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ENHANCING WELL-BEING BY DESIGN:  
THE ROLE OF CO-HOUSING AND NATURE

# GRADUATION THESIS

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GRADUATION THESIS

Defining guidelines for designing a healthy living environment to enhance well-being



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AR3AD110 Dwelling Graduation Studio  
Designing for Health and Care in an Inclusive Environment

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RESEARCH PLAN

1.1 Problem Statement

The home environment significantly influences well-being by shaping health behaviors and decisions. As a social and physical space, it is where individuals develop health habits and make lifestyle choices. Therefore, designers and planners can incorporate elements that promote healthier living.<sup>1</sup>

RELEVANCE

In neighborhoods like Tarwewijk in Rotterdam, health outcomes are lower than the national average. By comparing the statistics from buurtatlas.vzinfo.nl<sup>2</sup> for the Netherlands and Tarwewijk, it can be concluded that indicators related to psychological and physical health are generally worse in Tarwewijk than the national average. Specifically, issues such as stress, overweight, smoking, physical activity, self-reported health, mental health, anxiety/depression, and suicidal thoughts are more prevalent in this neighborhood than across the Netherlands. Figure 1 presents an overview of these statistics, indicating whether the figures are worse, equal, or better compared to the national average.

Moreover, biodiversity in Rotterdam has declined over the past decades, negatively impacting the city's environment, health, and economy, highlighting the urgent need for action. As biodiversity is vital for human well-being and ecological balance, supporting interdependent plant and

animal species, Rotterdam has recognized this issue and set ambitious goals to enhance its ecological richness. To guide these efforts, the city has developed a comprehensive biodiversity action plan.<sup>3</sup>

	even worse	worse	equal	better	even better
stress					
overweight					
smoking					
extensive alcohol use					
meeting the physical activity guidelines					
people playing sports					
walking or biking to school or work					
self-reported health					
mental health issues					
anxiety or depression					
suicidal thoughts					

Figure 1. Figure 1. Figures of Tarwewijk Compared to the Rest of the Netherlands | Author's own work.

<sup>1</sup>Blake D. Poland, Lawrence W. Green, and Irving Rootman, eds., *Settings for Health Promotion: Linking Theory and Practice* (Thousand Oaks, CA: SAGE Publications, Inc., 2000), 44, <https://doi.org/10.4135/9781452232829>.  
<sup>2</sup>Buurtatlas, *Gezondheid en leefstijl per buurt, wijk en gemeente*, accessed April 28, 2025, <https://buurtatlas.vzinfo.nl/#home>.  
<sup>3</sup>Gemeente Rotterdam, *Rotterdam, een rijke stadsnatuur*: Uitvoeringsagenda Biodiversiteit 2023–2027 (Rotterdam: Gemeente Rotterdam, 2023).

Furthermore, various news reports on the mental and physical health of (young) adults can be found on the Central Bureau of Statistics and NU.nl (Figure 2, 3 & 4). Both men and women are now less likely to rate their health as very good, and more young people are experiencing psychological issues.<sup>4,5</sup> Additionally, 20% of young adults are dissatisfied with their social lives, a significant increase compared to before the COVID-19 crisis.<sup>6</sup> Although the prevalence of obesity in the Netherlands is lower than in most EU countries, 35% of adults over 20 in the Netherlands are moderately overweight, a substantial increase from the 28% reported in the early 1980s.<sup>7</sup>

RESEARCH GOAL

This research aims to develop design guidelines that foster a healthy living environment in the Tarwewijk neighborhood of Rotterdam. The focus is on creating a project that not only enhances residents' well-being but also contributes to local biodiversity. By integrating nature into the design, the study will explore how ecological strategies can positively impact residents. Understanding these design interventions will help create living spaces that promote healthier, more sustainable lifestyles for the community, ultimately aiming to prevent future issues related to well-being.

Tevredenheid met sociale leven nog niet op niveau van voor corona

29-7-2024 06:30



© ANP / Robin Utrecht

Figure 2. News Article | Source: CBS, "Tevredenheid met sociale leven nog niet op niveau van voor corona," CBS.nl, July 29, 2024.

