of the place. Elements that mark the passage of time or elicit a continuity with the past create a meaningful link between the past, present and future within the project.* [Kellert et al., 2008]

- 1.4.3 Ecological Connection to Place: *The ecological survey should uncover the local ecological conditions. Both the landscaping and built environment should reference the local ecological conditions through the usage and depiction of local materials, wildlife, fauna, flora and habitats.* [Kellert et al., 2008], [BREEAM-NOR V6.1, 2023]

- 1.4.4 Cultural Connection to Place: *The cultural connection to place encompasses the history, geography and ecology of the area, as a component of individual and collective identity. The fusion of culture and ecology also helps foster long-term sustainability though a positive transformation of both nature and humanity. This in turn helps foster loyalty, responsibility and stewardship among the users of the place. Cultural connections can be established through historical references, references to works of art or architecture, music, traditions or events. The design should explore cultural reactions to space, light, colours or other sensory impressions. Design elements that address the following: Celebration of local culture, Celebration of place (e.g. local architecture, materials, flora, fauna, artists, landscape) and Art, should be included as decorative elements.* [Kellert et al., 2008], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023]

- 1.4.5 Spirit of Place: *The spirit of place is the level of commitment and meaning people extend to an environment that has become a cherished component of individual and collective identity, invoking a motivation for long-term stewardship and responsibility. The following questions can be relevant when addressing the spirit of a place: "Why is this place unique or typical of the area?", "What is a regional material palette?", and "What other senses can come into play here: colour palette, tactile palette, auditory palette, etc.?".* [Kellert et al., 2008], [BREEAM-NOR V6.1, 2023]

- 1.4.6 Identify User Groups: *Identify the users of the buildings, and their needs, relationship to the place, as well as the history and community of which they are a part of. The general public's relationship to the place should also be addressed. The assessment should identify external resources that may be of relevance to the project, such as user considerations, programme requirements from authorities and/or clients, or other factors that are relevant.* [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023]

- 1.4.7 Improve the Local Community: *The overall goal is to create buildings that people see as a positive element of their environment and identify with. Cultural and social equity factors and needs within the community must be assessed, and these needs should inform design and process decisions in order for the project to exert a positive influence on the local community.* [International WELL Building Institute, 2020], [DGNB System International, 2020], [LEED V 4.1, 2024], [LIVING BUILDING CHALLENGE 4.1, 2024]

- 1.4.8 Climate Adaptation: *Climate adaptive strategies should be chosen based on the analysis of local climate conditions. These should address thermal comfort, reduction of energy use, water consumption, designing of durability and resilience, extreme weather.* [BREEAM-NOR V6.1, 2023]

- 1.4.9 Landscape Features Define Building Form: *The design should strive to integrate, rather than be isolated from the biophysical context. Prominent geological features, water and natural objects should define the placement and shape of the building and interventions. The design should limit the need for excavation and other intrusive interventions.* [Kellert et al., 2008]

- 1.5 Lansdcaping

- 1.5.1 Assess and Mitigate Site Hazards: *The site is controlled for potential contamination in soil, underground water, and landslide risks.* [International WELL Building Institute, 2020]

- 1.5.2 Construction Activity Pollution Prevention: *Measures must be taken to ensure that erosion, noise and pollution from the building phase is kept to a minimum. This includes using electric equipment and machinery, and creating an erosion and sedimentation control plan. Through these measures the negative effects on people during the construction phase are minimised.* [LEED V 4.1, 2024], [DGNB System International, 2020]

- 1.5.3 Natural Landscape With Minimal Management: *The landscape around the project should be left as is, or restored to it's natural state.* [Xue et al., 2019]

- 1.5.4 Outdoor Space: *The project should provide outdoor space greater than or equal to 60 percent of the total site area (including building footprint). At least 80 percent of the outdoor open space must be vegetated space (including green roofs) with two or more types of vegetation or have an overhead vegetated canopy. The following types of areas must be represented: a social area (an area accommodating outdoor social activities), a recreational area (an area that encourage physical activity), diverse green spaces (landscape with two or more types of vegetation, providing visually stimulating views year-round), and a garden (with food production). All outdoor areas must be physically accessible.* [LEED V 4.1, 2024], [DGNB System International, 2020], [Xue et al., 2019]

- 1.5.5 Use of Onsite Masses: *The land masses excavated in relation to the construction of the project should be used as fill mass within the project. There should be a mass balance on site, resulting in no waste mass and no need to introduce soil from other environments.* [Kellert et al., 2008]

- 1.5.6 Parking: *The project should have parking spots for cars and bike racks to accommodate both service users, visitors and employees. All parking spaces should*

be on permeable surfaces. [LIVING BUILDING CHALLENGE 4.1, 2024]

- 1.6 Building Placement And Landscape
- 1.6.1 Footprint and Building Density: *The footprint of the building should not exceed 50 percent of the area of the site in order to reduce excess use of land for building purposes and limit soil sealing in undeveloped areas. The building shape should be optimised through control of the form factor (maximum 4:1 relationship between area of all exterior surfaces and building volume).* [DGNB System International, 2020], [BREEAM-NOR V6.1, 2023]
- 1.6.2 Building Orientation: *The project should be placed and oriented based on the local landscape and climatic patterns. The orientation should allow for the utilisation of daylight without creating a need for extensive cooling, as well creating shelter from winds and local pollution patterns.* [BREEAM-NOR V6.1, 2023]
- 1.6.3 Building Design: *The overall design and shape of the building should allow for daylight to be drawn as far into the building as possible, providing good visibility and sunlight without glare or danger of overheating. Thermal buoyancy should be utilised, and the design should allow for local energy production through the use of PVs.* [BREEAM-NOR V6.1, 2023]
- 1.6.4 Connection Between Landscape and Building: *The building should interact with the landscape in meaningful and interesting ways by emphasising landscape features such as slope, sunlight, and wind direction. This invokes a sense of being part of the place, rather than separated from it.* [Kellert et al., 2008]
- **2. Materials**
- 2.1 Use of Safety and Healthy Materials
- 2.1.1 Material Restrictions: *Chemicals and materials that may be harmful to people, animals or flora should not be used within the project. These include materials and chemicals that emit particles that may pollute the indoor air, materials listed on the Living Building Challenge's Red List, and all materials listed as hazardous by the local authorities.* [Attia, 2016], [International WELL Building Institute, 2020], [DGNB System International, 2020], [LIVING BUILDING CHALLENGE 4.1, 2024]
- 2.1.2 Use of Materials That Improve Indoor Air Quality: *Materials such as wool, hemp and mineral paint may help absorb pollutants, while indoor plants purifies the air through photosynthesis.* [LIVING BUILDING CHALLENGE 4.1, 2024], [International WELL Building Institute, 2020]
- 2.1.3 Select Products With Disclosed Ingredients: *The products used in the project should all have their ingredients disclosed by their manufacturers or through a third party. All manufacturers are required to assess their materials based on the hazards*

of chemicals within their products, and the risk of exposure through intended and unintended use, as well as end-of-use phases. [International WELL Building Institute, 2020], [Attia, 2016]

- 2.1.4 Select Optimised Products: *Permanently installed products, such as flooring, insulation, ceiling and wall systems, should preferably be certified under or recommended by internationally recognised certification systems for healthy and sustainable materials, i.e. Declare certification, Cradle-to-Cradle certification, or Svanemerket.* [International WELL Building Institute, 2020], [DGNB System International, 2020]

- 2.2 Responsible Materials Use

- 2.2.1 Local Materials: *The use of local and indigenous materials can invoke a positive relation to place as they relate to the local environment and culture. Local materials also tend to require less energy for manufacturing and transport. 20 % or more of the construction materials must come from within 500km of the construction site. 30 % must come from within 1000 km of the construction site, and 25 % must come from within 5000 km. The remaining 25 % may be sourced from any location.* [Kellert et al., 2008], [LIVING BUILDING CHALLENGE 4.1, 2024]

- 2.2.2 Organic Materials: *The project must utilise organic materials wherever possible. Elements from nature, especially if untreated, have distinctive patinas that may change over time, and provide positive visual and tactile responses. These materials may both reflect local ecology and geology, thus promoting identity of place, or may act as more general references to nature. Natural materials include: wood, leather, wool, earth, stone, hemp and cork.* [Kellert et al., 2008], [DGNB System International, 2020], [Kellert and Calabrese, 2015], [Browning et al., 2014]

- 2.2.3 Sustainably Sourced Materials: *The materials used should be sustainably sourced. 50 % of the wooden materials should either be FSC, salvaged or harvested on site for either the purpose of clearing the site for construction or to restore the continued ecological functions of the site. The remainder should be from low risk sources. All raw materials required for the building should be extracted, produced and processed under minimum, fair, humane, social standards in all countries of origin.* [LIVING BUILDING CHALLENGE 4.1, 2024], [DGNB System International, 2020]

- 2.2.4 Materials Efficiency: *Material efficiency is ensured through modular design of patients rooms, designing to standard dimensions where possible to reduce cut-offs, using recycled and recyclable materials, design for deconstruction and reuse, and usage of prefabricated elements. The waste from the construction period should be no more than 19 kg/m2 internal gross floor area.* [BREEAM-NOR V6.1, 2023]

- 2.2.5 Choose Materials That Fit Local Climate and Surroundings: *The materials used within the project should help reduce heating and cooling loads. As well as be*

culturally and aesthetically compatible with the surroundings. [Craft et al., 2017]

- 2.2.6 Use Materials Than Can Be Reused: *80 % of the materials used should be recyclable or reusable. The rest must be able to biodegrade safely.* [DGNB System International, 2020], [Attia, 2016]

- 2.2.7 Use of Reused or Recycled Materials: *The project should aim for FutureBuilt Circular Building classification. Local material databases should be browsed in order to find reusable materials from local demolition projects. The project should feature one salvaged material per 500 m2 of gross building area. The pollution prevented by the reuse of components can be recorded in the LCA.* [DGNB System International, 2020], [LIVING BUILDING CHALLENGE 4.1, 2024], [BREEAM-NOR V6.1, 2023]