Jongvolwassene negatiever over eigen gezondheid

4-6-2024 06:30



© Hollandse Hoogte

Figure 3. News Article | Source: CBS, "Jongvolwassene negatiever over eigen gezondheid," CBS.nl, June 4, 2024.

Obesitas afgelopen 40 jaar verdrievoudigd

4-3-2024 00:00



© Shutterstock / Amani A

Figure 4. News Article | Source: CBS, "Obesitas afgelopen 40 jaar verdrievoudigd," CBS.nl, March 3, 2024.

1.2 Theoretical Framework

FRAME OF REFERENCE

Research from fields of landscape and spatial planning, public health and the environment, and health services, analyzed the positive impact of blue and green infrastructures, on health in the article 'Natural Environments - Healthy Environments?'. Residents in greener environments report better health outcomes. Conversely, those in urbanized areas with less greenery experience more health issues and higher risks of mental illness, while greener spaces reduce these problems. Thus, increasing urban green and blue spaces correlates with improved public health outcomes.<sup>8</sup>

More research on the topic of nature and well-being is described in the book 'Forests, Trees and Human Health'. Different researchers from the overarching fields of spatial planning and design, environmental and nature studies, and social sciences, collectively contributed to understanding the interactions between well-being and the natural environment. Chapter 5 'Health Benefits of Nature Experience: Psychological, Social and Cultural Processes' highlights the benefits of nature exposure on well-being, including mental and physical health<sup>9</sup> and its contribution to social cohesion and personal development.<sup>10</sup>

Extensive research by Potvin and Soubhi, researchers in the fields of medical research, health care and epidemiology, has demonstrated that the home environment has a significant impact on well-being. In 'Settings for Health Promotion: Linking Theory and Practice', they identified the home as crucial for shaping health behaviors and well-being, serving as a social and physical space where individuals learn health habits and make important health decisions.<sup>11</sup> They propose the idea that health-promoting environments suggest a mutual influence between people and their surroundings. Consequently, the design and features of a place, like the home, play a significant role in shaping the health and habits of its residents.<sup>12</sup>

The sustainability consulting firm Terrapin Bright Green which is committed to creating a healthier world, has published the book '14 Patterns of Biophilic Design'. Various researchers from the the Terrapin Bright Green Firm, together with fields of the built environment, biology and health sciences have contributed to this work, demonstrating that biophilic design reduces stress, enhances creativity and well-being, and accelerates healing.<sup>13</sup>

<sup>4</sup> "Jongvolwassenen zijn steeds vaker negatief over hun eigen gezondheid," Nu.nl, accessed April 28, 2025, <https://www.nu.nl/gezondheid/6315324/jongvolwassenen-zijn-steeds-vaker-negatief-over-hun-eigen-gezondheid.html>.

<sup>5</sup> Centraal Bureau voor de Statistiek, "Tevredenheid met sociale leven nog niet op niveau van voor corona," July 29, 2024, <https://www.cbs.nl/nl-nl/nieuws/2024/31/tevredenheid-met-sociale-leven-nog-niet-op-niveau-van-voor-corona>.

<sup>6</sup> Centraal Bureau voor de Statistiek, "Jongvolwassene negatiever over eigen gezondheid," June 4, 2024, <https://www.cbs.nl/nl-nl/nieuws/2024/23/jongvolwassene-negatiever-over-eigen-gezondheid>.

<sup>7</sup> Centraal Bureau voor de Statistiek, "Obesitas afgelopen 40 jaar verdrievoudigd," March 3, 2024, <https://www.cbs.nl/nl-nl/nieuws/2024/10/obesitas-afgelopen-40-jaar-verdrievoudigd>.

<sup>8</sup> Sierp De Vries et al., "Natural Environments—Healthy Environments? An Exploratory Analysis of the Relationship between Greenspace and Health," *Environment and Planning A* 35, no. 10 (2003): 1717–1731, <https://doi.org/10.1068/a35111>.

<sup>9</sup> Terry Hartig et al., "Health Benefits of Nature Experience: Psychological, Social and Cultural Processes," in *Forests, Trees and Human Health* (2011), 133, [https://doi.org/10.1007/978-90-481-9806-1\\_5](https://doi.org/10.1007/978-90-481-9806-1_5).

<sup>10</sup> Ibid., 137.

<sup>11</sup> Blake D. Poland, Lawrence W. Green, and Irving Rootman, eds., *Settings for Health Promotion: Linking Theory and Practice* (Thousand Oaks, CA: SAGE Publications, Inc., 2000), 44, <https://doi.org/10.4135/9781452232829>.

<sup>12</sup> Ibid., 77–78.

<sup>13</sup> Terrapin Bright Green, *14 Patterns of Biophilic Design: Improving Health and Well-Being in the Built Environment* (2014), 3.



The research outlines how integrating natural elements improves satisfaction with built environments, linking nature, human biology, and design to optimize health benefits in daily life. 14 Patterns are described that detail how each pattern contributes in specific ways. Additionally, design considerations for various scales, including urban and building levels are discussed. 14

With a greater focus on a smaller scale, focusing on co-housing principles, researchers from the fields of public health, biomedical research, experimental and health sciences, and epidemiology conducted a scoping review on the effects of co-housing, in ‘Cohousing as a Model for Social Health: A Scoping Review’, revealing several health benefits linked to this model (a more detailed literature review on these health benefits is provided in Chapter 2.2.1 (p. 28-29)). Although direct studies on health outcomes in co-housing are limited, evidence suggests a positive association with self-reported improvements in physical and mental health and overall quality of life. The review highlights significant research gaps and emphasizes the emotional and social connections formed in these communities, which provide ongoing psychosocial benefits. While promising, more rigorous research is needed to confirm these findings. 15

Additionally, researchers Peters and Halleran, from the discipline of architectural science, illustrate in ‘How Our Homes Impact Our Health’ that shared spaces in residential buildings are vital for residents’ well-being. Common areas, such as rooftops and lounges, foster social interaction, reducing feelings of isolation and loneliness and contribute to a sense of community. They can also encourage physical activity by providing opportunities for both passive and active recreation, supporting mental and physical health. Shared outdoor areas connect residents to nature, known for its mental health benefits, while integrating greenery enhances overall well-being.

Furthermore, at the scale of the dwelling itself, the article discusses that natural light and views of nature are critical in enhancing residents’ well-being. Large windows and strategically placed panes bring abundant natural light, improving mood, vitality, and sleep by regulating circadian rhythms. For example, morning light in bedrooms reinforces sleep-wake cycles. Views of greenery or water from windows reduce stress and aid recovery, making these connections a priority in design. Outdoor spaces like balconies, terraces, or gardens provide access to fresh air, sunlight, relaxation, and social interaction, fostering community and connection. It also highlights that flexible layouts are crucial for well-being-focused design. Homes should adapt to residents’ changing needs, enabling transitions between activities like working, relaxing, and socializing. Spaces that support physical activity, such as open indoor areas for exercise or communal spaces, enhance both physical and mental health. 16

## DEFINITIONS

### Blue and green infrastructures

Blue and green Infrastructures (BGI) refer to networks of natural areas, water bodies, and environmental features that provide ecosystem services. Green infrastructure focuses on vegetation and green spaces, while blue infrastructure centers on water systems. 17

### Biodiversity

The variety of living organisms, including animals, plants, fungi, and microorganisms, that interact within ecosystems to sustain balance and support life. It provides essential resources like food, clean water, and medicine. 18 In the built environment, biodiversity creates habitats, improves air and water quality, enhances human well-being, and increases urban resilience to climate change. 19

### Co-housing

Co-housing combines private and shared spaces, with residents managing common facilities and activities to promote social interaction and community. 20

### Health

The World Health Organization (WHO) has defined health as ‘a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity’. 21

### Well-being

The overall state of functioning as a healthy person across various aspects of life. It is a holistic concept that includes multiple dimensions of health and satisfaction. Well-being is best understood as a combination of three key components: psychological well-being (mental and emotional health), social well-being (the quality of relationships and social connections), and physical well-being (physical health and functioning). 22

### Biophilic design

The practice of designing spaces that support human health by connecting people with nature, aims to create environments that are inspiring, restorative, and functional. It integrates the built space with the surrounding ecosystem and takes into account local context, health conditions, cultural factors, and user experiences to strengthen the connection with nature and foster a sense of belonging. 23

### Scales

The research defines three scales. The **urban scale** focuses on the neighborhood's spatial, social, and ecological context, examining interactions among buildings, public spaces, and the community. The **building block scale** examines a single building block, focusing on shared spaces and the relationships between buildings and greenery. Finally, the **interior and dwelling scale** centers on individual housing units, emphasizing connections to outdoor and common areas.