- 2.2.8 Materials With Reduced Carbon Footprints: *The project should use products with lower than industry average carbon footprint for their product category (in so far as average embodied carbon data is readily available.).* [LIVING BUILDING CHALLENGE 4.1, 2024]

- 2.3 Waste Management

- 2.3.1 Construction and Demolition Waste Management: *A waste management plan must be developed and implemented in order to deal with construction waste. A minimum of 90% of the waste from the construction stage must be sorted.* [LEED V 4.1, 2024], [LIVING BUILDING CHALLENGE 4.1, 2024], [BREEAM-NOR V6.1, 2023]

- 2.3.2 Reuse and Recycle Construction Waste: *A minimum of 80% of the construction waste should be reused or recycled. 99% of metal, 99% of cardboard and paper, 100% of soil and biomass, 95% of rigid foam, carpet and insulation, and 90% of everything else should be reused or recycled.* [LIVING BUILDING CHALLENGE 4.1, 2024], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023]

- 2.3.3 Recyclables: *The project must provide dedicated infrastructure for the collection of recyclables and compostable food scraps during occupancy.* [LIVING BUILDING CHALLENGE 4.1, 2024]

- 2.4 Materials Database

- 2.4.1 Create a Materials Database: *All materials used within the project should be documented and listed in a materials database. The database should include both environmental information and ingredient lists, as well as information about maintenance, future reuse and material recycling.* [Attia, 2016], [DGNB System International, 2020], [BREEAM-NOR V6.1, 2023]

- 2.4.2 EPDs: *All products used within the project have an EPD to document the product's environmental impact.* [BREEAM-NOR V6.1, 2023]

- 2.5 Embodied Carbon and Emissions
- 2.5.1 Calculation of Embodied Carbon/GWP: *An LCA must be conducted during the design phase in order to calculate the project's overall carbon emissions and global warming potential.* [Attia, 2016], [DGNB System International, 2020], [BREEAM-NOR V6.1, 2023]
- 2.5.2 Reduction of Embodied Carbon: *The project must demonstrate a 40 % reduction in embodied carbon from building materials, compared to the benchmark set by DFØ. The reference values for a similar building type (retirement home) is 6.7 kgCO2 eqv./BTA m² year, or 337 kgCO2 eqv./BTA m². The initial LCA should lead to an optimisation of materials and design.* [LIVING BUILDING CHALLENGE 4.1, 2024], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023], [DGNB System International, 2020]
- 2.5.3 Carbon Offset: *The project must account for the total embodied carbon emissions (tCO2e) from construction through reforestation of the local area, utilisation of carbon-sequestering materials or purchase of carbon-offset through an ILFI-approved provider.* [LIVING BUILDING CHALLENGE 4.1, 2024], [Attia, 2016]
- 2.5.4 Collect As-built Data: *As-built data and greenhouse gas accounts must be collected and reviewed after completion of the project. Any sustainability goals that are related to greenhouse gas emissions, and have not been achieved must be reported to the developer.* [BREEAM-NOR V6.1, 2023]
- **3. Energy**
- 3.1 Energy Usage
- 3.1.1 Calculate Energy Usage: *The average yearly energy usage of the building must be calculated through the use of simulation during the design phase.* [BREEAM-NOR V6.1, 2023]
- 3.1.2 Optimise Energy Performance: *Use energy simulations during the design stage to predict the energy usage of the final design and affect decision-making. Implement measures to reduce loads and HVAC-related strategies (both passive and active) appropriate to the facility in order to reduce total energy consumption. Assess building shape, thermal envelope, glazing areas, thermal mass, location of functions with heat gains and location of energy demanding functions.* [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023]
- 3.1.3 Energy Reduction: *The total net energy use of the project should be 10% lower than the benchmark stated by TEK-17 (195 kWh/m2 heated gross area per year). After accounting for on-site renewable power, the project should 70% reduction in total net annual energy consumption. The efficiency of the combined cooling, heating*

and water service heating capacity should be improved by 20% (from 105 kWh/m2). [LIVING BUILDING CHALLENGE 4.1, 2024], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023]

- 3.1.4 Energy Used During Construction: *Tools and machinery used in the construction of the project must be powered by renewable energy.* [Attia, 2016], [BREEAM-NOR V6.1, 2023]
- 3.1.5 Energy Marking: *The project must achieve the energy marking B or better.* [BREEAM-NOR V6.1, 2023]
- 3.1.6 Renewable Energy: *All the buildings energy should come from renewable sources.* [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023]
- 3.2 Energy Production
- 3.2.1 On-site Energy Production: *On-site renewable energy systems must be implemented in the design of the project.* [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023]
- 3.2.2 Energy Sharing Strategies: *Measures should be taken to allow for exportation of excess energy.* [Craft et al., 2016]
- **4. Thermal Comfort**
- 4.1 Thermal Performance
- 4.1.1 Building Envelope: *The building envelope should be designed to maintain a stable indoor environment, reduce heating and cooling loads throughout the year and avoid heat loss and thermal bridges.* [Craft et al., 2016], [BREEAM-NOR V6.1, 2023]
- 4.1.2 Thermal Modeling: *A simulation or model of the interior thermal environment of the building must be used to assess the performance of the design. The model will, in combination with calculations, be used to address the building's heat loss, density, thermal mass, airflow and temperature variation.* [BREEAM-NOR V6.1, 2023]
- 4.1.3 Indoor Temperatures: *For common areas the temperature is set to be between 19 and 26 degrees Celsius.* [DGNB System International, 2020], [BREEAM-NOR V6.1, 2023]
- 4.1.4 Thermal Parameter Monitoring: *Dry bulb temperature, relative humidity, and air speed are measured, and the results are displayed on monitors within each room. The data is updated every 15 minutes, and reported at least two times per year (summer: June, July or August, and winter: December, January or February).* [International WELL Building Institute, 2020]

- 4.2 Thermal Control
- 4.2.1 Thermal Zoning: *At least 90% of regularly occupied spaces have a thermostat that is accessible to users. Common areas are divided into thermal zones with a size of maximum 100 m2. Private rooms and offices are individual zones, and can be controlled individually.* [International WELL Building Institute, 2020]
- 4.2.2 Individual control: *All private rooms have the ability to heat and cool their individual environment.* [International WELL Building Institute, 2020]
- 4.2.3 Operable Windows: *All rooms for regular occupancy have operable windows or doors leading to outside areas. Windows should have two modes of opening: one where the opening is as close to the ceiling as possible, and one where the window may be used as an escape route. The second mode is only accessible during emergencies.* [International WELL Building Institute, 2020]
- 4.2.4 Heating and Cooling Strategy: *Ground source heat pumps and heat exchange systems help heat the air within the mechanical ventilation system during the colder half of the year. Heat pumps provide extra heating inside the individual rooms. Cooling is primarily done through the use of natural ventilation.* [BREEAM-NOR V6.1, 2023]
- 4.2.5 Humidity Control: *The mechanical system in the building has the capability of maintaining a relative humidity between 20% and 60% at all times by adding or removing moisture from the air.* [International WELL Building Institute, 2020]
- 4.3 Outdoor Thermal Comfort
- 4.3.1 Manage Outdoor Heat: *At least 50% of pedestrian pathways are shaded for at least 2 daylight hours every day from June until August. At least 25% of parking spaces are shaded for at half of the daylight hours between June and August. Enclosed outdoor areas have canopies, vegetation or awnings that provide shaded areas throughout the day.* [International WELL Building Institute, 2020]
- 4.3.2 Shelter From Wind: *Main entrance and courtyard must be designed in a way that provides shelter from the wind.* [International WELL Building Institute, 2020]
- **5. Air**
- 5.1 Air Quality
- 5.1.1 Smoke Free Environment: *There are no designated smoking areas within the project, and smoking is prohibited within the building and enclosed outdoor areas. Users who smoke have to go to the parking lot to do so.* [International WELL Building Institute, 2020], [LEED V 4.1, 2024]
- 5.1.2 Pollutant Thresholds: *The project follows the local governments thresholds*

for pollutants, and the Total Volatile Organic Compound (TVOC) must not exceed 500 /mu/m³ per 8 hours. Carbon monoxide must not exceed 7 mg/m³ [6 ppm]. The amount of pollutant must be monitored. Radon must not exceed 0.15 Bq/L [4 pCi/L]. Filters in ventilation system helps control the amount of pollutants. [International WELL Building Institute, 2020], [BREEAM-NOR V6.1, 2023]

- 5.1.3 Air Quality Monitoring: *Monitors inside each ventilation zone measures pollutants: PM2.5 or PM10, Carbon dioxide, Carbon monoxide, Ozone, Nitrogen dioxide, Total VOCs, Formaldehyde, as well as the parameters mentioned in 4.1.4.* [International WELL Building Institute, 2020], [DGNB System International, 2020]

- 5.1.4 Pollution Infiltration Management: *All entryways to the building have a system composed of grilles, grates, slots or mats that catch dirt and particles upon entry to the indoor areas. The vestibule must have a double doorway system.* [International WELL Building Institute, 2020], [LEED V 4.1, 2024]

- 5.1.5 Combustion Minimisation: *Equipment used for heating, cooling water heating, process heating and water generation are electric, supplied by ground heat or district heating.* [International WELL Building Institute, 2020]

- 5.1.6 Microbe & Mold Control *All coils and drain pans may be opened to be inspected for mold growth and cleaned. Ultraviolet lamps are used within the central air handling units in order to irradiate the surfaces.* [International WELL Building Institute, 2020]

- 5.2 Ventilation System

- 5.2.1 Ventilation Design: *The project uses hybrid ventilation principles. On days where the outdoor temperature is below 19 degrees, mechanical ventilation with a heat recovery system is used to ensure comfortable indoor temperatures. When the outdoor temperature is above 19 C, the mechanical system is turned off, and the building relies on natural ventilation through the use of windows and vents. The building must therefore be designed with natural ventilation in mind. The ventilation system must ensure an air exchange rate of 0,35 m3 air per person and 1,05/10 m2 room area per second.* [International WELL Building Institute, 2020], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023], [Kellert et al., 2008]

- 5.2.2 Operable Windows: *All patient rooms and at least 75 percent of the regularly occupied spaces have operable windows that provide access to outdoor air. The openable window areas should be at least 4 percent of the area of the occupiable space for each floor.* [International WELL Building Institute, 2020], [LIVING BUILDING CHALLENGE 4.1, 2024]

- 5.2.3 Exhaust Vents: *Kitchens, bathrooms, janitorial areas, rooms for cleaning and printer rooms have direct exhaust to the outdoor areas. These rooms should have*

negative pressure compared to adjacent rooms in order to promote air circulation and minimize the build-up of pollutants. Exhaust outlets are placed at least 10m from air intakes. [International WELL Building Institute, 2020], [LIVING BUILDING CHALLENGE 4.1, 2024], [BREEAM-NOR V6.1, 2023]

- 5.2.4 Supply Air: *All private rooms are ventilated with outdoor air that hasn't circulated from other rooms within the building. All occupiable spaces with recirculated air are treated with purification systems.* [International WELL Building Institute, 2020]
- **6. Water**
- 6.1 Water Usage
- 6.1.1 Monitor Water Usage: *Water usage should be monitored.* [LIVING BUILDING CHALLENGE 4.1, 2024]
- 6.1.2 Reduction of Water Usage: *Water usage should be reduced by 40 percent compared to similar buildings through water saving equipment.* [LIVING BUILDING CHALLENGE 4.1, 2024], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023], [DGNB System International, 2020]
- 6.2 Drinking Water
- 6.2.1 Water Quality: *Water intended for human contact should be controlled for pollutants, pH and turbidity at regular intervals.* [International WELL Building Institute, 2020]
- 6.2.2 Drinking Water Promotion: *The project provides at least one drinking water dispenser or sink designed for water-bottle refilling per floor within regularly occupied areas. Each patient room should have a sink designed for water-bottle refilling.* [International WELL Building Institute, 2020]
- 6.3 Water Capture and Reuse
- 6.3.1 Water Capture: *Precipitation may be captures and used as non-potable water or for gardening purposes. If it is to be used as potable water it must be purified without the use of chemicals. Other closed-loop water systems may also be used.* [LIVING BUILDING CHALLENGE 4.1, 2024], [Persson, 2005], [LEED V 4.1, 2024], [DGNB System International, 2020]
- 6.3.2 Grey and Black Water Handling: *Grey and black water is addressed on site through reuse, a closed-loop system or infiltration. Filtered/purified grey water can be used as non-potable water for watering plants in the outdoor area.* [LIVING BUILDING CHALLENGE 4.1, 2024], [DGNB System International, 2020]
- 6.4 Moisture

- 6.4.1 Design Envelope For Moisture Control: *The building envelope is designed to minimise moisture intrusion and accumulation. Air tightness tests assess water vapour transfer.* [International WELL Building Institute, 2020]
- 6.4.2 Keep Humidity Within the Building Interiors At Comfortable Levels: *Humidity levels in interior rooms should be between 20 and 40 %.* [DGNB System International, 2020]
- 6.5 On-site Water
- 6.5.1 Rainwater Management: *Precipitation is handled on site through processes replicating natural site hydrology processes, such as drainage, permeable surfaces and flood paths. The system should avoid unwanted collections of water within the outdoor area, and retain the runoff from the 90th percentile of regional rainfall events. A 600 mm threshold leads excess water away from the building, and ensures proper water handling.* [LIVING BUILDING CHALLENGE 4.1, 2024], [Xue et al., 2019], [BREEAM-NOR V6.1, 2023], [LEED V 4.1, 2024]
- 6.5.2 Roof Garden Water Handling: *At least 70 % of the roof is constructed as green roof in order to handle stormwater runoff.* [Kellert et al., 2008], [BREEAM-NOR V6.1, 2023]
- 6.5.3 Permeable Surfaces: *All courtyard surfaces should be permeable to water.* [Persson, 2005], [Xue et al., 2019], [BREEAM-NOR V6.1, 2023]
- 6.6 Water as Design Feature
- 6.6.1 Incorporation Of Water In Landscaping: *Water elements such as ponds, rain beds, streams or wetlands should be incorporated in the landscaping of the project. These elements act both as design elements and help capture and retain precipitation.* [Kellert et al., 2008], [BREEAM-NOR V6.1, 2023], [Xue et al., 2019]
- 6.6.2 Indoor Water Features: *Water should be incorporated as design elements within the interior of the project.* [Kellert et al., 2008]
- **7. Light**
- 7.1 Light Conditions
- 7.1.1 Provide Visual Acuity: *Rooms and areas will have illuminance thresholds related to their intended use. Offices, classrooms and similar workspaces must have 300 lux at task surface. Circulaton areas and storage spaces - 100 lux at floor level. Dining areas, lounges, restrooms - 100 lux at task surfaces. Dwelling units - 300 lux at task surfaces.* [International WELL Building Institute, 2020]
- 7.1.2 Circadian Lighting Design: *Regularly occupied areas with automatic light fixtures are dimmed at 8 pm. All electric lights are dimmable. For at least four hours*

every day between March 21st and September 21st a daylight level of 250 lux is achieved at 45 cm above each workstation. [International WELL Building Institute, 2020]

- 7.1.3 Visual Balance: *The ambient lighting within all regularly occupied spaces meets the following requirements: The luminance contrast between horizontal and vertical lighting is no more than 10:1 between adjacent, independently controlled zones, The automatic lighting system automatically changes light levels, color and distribution over a time period of 10 minutes, and The Correlated Color Temperature (CCT) within each room is consistent (+/- 200 K). The lighting must be designed by a lighting professional.* [International WELL Building Institute, 2020]

- 7.2 Daylight

- 7.2.1 Daylight Simulation: *Simulations and calculations must be used to prove sufficient daylight conditions. he following reflection factors should be used in each room: floors: 0.3, walls: 0.5, windowsills: 0.8, ceilings: 0.8. The simulations must show that the patient rooms, outdoor courtyard and dining area receives at least 3 hours of daylight on February 1st, and that all regularly occupied areas receive at least 1 hour of sunlight on the 17th of January.* [International WELL Building Institute, 2020], [BREEAM-NOR V6.1, 2023], [DGNB System International, 2020]

- 7.2.2 Provide Sufficient Daylight: *Simulations prove that the project achieves a Daylight Factor (DF) of at least 4% for 50% of the usable area, and 2,4% for 95 % of the area. Regularly occupied spaces must achieve an average sDA of 300 lux for 75% of the area throughout 50% of the daylight hours of the year.* [International WELL Building Institute, 2020], [BREEAM-NOR V6.1, 2023], [DGNB System International, 2020], [Kellert et al., 2008]

- 7.2.3 Daylight Design Strategies: *30% of the regularly occupied area must be within 6m horizontal distance to the envelope glazing on each floor. At least 75% of the seating and workstations are placed within 5m of the envelope glazing to ensure daylight and views. For the patients rooms the vertical envelope glazing areas must be at least 25% of the floor area, and for other regularly occupied areas it must be at least 10%. Overall, the envelope glazing (vertical and horizontal) must be no less than 25% of the total regularly occupied area. The visible light transmittance (VLT) through the glazed areas must be greater than 40%.* [International WELL Building Institute, 2020], [LEED V 4.1, 2024], [DGNB System International, 2020]

- 7.2.4 Glare Control: *All translucent areas must be equipped with glare-control and shading devices to ensure light levels doesn't exceed 3000 lux. Glare control must be implemented where the Daylight Glare probability (DGP) exceeds 0.4 for more than 5 percent of the annual hours of operation. The solutions must be designed so that daylight may still enter the building.* [BREEAM-NOR V6.1, 2023], [International

WELL Building Institute, 2020], [DGNB System International, 2020]

- 7.2.5 Window Design: *The windows and building must be designed to draw daylight far into the building and provide good visibility and sunlight without danger of overheating.* [BREEAM-NOR V6.1, 2023]
- 7.2.6 Window Placement: *Simulations should play a part in the finding the number and final placement of windows on the facades.* [BREEAM-NOR V6.1, 2023]
- 7.3 Electric Light
- 7.3.1 Electric Light Glare Control: *All light fixtures within regularly occupied spaces has a luminance of less than 6000 candela per m2 between 45 and 90 degrees from nadir.* [International WELL Building Institute, 2020], [LEED V 4.1, 2024], [DGNB System International, 2020]
- 7.3.2 Occupant Lighting Control: *All regularly occupied spaces contain lighting zones, divided by function or per 100m2. Each zone can be controlled individually, and have at least 3 different lighting levels or scenes. Regularly occupied spaces automatically swithc between scenes during the day, but can be overridden. All private rooms have individual controls.* [International WELL Building Institute, 2020], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023]
- 7.3.3 Color Rendering: *All regularly occupied spaces have light sources with a Color Rendering Index (CRI) of at least 90, Color Fidelity Index greater than 78, and a gamut index between 97 and 110.* [LEED V 4.1, 2024]
- 7.3.4 Illuminance: *The electric light fixtures must achieve illuminance levels between 300 and 3000 lux.* [LEED V 4.1, 2024]
- 7.4 Light and Space
- 7.4.1 Filtered Light and Shadows: *Filtered and diffused sunlight occur frequently in nature (light filtered through foliage, sparkling glare in water, starry skies etc.), and may be used within the interior to stimulate observation and calmness, as well as provide connections between spaces. Deliberate sculpting of light and shadow can also help emphasise tactility and texture in materials, shape and volume. Creative manipulation of light, shadow, diffused and filtered light can foster curiosity, mystery and stimulation.* [Kellert et al., 2008], [BREEAM-NOR V6.1, 2023]
- 7.4.2 Reflected Light: *Reflection can be used both to create uniform light levels, mitigate glare, and enhance penetration of light into interior spaces. 90 % regularly occupied spaces should have interior finishes with a surface reflectance greater than 80 % for ceilings and 55% for walls.* [Kellert et al., 2008], [LEED V 4.1, 2024]
- 7.4.3 Use of Light to Manipulate Feelings and Movement: *The manipulation of*

natural and artificial light can create feelings of security, curiosity and calmness. For example: Points with enhanced light levels can attract people and foster feelings of security and protection. These light pools can be used for navigation and to instigate movement through the space. Warmly lit areas can promote feelings of security and warmth. [Kellert et al., 2008]