14 Terrapin Bright Green, 14 *Patterns of Biophilic Design: Improving Health and Well-Being in the Built Environment* (2014), 3.

15 Elyse Warner, Emma Sutton, and Fiona Andrews, “Cohousing as a Model for Social Health: A Scoping Review,” *Cities & Health* 8, no. 1 (2024): 107–19, <https://doi.org/10.1080/23748834.2020.1838225>.

16 Terri Peters and Anna Halleran, “How Our Homes Impact Our Health: Using a COVID-19 Informed Approach to Examine Urban Apartment Housing,” *Archnet-IJAR: International Journal of Architectural Research* 15, no. 1 (2021), <https://doi.org/10.1108/ARCH-08-2020-0159>.

17 Zahra Ghofrani, Victor Sposito, and Robert Faggian, “A Comprehensive Review of Blue-Green Infrastructure Concepts,” *International Journal of Environment and Sustainability* 6, no. 1 (2017), <https://doi.org/10.1680/icembgi.65420.003>.

18 World Wildlife Fund, “What Is Biodiversity?” [Worldwildlife.org](https://www.worldwildlife.org/pages/what-is-biodiversity), n.d., <https://www.worldwildlife.org/pages/what-is-biodiversity>.

19 Zahra Ghofrani, Victor Sposito, and Robert Faggian, “A Comprehensive Review of Blue-Green Infrastructure Concepts,” *International Journal of Environment and Sustainability* 6, no. 1 (2017), <https://doi.org/10.1680/icembgi.65420.003>.

20 Elyse Warner, Emma Sutton, and Fiona Andrews, “Cohousing as a Model for Social Health: A Scoping Review,” *Cities & Health* 8, no. 1 (2024): 107–19, <https://doi.org/10.1080/23748834.2020.1838225>.

21 Terry Hartig et al., “Health Benefits of Nature Experience: Psychological, Social and Cultural Processes,” in *Forests, Trees and Human Health* (2011), 131, [https://doi.org/10.1007/978-90-481-9806-1\\_5](https://doi.org/10.1007/978-90-481-9806-1_5).

22 Sarah D. Pressman, Tara Kraft, and Stephanie Bowlin, “Well-Being: Physical, Psychological, and Social,” in *Encyclopedia of Behavioral Medicine* (Cham: Springer International Publishing, 2020), 2334–2339, [https://doi.org/10.1007/978-3-030-39903-0\\_75](https://doi.org/10.1007/978-3-030-39903-0_75).

23 Terrapin Bright Green, 14 *Patterns of Biophilic Design: Improving Health and Well-Being in the Built Environment* (2014).

# 1.3 Hypothesis

As an architecture student involved in the discussion on how nature and co-housing impact well-being, it is important to translate research into design strategies that can contribute to improving quality of life.

Figure 5 contains a map of the relevant literature, showing contributing disciplines, theories, data types, and my position within these frameworks. This knowledge can be applied across various scales

It is hypothesized that, at the urban scale, green and blue infrastructure, such as parks and water bodies, may reduce stress, promote activity, and support social interaction. At the building block scale, co-housing and shared spaces could potentially strengthen community bonds and reduce loneliness. Biophilic design might also contribute to well-being by integrating nature. Finally, at the interior/dwelling scale, floor plans that incorporate elements like gardens, balconies, and sky views may help connect residents with nature, fostering holistic health and well-being. Given the fact that indicators related to psychological and physical health in Tarwewijk are generally worse than the national average, these considerations could make a valuable contribution to developments in the neighborhood.