- **8. Nature**

- 8.1 Provide Connection To Nature

- 8.1.1 Provide Nature Access Indoors: *At least 75% of workstations and seating arrangements have a direct line of view to indoor plants, water features or nature views. The remaining workstations and seats must be within 10m of indoor plants, water features or nature views. Every office space, patient room and living area must have a visual connection to the outside, and at least 80% of common areas have a door leading to an outside area.* [International WELL Building Institute, 2020], [LIVING BUILDING CHALLENGE 4.1, 2024], [DGNB System International, 2020]

- 8.1.2 Views and Vistas: *All patient rooms must have views of natural landscapes and vegetation. All regularly occupied rooms must have views to the outside. 30% of views may be to atrium areas, and all views to the outside must include elements of nature, living systems or natural processes. Views of nature or presence of natural elements can reduce stress and offer patients the opportunity to change focus, rest their eyes and avoid further cognitive exhaustion.* [Kellert et al., 2008], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023], [Browning et al., 2014], [Xue et al., 2019]

- 8.1.3 Provide Nature Access Outdoors: *The enclosed outdoor area within the building must be at least 20% of the building interior area. Out of the outdoor space at least 80% must be universally accessible. At least 70% of the accessible area must include plants or natural elements.* [International WELL Building Institute, 2020], [BREEAM-NOR V6.1, 2023], [DGNB System International, 2020]

- 8.1.4 Presence of Water: *Water features must be incorporated within the design of the project in order to promote stimulating and calming emotions. Ways of incorporating water could be through the use of: water mirrors, waterfalls, fountains, or aquariums.* [BREEAM-NOR V6.1, 2023]

- 8.1.5 Design of Outdoor Areas: *The outdoor area must also include seating areas, activity spaces, water features, shelter that protect against weather and wind, natural stones and open green spaces.* [DGNB System International, 2020]

- 8.1.6 Usage of Natural Materials: *Natural materials, patterns, shapes, colors, images and sounds must be present within the interior of the project. As well as plants, water and views of nature.* [International WELL Building Institute, 2020]

- 8.1.7 Natural Shapes And Forms: *Botanical motifs, animal motifs, shells and spirals, egg, oval and tubular forms, curved and flowing lines, and general simulations of natural features should be implemented within the building interior in order to promote references to nature. Examples of design elements are: pictures of nature, shape and form of walls or furniture, and ornaments. Curved spaces and rooms without right angles can also promote a sense of mystery and discovery by only revealing part of the views at a time.* [Kellert et al., 2008]

- 8.1.8 Structural Elements Referencing Nature: *Columnar, tree-like support structures should be used as structural and design elements to promote references to forested areas. Arches, vaults, and domes also reference forms found within nature, such as beehives, shells and cliffs.* [Kellert et al., 2008]

- 8.1.9 Use of Natural Patterns And Processes: *The design must incorporate one or more natural patterns or processes, such as Sensory Variability and Information Richness (Variable environments, with a variety of sensory inputs, such as light, sound, touch, smell, colors and views, to stimulate the users of the building.), Age, Change And the Patina of Time (Elements that features changes throughout the year, or show signs of aging. This could be achieved through the use of natural materials or by the use of flowers, bushes and trees that change their nature over the course of time.), Central Focal Point (The project should be organized through a central point of reference in order to facilitate navigation and circulation. This reference point should be a courtyard, and outside space that's accessible from within all areas within the project.), Transitional Spaces (The project should offer transitional spaces between different functions, as well as between outside and inside spaces.), Fractals (Nature contains patterns of similar or related forms, repeated in high quantities. These shapes are referred to as fractals and fractal-based patterns can be incorporated within the design of the building. Fractals are often related in arithmetically or geometrically complex patters. These relations include the Fibonacci-ratio and the Golden Proportion), Biomorphic Design (Forms that resemble forms encountered within nature or posess the same logic as natural structures and patterns promote strong feelings of connection with nature.), Geomorphology (Geomorphic design mimics or embrace landscape and geology. By playing with the relationship between the ground and the building, the design might appear integral to their geological context.), or Biomimicry (Biomimicry involves imitating strategies found within nature, such as the structural strength of shells and crystals, thermal properties of termite mounds and double skin facades.).* [Kellert et al., 2008], [BREEAM-NOR V6.1, 2023]

- 8.2 Local Habitat and Ecosystem

- 8.2.1 Increase Biodiversity: *Measures must be taken to ensure the project support of the existing ecosystem, and carefully introduce new and native flora and fauna within*

both outdoor areas and buildings. The buildings should have a combination of vertical greening and green roofs to further encourage biodiversity. No more than 5 of the same plant should be planted within the courtyard. [Craft et al., 2016], [BREEAM-NOR V6.1, 2023], [DGNB System International, 2020], [Xue et al., 2019], [Persson, 2005]

- 8.2.2 Measures For Habitat Connectivity: *The project should maintain existing animal habitats and links between surrounding biotopes. Buildings must be planned in a way that doesn't block green corridors or disrupt green pockets.* [DGNB System International, 2020], [BREEAM-NOR V6.1, 2023]

- 8.2.3 Avoidance of Invasive Species: *No invasive plant species must be planted on the land as part of the project.* [DGNB System International, 2020]

- 8.3 Plants

- 8.3.1 Indoor Plants: *The interior spaces must include potted plants, and larger flower beds in order to improve air quality and provide a connection to nature.* [Kellert et al., 2008]

- 8.3.2 Facade Greenery: *A minimum of 10% of the exterior walls must be covered in climbing plants or other green facades.* [Kellert et al., 2008], [Persson, 2005], [DGNB System International, 2020]

- 8.3.3 Green Roofs: *90% of the roofs within the project should be covered in grass or vegetation. At least 10% of the roof surface must be outdoor areas available to the users of the building.* [Kellert et al., 2008], [Persson, 2005], [BREEAM-NOR V6.1, 2023], [DGNB System International, 2020]

- 8.3.4 Outdoor Plants: *A range of different plants should be included within the outside area of the project to create a diverse courtyard. At least 50% of the flowers used within the courtyard should be wild Norwegian flowers found within the project's region. The courtyard should include at least 2 types of fruit trees or bushes. All plants used should have a value for birds and pollinating insects, such as flowers with pollen/nectar, or fruit and berries. The variety of plants should ensure that there are plants flowering throughout the entire summer season.* [Kellert et al., 2008], [Persson, 2005], [BREEAM-NOR V6.1, 2023]

- 8.3.5 Native Species Ratio: *All plants used within the courtyard should grow wildly in nearby areas, or be domesticated plants suitable for the climatic conditions and have seeds produced within the Nordic countries.* [Xue et al., 2019], [Persson, 2005], [BREEAM-NOR V6.1, 2023]

- 8.3.6 Urban Farming: *The project must dedicate at least 10% of the total project area to growing food through the implementation of a vegetable garden, fruit trees and*

bushes. Every non-hard surface within the courtyard should have soil deep enough to grow vegetables. [Xue et al., 2019], [Craft et al., 2017], [Persson, 2005], [LIVING BUILDING CHALLENGE 4.1, 2024]

- 8.4 Animals
- 8.4.1 Maintaining Habitats: *Hiding places and "residences" for animals must be established in the area in order to ensure that animals can remain within their habitat. These can be leaf and twig mounds, vegetation that isn't managed, bird boxes, bat boxes, squirrel boxes, insect hotels, dead wood, and beehives.* [Kellert et al., 2008], [BREEAM-NOR V6.1, 2023], [DGNB System International, 2020]
- 8.4.2 Incorporating Animals Within the Building: *Beehives, nesting boxes and greenery on the roof encourages insects, birds and animals to live on and within the building.* [Kellert et al., 2008], [DGNB System International, 2020], [Craft et al., 2016], [Persson, 2005]
- 8.4.3 Biotopes For Insects: *One biotope for specific insects should be established for every 100 m2 courtyard.* [Persson, 2005]
- 8.4.4 Nectar Producing Flowers: *All the vegetation planted within the project boundary should be nectar giving and serve as a insect and butterfly takeaway.* [Persson, 2005]
- **9. Spaces & Design**
- 9.1 Circulation Network
- 9.1.1 Staircases: *At least one staircase must service all occupiable floors of the project and provide access to daylight, and/or nature views.* [International WELL Building Institute, 2020]
- 9.1.2 Signage: *The project must have proper signage to ensure that it's easy to navigate. A reception desk must be located within sight from the main entrance.* [International WELL Building Institute, 2020]
- 9.1.3 Entrance: *The main entrance must be identifiable and easy to find.* [DGNB System International, 2020]
- 9.1.4 Parking Infrastructure: *A designated drop-off zone must be located within 20m of the main entrance. Parking must be located 200m from the main entrance.* [DGNB System International, 2020]
- 9.2 Spatial Design
- 9.2.1 Spatial Variability: *Spaces should be organised in a way that promotes spatial variability, in complementary relation to organised and functional spaces.* [Kellert

et al., 2008]

- 9.2.2 Spatial Harmony: *Space, as in shape and form, should be blended with light, mass, scale and function in order to create harmonic interiors that fosters a sense of security, creativity, and curiosity and facilitates movement.* [Kellert et al., 2008]

- 9.2.3 Variety of Social Zones: *The project must include a variety of social zones, such as rooms where the main function is to be social (living rooms) and hallways, atria, and alcoves that promotes social interactions. Communication may be further encouraged through interior design elements such as galleries, glazed walls, wide stairways, seating, enclosed outdoor areas and daylight. These spaces should also incorporate nature.* [DGNB System International, 2020], [Craft et al., 2016]

- 9.2.4 Inside-Outside Spaces: *The common areas within the project should strive to have an enhanced connection with the outside environment through the use of glass-facades, sliding doors, natural elements, skylights and plants. The use of design elements such as atriums, interior gardens, foyers, collonades and porches will help establish this connection.* [Kellert et al., 2008]

- 9.2.5 Connections Between Buildings: *Separate buildings or building parts must be connected by sheltered corridors or bridges, so that one may walk somewhat protected from the weather when walking from one building to the next.* [Xue et al., 2019]