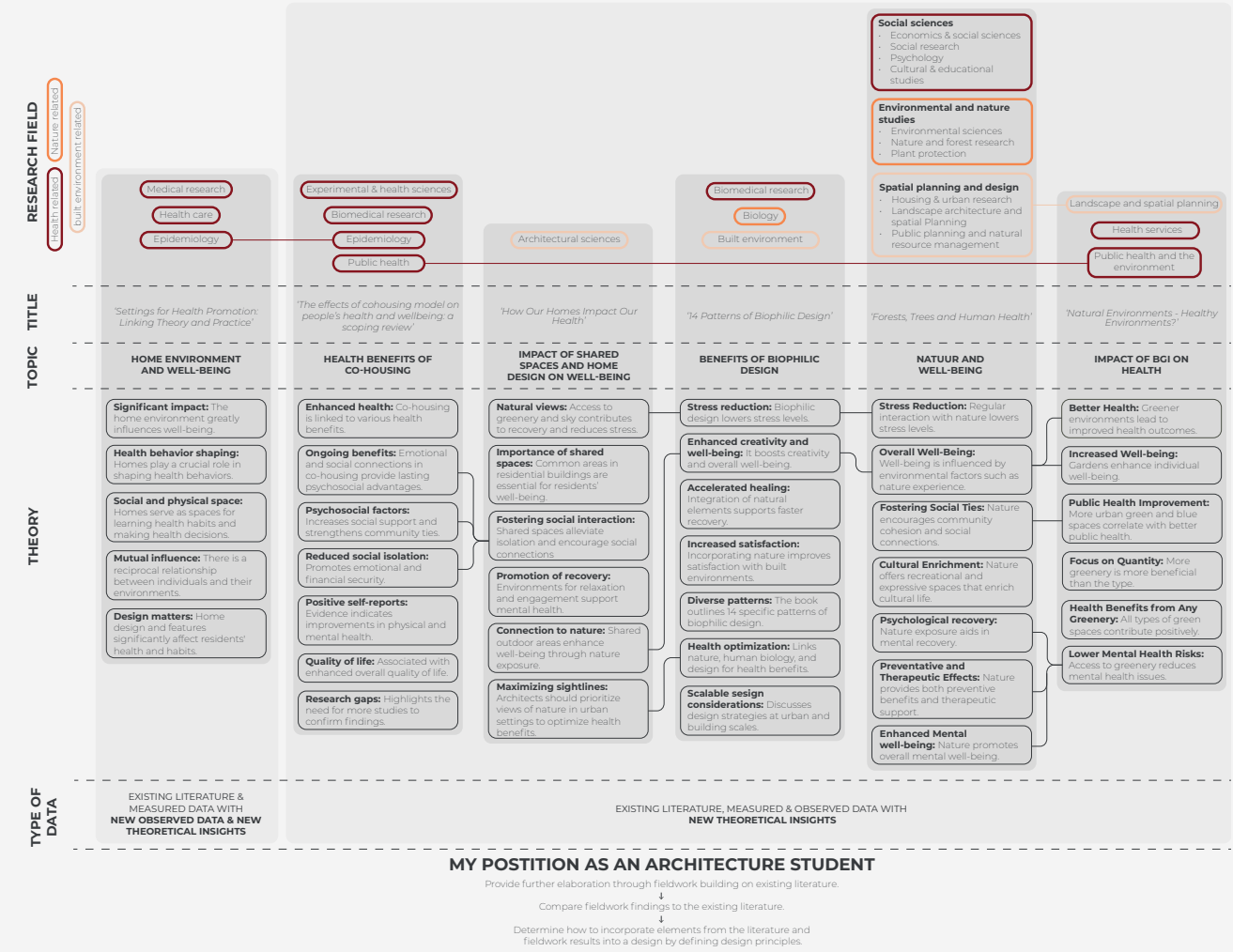


Figure 5. Map of Research Field | Author's Own Work.

## 1.4 Research Questions

### MAIN QUESTION

'How can the design of a healthy living environment on different scales enhance overall well-being of residents in the Tarwewijk, and in how far could nature and co-housing play a role in this?'

To answer this question, the sub-questions are organized into three different scales: urban scale (1), building block scale (2), and the dwelling/interior (3). The urban scale will address nature, while the building block and interior scales will address both nature and co-housing.