- 9.3 Design For Longevity

- 9.3.1 Design for Circularity: *The design must make use of reuse-able materials, and assembled in a way that facilitates disassembly and future retrofits to adapt to changing climate conditions, needs and technology.* [Attia, 2016], [Craft et al., 2017]

- 9.3.2 Design For Flexibility And Adaptability: *Individual rooms must be designed with spaciousness and flexibility in mind, both to invoke feelings of openness often found in nature, and to promote flexibility and adaptability. The overall design must be flexible enough to be altered to adapt future needs. This should be done through the use of modules, allowing building expansions to be implemented without modifying the existing loadbearing structure, and by keeping most of the ensuring that the majority of interior walls aren't loadbearing.* [Kellert et al., 2008], [DGNB System International, 2020], [Attia, 2016]

- 9.3.3 Technological Solutions: *The technical solutions within the building must be designed in a way that allows for them to be accessed in order to perform maintenance and replacements without creating a need for extensive refurbishment.* [DGNB System International, 2020]

- **10. Human Well-being**

- 10.1 Promoting Physical And Mental Health

- 10.1.1 Cycling Infrastructure: *The project must provide storage for bikes, as well as showers and wardrobes, in order to encourage biking.* [International WELL Building Institute, 2020], [LIVING BUILDING CHALLENGE 4.1, 2024]

- 10.1.2 Active Outside Spaces: *The outside area must include active spaces that promote social, physical activities.* [International WELL Building Institute, 2020]

- 10.1.3 Promote Mental Health And Well-being: *The overall design promotes mastery of self, calmness, comfort, and recovery. The program includes spaces dedicated to physical and mental well-being, such as a meditation/mindfullness-room, excercise area, yoga studio and activity rooms. The layout of the building allows for different levels of social interactions, and "escape routes" if the situations becomes too overwhelming for the patients.* [International WELL Building Institute, 2020]

- 10.1.4 Provide Restorative Space: *The project must include one room that aims to create a particularly restorative and relaxing space. This room must include adjustable lighting, sound interventions, comfortable seating, subdued colors, textures and forms, smells and thermal control.* [International WELL Building Institute, 2020]

- 10.1.5 Build At A Human Scale: *The project must maintain an approriate scale for the local infrastructure and human beings.* [LIVING BUILDING CHALLENGE 4.1, 2024]

- 10.2 Sensory Design

- 10.2.1 Aromatic Plant Design: *Plants should be used as both natural elements, and a source of aromatic experiences, further enhancing the sensory inputs within the project's interior.* [Kellert et al., 2008], [Xue et al., 2019]

- 10.2.2 Use Of Color: *Interior and exterior colors must be planned and used as a strategy to promote the desired feelings and atmospheres within the individual rooms. White, black and grey interiors should be avoided as they invoke assosiations to man-made, sterile environments. Natural colors and shades should be promoted.* [Kellert et al., 2008]. [Xue et al., 2019]

- 10.2.3 Tactile Surfaces: *The project must include some tactile surfaces that provide stimulation and resemble surfaces found in nature. These types of surface can also have sound-dispersing or absorbing qualities.* [BREEAM-NOR V6.1, 2023], [Kellert et al., 2008]

- 10.3 Inclusive Design

- 10.3.1 Conduct An Inclusivity Assessment: *The design must take inclusivity and the users challenges and capabilities into consideration. Before finalising the design,*

an inclusivity assessment must be conducting, assessing: sensory abilities and properties, immunological functions, physical abilities and characteristics, and cognitive skills. The accessibility and user friendliness of roads, outdoor areas, horizontal and vertical circulation within the project, sanitary areas, evacuation routes and access areas must be taken into account. The assesment must then result in an Inclusive Design Strategy. [BREEAM-NOR V6.1, 2023]

- 10.3.2 Accessible Design: *All people must be able to use the building regardless of their physical capabilities. The design must therefore feature barrier-free infrastructure, tactile information surfaces for doors and and elevators, and accessible toilets on all floors. All patient rooms must feature accessible bathrooms.* [DGNB System International, 2020], [BREEAM-NOR V6.1, 2023]

- 10.3.3 Design For Safety And Security: *All users of the project must feel safe within the area. This requires the design to allow all users to move freely, have an overview of their environments and have opportunities to escape both social encounters and dangerous situations. The design must also accommodate for the removal of dangerous individual in order to de-escalate situations.* [DGNB System International, 2020]

- **11. Acoustics**

- 11.1 Acoustic Environment

- 11.1.1 Acoustic Zones: *The project must be divided into different acoustic zones according to their activities: Loud zone (areas for loud activities such as mechanical rooms, technical rooms, kitchens, fitness rooms, social spaces, recreational rooms and music rooms), Quiet zone (areas for concentration, rest and privacy such as study rooms, patient's private rooms, offices, and meditation rooms), Mixed zone (areas for learning and collaboration such as meeting rooms and classrooms), Circulation zone (hallways, staircases, lobbies, and atria), and Not applicable zones (areas without significant sources of sound, such as storage rooms, janitor rooms and closets). The Loud zone and Quiet zone rooms should be separated by sound absorbing measures, sound insulation or Non-applicable, Circulation of Mixed zone rooms.* [International WELL Building Institute, 2020]

- 11.1.2 Acoustic Design: *The design must take measures to manage acoustic comfort, background noise, speech privacy, reverberation time, and impact noise.* [International WELL Building Institute, 2020], [BREEAM-NOR V6.1, 2023], [Xue et al., 2019]

- 11.1.3 Limit Background Noise: *Measures must be taken to keep backround noise within acceptable levels according to the acoustic zone: Loud Zone (dBA: 50, dBC: 70), Quiet zone (dBA: 35, dBC: 55), Mixed Zone (dBA: 45, dBC: 65), and Circula-*

tion zone (dBA: 40, dBC: 60). Average backround noise level in patient rooms must not ecxeed 35 dBA. [International WELL Building Institute, 2020], [LEED V 4.1, 2024], [BREEAM-NOR V6.1, 2023], [DGNB System International, 2020]

- 11.1.4 Provide Enhanced Speech Intelligibility: *Rooms used for learning, performance or other types of remote communication must have speech reinforcement systems installed.* [International WELL Building Institute, 2020]

- 11.2 Sound Insulation

- 11.2.1 Sound Insulation In Walls: *Interior walls must have the following Sound Transmission Class (STC) or Weighted Reduction Values (Rw), and Noise Insulation Class (NIC) or Weighted Difference Level (Dw): between loud zones and other occupiable spaces (STC/Rw: 60, NIC/Dw: 55), between learning areas or sleeping and other occupiable rooms (STC/Rw: 55, NIC/Dw: 50), between adjacent quiet rooms (STC/Rw: 50, NIC/Dw: 45), between rooms for concentration and other regularly occupied spaces (STC/Rw: 45, NIC/Dw: 40), between circulation zones and regularly occupied spaces (STC/Rw: 40, MIC/Dw: 35). Doors that connect two occupiable rooms and and doors to mechanical equipment rooms have sound insulation properties (STC/Rw: 30).* [International WELL Building Institute, 2020], [LEED V 4.1, 2024]

- 11.2.2 Impact Noise Reducing Flooring: *The floors must achieve the following minimum Impact Insulation Class (IIC) and Normalized Impact Sound Ratings (NISR): Quiet zone, except areas for concentration, (IIC: 55, NISR: 57), Areas for fitness (IIC: 50, NISR: 52), Areas for concentration (IIC: 45, NISR: 52), Areas for dining (IIC: 45, NISR: 47).* [International WELL Building Institute, 2020]

10.2.2 Project-specific Guidelines for Psychiatric Design

As the aim of this project is to create a psychological institution where patients may thrive and recover, guidelines for the design of hospitals and psychological institutions in the Nordic Countries must also provide the foundation for the final design. The guidelines have been divided into the categories: Security & Safety, Size, Structure, Siting, Staffing, Sense of Normalcy, and Physical Milieu.

Design Interventions and Examples

- **1. Security & Safety**

- 1.1 Patient Safety

- 1.1.1 Prevent Self-harm *Anti-ligature elements/non-weight-bearing fixtures, safe radiator surfaces, unbreakable glass surfaces, and doors opening outwards to avoid the*

opportunity to barricade oneself in. [Chrysikou, 2014], [Bergsland, 2024], [Bergsland, 2008]

- 1.1.2 Fire Safety *Every patient room must be it's own fire cell, and have windows large enough to be used as an escape route.* [Bergsland, 2008]
- 1.1.3 Social Interactions *The patients must have the opportunity to retreat from social interactions and situations. This may be ensured through the design of the circulation system, as well as ensuring that all areas have enough space. The facility must have neutral rooms for conversation and therapy, as opposed to having all consultation happening within the doctor or therapists offices.* [From et al., 2009]
- 1.2 Staff Safety
- 1.2.1 Open and Visible Environments *Interior and exterior environments should be designed such a way that staff may get an overview of situations that arise. However, it's important that the patients don't get the sensation that they're being kept under surveillance, and hatches and peep-holes must be avoided.*[Chrysikou, 2014], [Bergsland, 2020], [From et al., 2009], [Program för teknisk standard, 2018a]
- 1.2.2 Safe Interactions With Users *Doors open out into hallways and open areas, so that they can't be used to hide behind. Rooms used for conversation and therapy should have a safe retreat.* [Bergsland, 2008]
- 1.3 Secure Facilities
- 1.3.1 Entrance and Exit *Exits and entrances must be easy to find in case of emergencies and unforeseen events. The main entrance must have a receptionist that welcomes visitors and keeps an overview of the entrance/exit. The front doors must open automatically during visitors hours.* [Chrysikou, 2014], [Bergsland, 2008]
- 1.3.2 Medication Storage *Medication must be stored in a designated room, where patients have no access. Staff must be able to access the medication storage at any time.* [Chrysikou, 2014]
- 1.3.3 Locks *Patients should have the opportunity to lock their rooms, but staff must have emergency overrides. Storage areas and closets that contain objects that may be abused must be lockable.* [Chrysikou, 2014]
- 1.3.4 Safe Removal of Individuals *Common areas must contain facilities that facilitate the removal of violent individuals, ensuring the safety of other patients and staff. These rooms should not be seclusion units, but rather calm areas with limited sensory input. They must have a view outdoors.* [Chrysikou, 2014]
- 1.3.5 Clinical Functions Close To Ward *Doctors, psychiatrists and therapists should have facilities located so that patients may retreat to their private rooms without*

having to walk through the common area and encounter unwanted social interactions. [Chrysikou, 2014]

- 1.3.6 Safety- and Robustness Zones *The project must be divided into different safety- and robustness zones with a varying degree of safety measures. Green Zones are areas where the patient's generally doesn't go, or are accompanied by staff (Staff area, offices and technical rooms). These rooms have no security measures other than an alarm. Yellow Zones contain rooms where patients are seldom on their own (common rooms such as living rooms and activity rooms). Rooms within the Yellow Zones should have some security, safety and robustness measures such as reinforced walls, heavy furniture that can't be thrown, ways to remove violent individuals and escape routes. Orange Zones are areas where the patients are generally alone, such as bathrooms and the patient's private rooms. These rooms must have anti-ligature elements, and all fixtures must be securely fastened. The project has no Red Zone areas, as the patients should be low risk.* [Bergsland, 2024], [Sykehusbygg, 2018,]

- **2. Size**

- 2.1 Physical Size of Project

- 2.1.1 Number of Floors *The project should have a maximum of 4 floor, in order to not seem intimidating. In order to reduce the perceived size the design should use measures to break down the facade (angles, change of materials).The design should aim to have no more than two stories visible above ground in the facade.* [Bergsland, 2020], [Bergsland, 2013]

- 2.1.2 Ceiling Height *There must be a 3m distance between floor and ceiling in all rooms.* [Bergsland, 2008], [Sykehusbygg, 2018,]

- 2.1.3 Spaciousness *The project must have a Gross/Net-factor of 2 to ensure sufficient space and avoid crowding. Common areas must have room to avoid unwanted social interactions. Proxemics must be taken into account when deciding the sizes of rooms.* [Bergsland, 2008], [Bergsland, 2024], [Program för teknisk standard, 2018a], [Bergsland, 2020]

- 2.2 Facility Scale

- 2.2.1 Number of Patients *Wards should not exceed 15 patients.* [Bergsland, 2020], [Chrysikou, 2014]

- 2.2.2 Number of Wards *A psychiatric institution should not contain more than 5 wards, in order for staff to maintain an overview of all patients.* [Bergsland, 2020], [Chrysikou, 2014]

- **3. Structure**

- 3.1 Circulation
- 3.1.1 Hallways/corridors *Corridors should be kept short (max 30m), or have a change in direction to invoke a feeling of shorter corridors. Hallways must have a minimum width of 2,4m to make sure people can comfortably pass each other, in order to reduce stress. The hallways should also feature lighting from the side, either through the use of glazing or light fixtures.* [Bergsland, 2020], [Ulrich et al., 2018], [Bergsland, 2013], [Chrysikou, 2014], [Bergsland, 2008], [From et al., 2009], [Ulrich et al., 2018]
- 3.1.2 Logical Direction *The project should offer few choices as of where to go, but rather have a logical organisation where new patients may orientate themselves easily and avoid confusion.* [Bergsland, 2024]
- 3.1.3 Avoid Dead Ends *Dead end corridors should be avoided, and hallways should be organised around a central area.* [From et al., 2009]
- 3.1.4 Way-finding *The project must focus on creating places to remember in order to facilitate way-finding.* [Bergsland, 2013], [Bergsland, 2008]
- 3.2 Entrance
- 3.2.1 Staffed Reception *The project must have a welcoming entrance area with a reception desk where a person greets all visitors.* [Bergsland, 2024], [From et al., 2009]
- 3.2.2 One Entrance *The project must have one entrance for all users, visitors and staff.* [From et al., 2009]
- 3.3 Common areas
- 3.3.1 Central Outdoor Area *The project should be organised around a central, open outdoor area to provide overview, a sense of freedom and access to nature. The patients should have access to this area straight from their private rooms.* [From et al., 2009]
- 3.3.2 Open Areas *Common areas should be spacious and open. Instead of putting each function in it's designated room the project should strive to create an area where several activities may take place and the patients themselves can choose whether to actively or passively take part in them.* [Chrysikou, 2014]
- 3.3.3 Escape Routes *All common areas should have a way for patients to remove themselves from uncomfortable or unwanted situations or interactions.* [Bergsland, 2024]
- 3.3.4 Bathrooms *Bathrooms should not open directly into social areas or main corridors.* [Chrysikou, 2014]

- **4. Siting**
- 4.1 Location
- 4.1.1 Points of Interest *The project should be located close to other points of interest, and not be isolated from society.* [Chrysikou, 2014]
- 4.1.2 External Recreational Areas *The project must be located within walking distance of parks or recreational areas, encouraging field trips outside of the facility.* [Chrysikou, 2014]
- 4.2 Outside Areas
- 4.2.1 Courtyard *The project should feature large outside areas for it's users. Patients should be able to move freely through the outdoor area.* [Bergsland, 2020], [Chrysikou, 2014]
- 4.2.2 Entrance *The entrance area must feature seating and have rooms for cars to deliver or pick-up patients.* [Chrysikou, 2014]
- 4.2.3 Outside Access *As much of the building as possible should have direct outside access.* [From et al., 2009]
- 4.2.3 Areas Protected From Weather *The outside area should have an area that's protected from weather.* [From et al., 2009]
- 4.2.4 Areas For Therapy *The outside area should be used as a means of reducing stress, and as a place for therapy.* [Program för teknisk standard, 2018a]
- 4.3 Views
- 4.3.1 Interesting Views *The project must feature views that are interesting to watch, such as a bus stop, road, trail or wildlife habitat where objects move and interact.* [Chrysikou, 2014]
- 4.3.2 Avoid Outside Views Into Project *Outsiders must not be able to view into the interior of the project and watch the patients.* [Bergsland, 2020]
- 4.3.3 Views of Nature *The project must offer views of nature and landscapes from both patients rooms and common areas.* [Ulrich, 1984], [From et al., 2009], [Chrysikou, 2014]
- **5. Staffing**
- 5.1 Staff Areas
- 5.1.1 Close Proximity Between Staff and Patients *Treatment rooms, doctors offices and therapy rooms should be located within the common area, for close access during the daytime. Each ward must have a staff room, where staff can reach patient's*

rooms within a short time, and vice versa. Staff should be able to see the doors of all patient rooms from their central staff room, and the patients should all be able to see the staff as they exit their private rooms. The staff area should not feel like a a guard tower, and patients should not feel like they're under surveillance. [Chrysikou, 2014], [Bergsland, 2020], [From et al., 2009], [Program för teknisk standard, 2018a]

- 5.1.2 Administration *Administration should be located close to the main entrance.* [Bergsland, 2024]
- 5.1.3 Maintenance *Maintenance staff and workshops should be located close to delivery points and circulation routes in order to move tools and objects around the building.* [Chrysikou, 2014]
- 5.1.4 Open Team-stations *Staff areas should be designed as open team-stations.* [Program för teknisk standard, 2018a]
- 5.2 Staff
- 5.2.1 Number of Staff *The project must accommodate the same number of regular staff as there are patients.* [Bergsland, 2024]
- **6. Sense of Normalcy**
- 6.1 Functions
- 6.1.1 Visitor Areas *The project must have designated areas for visitors, with both places to sit and talk and perform more active social interactions (particularly with children in mind).* [Chrysikou, 2014], [Program för teknisk standard, 2018b]
- 6.1.2 Variety of Common Areas *The project must contain a variety of common areas, in order to accommodate different opportunities for socialisation and activities. All common areas must be comfortable and socially supportive, yet offer the possibility to withdraw if necessary.* [Chrysikou, 2014], [Ulrich, 2003], [From et al., 2009]
- 6.1.3 Activity Areas *The project must include areas that serve particular activities such as exercise rooms, kitchens, music rooms and arts & crafts rooms, where patients can perform recreational activities and be active participants in their own recovery.* [Chrysikou, 2014], [From et al., 2009]
- 6.1.4 Neutral Rooms For Conversation *The project must contain rooms for conversations between patients and staff, as well as next of kin. These rooms should be located away from the wards, treatment area and main common area.* [Program för teknisk standard, 2018a]
- 6.1.5 Tea And Coffee *Tea and coffee equipment should be located in calm common areas, as places for social interactions.* [Chrysikou, 2014]

- 6.1.6 Dining Room *The project must include a dining area with room for all patients. The dining room must provide external views.* [Chrysikou, 2014]
- 6.1.7 Sensory Modulation *Rooms for sensory modulation can be used both as a means of therapy, and as an alternative to isolation.* [Program för teknisk standard, 2018a]
- 6.2 Furnishings
- 6.2.1 Homeliness *The general decoration of the project should aim to create a homely atmosphere, as opposed to the sterile environments of institutionalised architecture. I.e. the TV area should have a comfortable coach or individual seating arrangements.* [Chrysikou, 2014], [Program för teknisk standard, 2018a], [Bergsland, 2013]
- 6.2.2 High-Quality Furniture *The project must contain high-quality furniture, that's comfortable and beautiful, in order to create a sense of worth for the patients. The furniture should be movable, but too heavy to throw.* [Chrysikou, 2014], [Bergsland, 1991], [Program för teknisk standard, 2018a]
- 6.3 Personalisation
- 6.3.1 Flexible Furnishings *Bedrooms must contain sturdy, but relatively lightweight furniture so that the patients can adapt the layout of their private quarters to their needs and wants.* [Chrysikou, 2014], [Ulrich et al., 2018], [Bergsland, 2008], [Program för teknisk standard, 2018a]
- 6.3.2 Control of Environment *Patients must be able to adjust the environment of their private rooms, through the adjustment of lightning and heat.* [Bergsland, 2008], [Ulrich et al., 2018], [Chrysikou, 2014], [Program för teknisk standard, 2018a]
- 6.3.3 Openable Windows *Windows in patient rooms should be openable in order to adjust heat and airflow. Max opening: 10 cm, unless the fire alarm has gone off.* [From et al., 2009]
- 6.4 Privacy
- 6.4.1 One Person Bedroom *All patients must have private bedrooms with an accompanying bathroom.* [Chrysikou, 2014], [Bergsland, 2020], [Ulrich et al., 2018]
- 6.4.2 Soundproofing *Private rooms must have soundproofing measures.* [Chrysikou, 2014]
- 6.4.3 Lockers *Patients should have private lockers within the kitchen area, as well as within their rooms.* [Chrysikou, 2014]
- 6.5 Freedom
- 6.5.1 Access To Outdoor Areas *Patients must be able to access outdoor areas without being accompanied by staff.* [Chrysikou, 2014]