Because some scales are closely interconnected, or aspects of certain scales may also apply to other scales, some chapters will occasionally refer to information from other chapters and scales.

### SUB QUESTIONS

**1.** How can the integration of blue and green infrastructure in the built environment enhance the overall well-being of Tarwewijk residents?

**1.1** How do green and blue infrastructures impact people's well-being?

**1.2.** What green requirements must new developments in the Tarwewijk meet according to Rotterdam's guidelines?

**1.3.** Does the target group in Tarwewijk, have a need for more green spaces in their living environment?

**2.** How can design strategies for co-housing, including nature and shared spaces, contribute to the well-being of residents?

**2.1.** What are the benefits of co-housing in relation to the well-being of residents?

**2.2.** What role do shared spaces in the building play in enhancing well-being?

**2.3.** How can greenery be integrated into the residential building project to contribute to well-being?

**3.** In what ways can individual dwellings impact the well-being of residents?

**3.1.** How can the connection between a dwelling and nature contribute to the well-being of residents?

**3.2.** What is the relationship between dwellings and shared spaces in enhancing the well-being of residents?

## 1.5 Methodology

This research will employ various methodologies, including desk research (literature review), fieldwork (interviews, surveys, and mapping), and analysis of reference projects. Since the building is located within the building block, there will be overlap between these two scales, leading to their combination in the methods description.

### DESK RESEARCH

At the urban scale, desk research will examine the benefits of blue and green infrastructures on well-being & Rotterdam's biodiversity and nature inclusivity guidelines. At the building block and interior scales, the research will explore the benefits of co-housing and shared spaces on well-being, as well as the benefits of the connection with nature.

### PROJECT ANALYSIS

At the building block and interior scales, co-housing projects will be analyzed in preparation for fieldwork. The projects that will be analyzed correspond to the projects from the fieldwork research.

### FIELDWORK

At the urban scale, fieldwork will be conducted in Tarwewijk, including interviews with residents about their need for neighborhood greenery and mapping existing greenery. At the building block and interior scales, co-housing projects which are analysed will be visited, with interviews and surveys conducted on residents' experiences with co-housing, shared spaces, and nature. The projects visited include Ecodorp Zuiderveld (Nijmegen), Groene Mient (The Hague), Kas & Co (Utrecht), De Warren (Amsterdam), and CW Delft. At each project, one or more residents were interviewed, and surveys were distributed across all locations. A total of 52 responses were collected. More detailed information about the fieldwork can be found in the Fieldwork Booklet (Appendix 3).

The fieldwork research questions are theory-based, derived from the literature. Additionally, the findings will be compared with those theories. Responses will be collected anonymously, ensuring no personal data is used.

# 1.6 Range

## CONTEXT

The aim is to develop design strategies for residential buildings in the form of co-housing, to enhance residents' psychological, social, and physical well-being. The study examines three scales: urban, building block, and dwelling/interior. The urban scale is defined by the Tarwewijk neighborhood in Rotterdam. The building block scale focuses on the northern part of Polslandstraat in Tarwewijk (Figure 6), where planned demolitions, resident relocations, and increasing insecurity are current issues. This is the area for which design principles will be developed.



Figure 6. Area Around Polslandstraat 1:100000 | Author's own work.

## TARGET GROUP

The area has renewal potential, as it was once a vibrant community that can thrive again by attracting long-term residents. The target group includes people who are either open to co-housing and value neighborly connections or those more interested in traditional housing, who enjoy living close to a city while still having a reasonable amount of greenery in their street. This group, whether current Tarwewijk residents or newcomers, can collectively enhance social cohesion in the redesigned environment.

## SCOPE

To limit the research scope, this study will focus on nature and co-housing, as these areas impact well-being. While the strategies examined may also mitigate climate change, the climate aspect will remain secondary to maintain focus. Fieldwork will be conducted in Tarwewijk, supplemented by related project analyses from other cities aligned with the theoretical framework. Recent developments reflecting these ideas offer an opportunity to explore whether residents experience the positive impacts suggested by theory, helping to either validate or refine these assumptions. Sub-question two will likely receive the most attention, with interviews informing key conclusions about residents' experiences in co-housing and green spaces, which are central to this research and design guidelines.