- 6.5.2 Washing Facilities *Patients should have access to washing facilities where they can do their own laundry.* [Chrysikou, 2014] Outdoor areas where patients can stay without staff [From et al., 2009]
- 6.5.3 Freedom of Movement *Patients should have freedom of movement within the facilities.* [Bergsland, 2013]
- 6.5.4 Accessibility *The project should follow accessible design guidelines to ensure the same level of freedom for all patients.* [Chrysikou, 2014]
- **7. Physical Milieu**
- 7.1 Architecture
- 7.1.1 Natural Materials *The project should use natural materials that are sturdy and provide associations to calm, natural environments.* [From et al., 2009]
- 7.1.2 Facade Style *The project should feature an orderly facade that's broken down through the use of materials or form so as not to seem overwhelming. The facade design should also assure that the building has it's own identity, and not feel as part of a hospital.* [Chrysikou, 2014], [From et al., 2009]
- 7.2 Decoration [Chrysikou, 2014]
- 7.2.1 Art *The interior should feature works of art, particularly art that references nature.* [Bergsland, 2024]
- 7.2.2 Decorative Elements *Common areas should feature a variety of decorative elements and plants.* [Chrysikou, 2014]
- 7.2.3 Patterns *Patterns and optical illusions that might trigger hallucinations.* [Chrysikou, 2014]
- 7.2.4 Colour *Colour and creative forms should be used to encourage playful processes and a feeling of comfort.* [From et al., 2009]
- 7.3 Interior Environmental Quality
- 7.3.1 Natural Light *Patients rooms, as well as common rooms must have access to natural light.* [Chrysikou, 2014], [Bergsland, 2013], [Program för teknisk standard, 2018a], [From et al., 2009]
- 7.3.2 Artificial Light *Artificial light should have a warm tint, and be dimmed at night in order to not disturb the patient's sleep.* [Bergsland, 2008]
- 7.3.3 Acoustic Environment *Measures must be taken to ensure good acoustic environments within the common areas. These include sound absorbing materials, and*

sound insulation between adjacent rooms. [Program för teknisk standard, 2018a], [From et al., 2009]

- 7.3.4 Natural Ventilation *The project should use natural ventilation as far as possible.*[Bergsland, 2013], [From et al., 2009]

10.3 Summary

The proposed Design Framework will serve as guidelines throughout the design project, ensuring that the resulting design implements biophilic design principles, and maintains a healthy interior environment that provides a sense of safety and competence for both staff and patients while also taking into consideration environmentally sustainable properties.

Chapter 11

Brief

The final chapter of this booklet describes the Design Brief that set the constraints for the design project.

Our main goal with this master thesis is to create a functional and welcoming psychiatric hospital. We aim to achieve this goal through the use of Biophilic Design Principles, and create a project that's economically, socially and environmentally sustainable in the process, but the patients should always be the first priority when making design decisions. Where there is a conflict between the Biophilic and Psychological guidelines, we therefore choose to place bigger value on the psychological ones, in order to develop a brief, concept and final design, where the well-being of the patients is the main design driver.

Overall aim & Research Question

Can Biophilic Design Philosophy create a Mental Health Facility where users experience quicker recovery rates and greater success of therapy?

The project must result in:

- *An environment where patients thrive and recover*
- *A building with little negative impact on the immediate environment*
- *A functional and welcoming psychiatric hospital*

11.1 The Final Design – A Low-Risk Treatment Facility For Nidaros DPS

Our final design will be a new Psychiatric Hospital Facility for Nidaros DPS, providing a separate treatment facility for short-term admittance of low-risk patients. As of today, Nidaros DPS has three wards as part of their Døgnenhet program, with a total of 39 beds.

The three wards all serve different purposes: Ward 1 (17 units) is a short-term and crisis ward, Ward 2 (16 units) is a rehabilitation ward for patients suffering from psychosis, and Ward 3 (6 units) is a trauma ward focusing on patients suffering from long-term trauma after abuse, as well as war or torture [St.Olavs-Hospital,]. Ward 1 is the ward with the lowest risk today, but this unit still admits patients with some risk of suicidal ideations and aggression, meaning that certain safety measures still need to be put in place in case of an episode.

Currently, patients falling into the "low-risk" category, such as patients with depression or anxiety, have to either rely on the outpatient ward or be admitted to the same ward as patients falling within the "crisis" category (patients with a risk of hurting themselves or others). Because of the wide range of diagnoses of the patients admitted to Ward 1 today, we believe it would be useful for both patients and employees to create another ward, located in a separate location. Not only may moving the low-risk patients away from patients with more severe diagnoses prove positive, but an increased number of beds for low-risk patients may lead to more people being admitted earlier, thus preventing their problems from reaching a severe stage.

11.1.1 Program

The new facility will have two wards, with 12 units each, and much like the other wards within Nidaros DPS the treatment and length of stay will be based on each individual patient's needs. This means that the design will have to work for both patients staying one week and three months. The main means of therapy is environmental therapy, which consists of stabilising measures like sleep, diet, and physical and social activities. The overall goal of the treatment is a bettering of symptoms and focus on the patient's mastery of their symptoms as well as the environment.

The employees within the ward are psychiatric nurses, psychological specialists, psychiatrists, doctors, therapists, physiotherapists, and environmental therapists.

11.1.2 Design Philosophy - Biophilic Design & Evidence-Based Design

Through biophilic design, we aim to create interior and exterior spaces where the patients can be immersed in nature. Extensive use of natural materials will create a safe, welcoming space, unlike the barren, alien interior that's featured in so many modern hospitals.

The design will also reflect current research within environmental psychology and therapy. Findings show that through well-designed, beautiful surroundings, one may increase the status of the patient, and provide them with motivation to actively participate in their own journey towards recovery. Patients should have a sense of freedom, and trust.

This way we hope to create a design which integrates the building into it's surroundings, as well as ensures that both users and other people in the neighbourhood enjoy using it

for a long time to come.

11.1.3 Site

When deciding on the site we considered several factors. Close proximity to nature, and a calm environment where patients had their own area, undisturbed by passersby, was of importance. On the other hand, an isolated location could contribute to stigma. As noted by Jan Devyr Lernbring, a service user at Östra Sjukhuset's psychiatric ward in Gothenburg, an area that everyone knows you only enter to get treatment further isolates patients from the rest of society (White, 2022). After all, the goal of mental health treatment and rehabilitation is to help the patient prepare to reenter society. It's therefore important that society and the patients can coexist, also while the patients are in treatment.

The chosen site for the project is in Bymarka in Trondheim, next to Fjellseter Kapell. The site was the location of Fjellseter Sanatorium in the early 1900s, and offers the patients a feeling of peace and serenity away from society, without being so remote that it invokes a feeling of isolation. Popular hiking and ski trails run past the site, but the patients will have a private area to maintain privacy. Several close hiking destinations can provide opportunities for small excursions for the patients, and the chapel may offer spiritual guidance for those that are interested. The site is accessed from Fjellseterveien, and the closest bus stop today is located 200m from the site.

The **total size of the site is 15500 m2**, allowing for flexibility in the placement of the building. The **footprint of the project (both building and landscaping) should not exceed 30% of the site, and the total built area (BYA of the building) must not exceed 20% of the total site area**. The site itself is sloped, and has a power line running through it, but has already been cleared of vegetation. The building should be placed at least 10 m away from the power line, and settle within a moderately sloped part of the site, in order to avoid unnecessary interventions in the landscape. A large parking lot below the site can provide sufficient parking for staff and visitors, and a track crosses the site, connecting the parking lot with the hiking trails.

11.1.4 Rooms & Functions

The rooms and functions was determined by consulting the Konceptprogram [Program för teknisk standard, 2018a], as well as Architect Knut Bergsland.

Outside Area:

- Fire pit or other private outdoor gathering area that can be used for therapy and social activities

- Nature path or hiking trail
- Greenhouses or areas for growing food
- Atrium (with easy access directly from the ward, placed so that it's easy for the employees to get an overview of the area.) - Minimum the same area as the average floor area.

Public Areas:

Room	Size (m2)	Number	Total	Comment
Entrance	10	1	10	By Lobby/Reception
Lobby	20	1	20	Waiting/visits
Reception	5	1	5	Staff present
WC & H-WC	10	5	50	-
Family Room	30	1	30	Toys and games
Visitation Room	20	1	10	-

Table 11.1: Public Areas

Private Areas For Patients:

Room	Size (m2)	Number	Total	Comment
Bedroom	15	24	360	Two wards
Bathroom	5	24	120	Attached to bedroom. Accessible design

Table 11.2: Private Areas For Patients

Common Areas for Patients:

Treatment Areas:

Employee Areas:

Room	Size (m2)	Number	Total	Comment
Smaller Living Room	2	30	60	One for each ward
Large Living Room	120	1	120	Within Common Area
Kitchen	50	1	50	Includes supporting areas. Possibility to cook their own food
Dining Area	120	1	Next to Kitchen	
Education Room	30	1	30	-
Exercise Area	35	1	35	-
Sensory Modulation	5	2	10	-
Activity Room	30	1	30	-
Wellness Room	15	1	15	Place to relax, with music, aromatherapy and lights
Music Room	20	1	20	-
Coffee/tea Area	15	1	15	-
Group Rooms	10	2	20	-
Library	20	1	20	-

Table 11.3: Common Areas For Patients

Room	Size (m2)	Number	Total	Comment
Group Therapy	30	1	30	In common area
Treatment Rooms	10	3	30	Physical Therapy, Acupuncture, etc
Doctors Office	15	1	15	-
Psychologists Office	15	1	15	-
Conversation Rooms	10	4	40	Neutral Ground

Table 11.4: Treatment Areas

Room	Size (m2)	Number	Total	Comment
Administration	10	1	10	-
Medicine Room	5	2	10	-
Offices	5	4	20	-
Employee Break Room	30	1	30	-
Staff Room	20	2	40	Connected to each of the wards
Meeting Room	25	1	25	-
Staff Wardrobe	15	2	30	-

Table 11.5: Employee Areas

Technical Rooms:

Total Area of Functions: 1670 m2

Gross/Net-Factor: 2

Total Area: 3340

Room	Size (m2)	Number	Total	Comment
Laundry Room	10	1	10	-
Storage Rooms	10	4	40	Clean linens, office supplies, activity supplies
Technical Room	20	1	20	-
Waste Room	10	1	10	-
Deliveries	10	1	10	-
Utility Closets	5	3	15	-
Janitors Workshop	15	2	30	-
Copy Room	5	1	5	-

Table 11.6: Technical Rooms

11.1.5 Goals For The Project

The design will follow the guidelines set in chapter 8 in order to create a building that gives back to nature and society. A summary of the main goals within the categories Biophilic Design, Sustainable Design and Psychiatric Design follows:

Biophilic Design

- Keep the total project footprint below 30% of the total site.
- 90% of the roof must be covered in vegetation.
- The project must use a massive wood construction system.
- The project must provide outdoor space equal to 60% of the building footprint.
- 10% of the outdoor area must be dedicated to growing food.