# 1.7 Research Plan

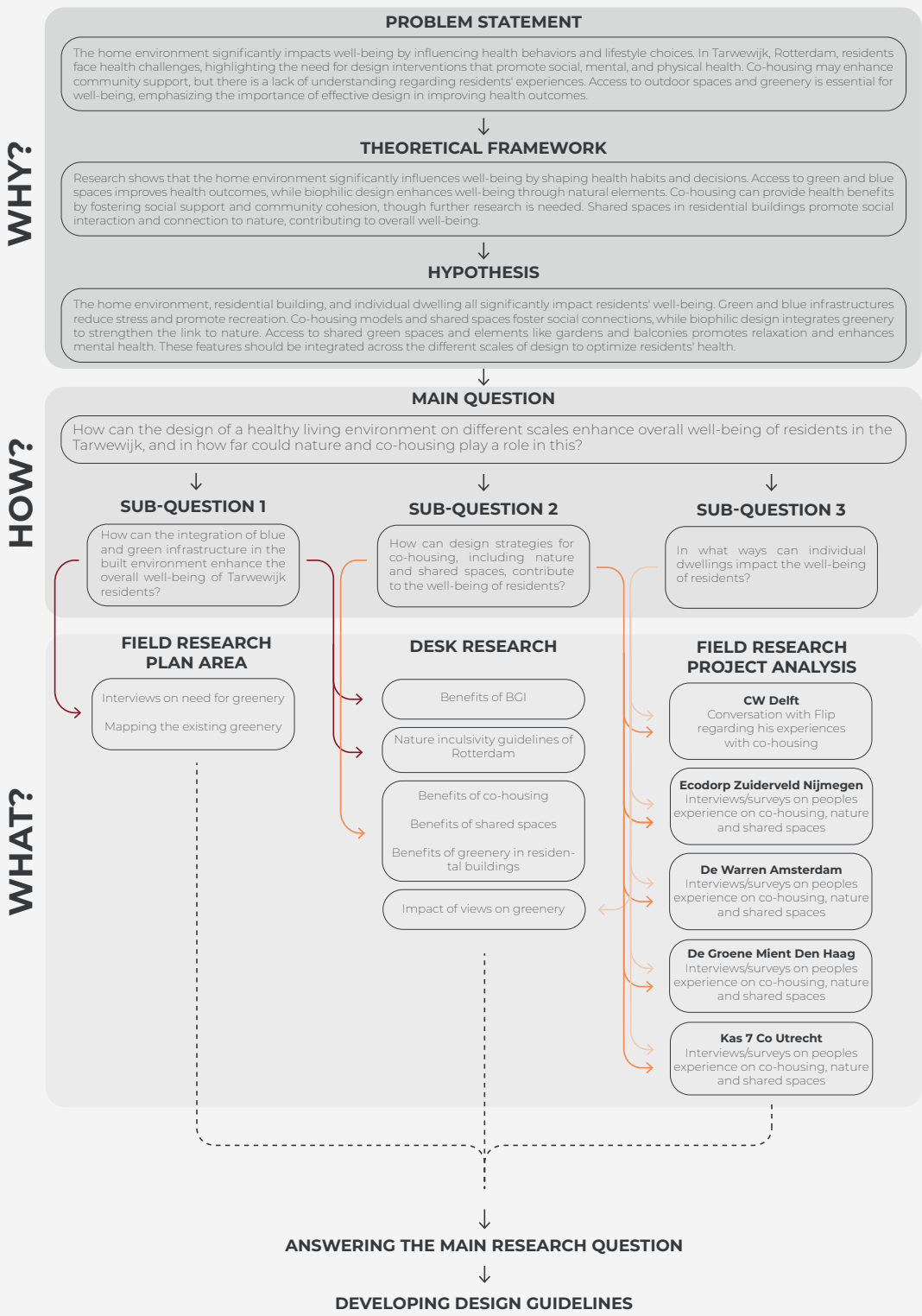


Figure 7. Research Plan | Author's own work.