Environmental Design

- All roof surfaces that are not covered in vegetation must have PVs. PV's should also be integrated in eligible facades.
- The building should demonstrate a 40% reduction in embodied carbon from building materials, compared to the DFØ Benchmark for retirement homes: 337 (kgCO2 eqv./ gross m2).
- Reduce net energy use by 10% compared to the TEK-17 requirement for retirement homes: 195 (kWh/m2 heated gross area per year) through the use of passive strategies.
- Achieve good indoor air quality through the use of hybrid ventilation.
- Achieve a daylight factor (DF) of 4% for 50% of the usable area.

Design for Psychiatry

- The design should invoke a feeling of mastery and control within the patients, in order to foster self-esteem and mastery of self.
- The design must offer users a high level of freedom.
- The design must adapt a high level of safety and security.
- All patients must have a view of natural landscapes from their rooms.
- The common areas must be more attractive than the patients personal spaces.

Chapter 12

Appendix

12.1 SCP-Model Building Assessment

NUMBER	PARAMETER	FEATURE	INSTITUTIONAL	DOMESTIC
1	Safety and Security	Locked storage areas and closets		
2		Clinic inside the ward		
3		Psychiatric offices, attached or included in the ward		
4		Front doors that opened out automatically		
5		Exit sign indications in circulation areas		
6		Mobile bedroom furniture		
7	Competence	Notices on walls and doors of circulation areas		
8		No mailboxes for individual service users accessible to the postman		
9		Fluorescent lighting on circulation areas		
10		Lack of separate staff dining area		
11	Personalisation and choice	No use of concrete, concrete blocks or metal panels on facades		
12		No use of resilient flooring in lounges		
13		No urinals		
14		Natural light in kitchenettes		
15		No sliding or revolving doors		
16		Service users' stereos, radios or TVs in bedrooms		

Figure 12.1: *Building characteristics checklist by Evangelia Chrysikou* [Chrysikou, 2014]

NUMBER	PARAMETER	FEATURE	INSTITUTIONAL	DOMESTIC
17	Safety and Security	No office for a resident (full-time) GP		
18		No mirrors to allow visibility to a corridor turning point or a room		
19	Competence	Administration offices inside the wards		
20		No rooms especially designed to accommodate activities		
21		No hoist in a bathroom		
22		Location close to shops		
23	Personalisation and choice	More than six residents per ward		
24		No coat-hanging area near the entrance		
25		Automatic door closers		
26		Identical bedroom furniture		
27		Common WC with automatically self cleaning toilet seat		
28		Freestanding toilet in bedrooms		
29		No continuous table arrangements in dinning room		
30		No individual food lockers in the kitchenette		
31		No stands for leaflets		
32		No areas accessible to external service users only		
33		No access to internal areas for external service users		
34		Lounge and dining room with external views		
35		Kitchenette, if existing, with eating area and direct connection to dining room		
36		No walk-in cooler for food		
37		Elevator close to front door and visible from it, if there was one		
38		Stairs, if existing, at the centre of the ward		
39		Variety of decorative objects, vases or plants in common areas		
40		Outdoor areas visible from interior social areas		
41		Bathrooms not opening directly into social areas or main corridors		
42		No more than one sink and more than one toilet cubicle in bathrooms		
43		Variation of windows followed size and shape		
44		No access to living areas for external service users without internal service users' presence		
45		Couch or comfortable seating in the TV area		
46		Room shape, window location and window size varying in bedrooms		

Figure 12.2: *Building characteristics checklist by Evangelia Chrysikou* [Chrysikou, 2014]

NUMBER	PARAMETER	FEATURE	INSTITUTIONAL	DOMESTIC
47	Safety and Security	Plain facade (vs brok		
48		No fireplace		
49		Bars on bedroom windows		
50		Bathroom window restrictions		
51		No pieces of fixed furniture in bedrooms		
52		No seclusion room attached to or inside the ward		
53	Competence	Laundry service for service users		
54		Parks or recreational areas within walking distance		
55		Tea or coffee equipment for service users		
56	Personalisation and choice	Different sizes of lot compared to neighbourhood		
57		Different distance between buildings		
58		Different parking arrangementsto adjacent buildings		
59		Different front doors to adjacent buildings		
60		Staff areas inside the ward for staff's short retreat		
61		Tables seating more than eight people		
62		Bedroom doors with labels or decorative elements		
63		No armchair in each bedroom		
64		No curtains on bedroom windows		
65		No en suite WCs for all rooms		
66		Bathrooms close to bedroom areas		
67		Paper towel dispensers		
68		No natural light on staircases		
69		Non institutional materials for the surfaces of circulation areas		
70		Natural light and operable windows in the kitchen		
71		Food prepared in the units		
72		External doors in kitchens		
73		No dedicated room for staff to sleep inside the ward		
74		Varying furniture in social areas		
75		No fluorescent and overhead lighting, only in common areas		
76		TV was in social areas instead of TV room		
77		Stereos in common areas		
78		Coffee tables in front of sofas or armchairs		
79		No dedicated staff area for rest inside the wards		
80		Decorative items in dinning room		
81		No triple bedrooms		
82		No resilient flooring in bedrooms		
83		Plastered ceilings in bedrooms		
84		Service users' posters, decorations or pictures in bedrooms		
85		Service user bathrooms with a bath or bath and shower		

Figure 12.3: *Building characteristics checklist by Evangelia Chrysikou* [Chrysikou, 2014]

NUMBER	PARAMETER	FEATURE	INSTITUTIONAL	DOMESTIC
86	Safety and Security	Differentiation of fencing and		
87		landscaping to the neighbouring buildings		
88		No direct access from social areas to out-of-doors areas		
89		Non operable windows or		
90		external doors in the dining rooms		
91		Smoke detectors and sprinklers		
92		on the dining room ceiling		
93		Sprinklers, smoke detectors and		
94		alarms on bedroom ceilings		
95		Bedroom windows with restricted opening		
96		No watch-panels on bedroom doors		
97		Operable bathroom windows		
98	Competence	No paved pedestrian paths around		
99		Dedicated laundry area with		
100		professional equipment I more than one washing machine		
101		Service users could prepare tea or coffee		
102		No elevator within the residence		
103	Personalisation and choice	Different front width		
104		Non-residential locations		
105		More than one office in the ward		
106		Different height than nearby buildings that were used for housing		
107		More than one door at the entrance		
108		No furniture by the entrance		
109		No natural light in circulation areas		
110		Entrance far from public spaces and close to bedrooms and bathrooms		
111		Bedroom interiors opened directly on public corridors or public areas		
112		Bins in lounges		
113		No curtains on dining room windows		
114		Dining room far from the lounge		
115		Food served through a door instead of designated hatch		
116		Vending machines or water coolers		
117		Washbasins in bedrooms		
118		No chests of drawers and bookshelves in bedrooms		
119		Watch panels with mechanism to control visibility from the corridor		
120		One couch instead of more than one or none in the lounge		
121		Seating in socio-friendly arrangements		
122		Curtains or shades in common areas		
123		Side tables in lounges		
124		Framed pictures instead of blue-tacked posters		
125		Kitchens with external views		
126		Service users could lock bedroom door from the outside		
127		No framed areas on walls for service users' pictures		
128		Normal instead of hospital beds		
129		Mirrors in bedrooms		
130		Only one shower in the shower rooms		
131		Ordinary instead of hospital bins in bathrooms or WCs		

Figure 12.4: *Building characteristics checklist by Evangelia Chrysikou* [Chrysikou, 2014]

NUMBER	PARAMETER	FEATURE	INSTITUTIONAL	DOMESTIC
181	Safety and Security	Front doors open to public		
182		Open stairs within residences (vs enclosed or between fire doors)		
183		Lounges with windows or doors to the outside operable by service users		
184		Doors opening inwards		
185		Glass mirrors in bathrooms and WCs and weight bearing fittings		
186	Competence	No handles by toilets		
187		Microwaves in kitchens		
188	Personalisation and choice	Signs or notices on lounge walls		
189		Table cloths		
190		Stainless steel kitchen counters		
191		Provision for some en suite accommodation		
192		Neighbouring to houses		
193		Either integrated to general housing schemes or stand alone		
194		Window size similar to adjacent housing		
195		Designated waiting area such as a recess/portico outside the entrance		
196		Stair surfaces built from materials such as wood, carpet, marble or mosaic		
197		Laundry area located near kitchens or bedrooms		
198		Single room accommodation		
199		Variety in lighting (vs fluorescent only)		
200		Variety in style and colour of curtains and bedspreads		
201		Curtains around the shower		
202		Decorative elements in bathrooms		

Figure 12.5: *Building characteristics checklist by Evangelia Chrysikou* [Chrysikou, 2014]

Chapter 13

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