# 1.8 Time Planning

## **WEEK 2.1**

Fieldwork visits to Ecodorp Zuiderveld (Nijmegen), Groene Mient (The Hague), Kas & Co (Utrecht), De Warren (Amsterdam), and CW Delft.

## **WEEK 2.2 - 2.5**

Desk research, processing fieldwork results and data unification

## **WEEK 2.6**

Data unification and defining guidelines

## **WEEK 2.7**

Finalize research and draft hand-in

## **WEEK 2.8**

Finalize research

## **WEEK 2.9**

Hand in research and preparation examination

## **WEEK 2.10**

P2 examinations

# 02 RESEARCH

## 2.1. BGI and Well-Being Tarwewijk

To explore how BGIs can be integrated into Tarwewijk to enhance residents' well-being, a preliminary literature review was conducted, complementing the theoretical framework (p.7). The review examines the contribution of BGIs to human well-being.

Given the pressure on biodiversity in Rotterdam, the municipality has developed policy documents outlining ambitions to improve urban biodiversity. These documents are analyzed with a focus on the project site (Figure 6, p.14) in the northern part of Polslandstraat.

In addition to municipal plans, resident needs and preferences are considered through interviews.

By synthesizing findings from the literature review, policy analysis, and interviews, this research aims to answer how BGIs can be integrated into Tarwewijk to improve residents' well-being.

### 2.1.1 BGI AND WELL-BEING

The theoretical framework (p. 7) highlights the positive impact of BGI on human well-being. This chapter further explores this topic by providing a more detailed literature review.

BGIs, such as parks, green spaces, and water bodies, impact well-being by addressing environmental, social, physical, and psychological needs. They provide ecosystem services that improve urban living, such as better air and water quality, increased biodiversity, and climate regulation, all contributing to healthier environments. Cleaner air and water reduce respiratory and waterborne illnesses, while climate regulation mitigates heat stress. Biodiversity enhances ecological resilience, supporting human well-being by fostering healthier ecosystems.

Beyond environmental benefits, green and blue spaces promote social cohesion by offering places for people to connect, interact, and strengthen social ties. They foster a sense of belonging and responsibility, leading to greater civic engagement. When communities maintain these spaces, bonds between residents grow, enhancing sustainability and well-being.<sup>24</sup>

BGIs also have profound mental health benefits. Access to green spaces reduces stress, improves mood, and enhances emotional resilience, offering a refuge from urban life. These spaces help alleviate psychological stress and prevent conditions like depression, anxiety, and cardiovascular disease. Regular exposure strengthens mental health, fostering resilience and better overall health.

Physically, BGIs encourage active lifestyles, offering opportunities for walking, cycling, and exercise, essential for preventing chronic diseases. Exercise in natural settings is particularly beneficial, enhancing stress relief. Urban areas without greenery lack these benefits, emphasizing the need to integrate nature into cities.<sup>25,26</sup>

Nature also contributes to personal development by helping individuals build problem-solving skills, self-reliance, and confidence. It provides unique challenges that foster personal growth. Even unstructured exposure boosts self-esteem and competence.<sup>27</sup>

The proximity of green spaces to homes is especially important. Research shows nearby greenery has a greater impact on health, particularly in lower socioeconomic communities that rely on local spaces for recreation and relaxation. Accessible green spaces correlate with fewer stress symptoms and better health, highlighting the importance of BGIs in reducing health disparities and promoting equity.

Empirical research emphasizes the benefits of BGI. Studies show that the quantity of green space is more important than its type for promoting well-being. Moderate urbanization areas benefit most, as greenery mitigates stress and pollution. Gardens and small-scale green features also enhance quality of life.<sup>28</sup>

### 2.1.2. BIODIVERSITY GUIDELINES ROTTERDAM

The biodiversity in Rotterdam is under pressure due to population growth, housing development, and other urban challenges. The city recognizes this urgency and has set ambitious goals: by 2050, working with nature rather than against it, should be the norm. To achieve this, the municipality has adopted a Biodiversity Framework (Appendix 6) that outlines structural steps. This includes connecting existing green structures into an urban and regional network, strengthening nature values, and improving the water system. This Biodiversity Framework forms the basis for preserving, enhancing, and strengthening biodiversity in Rotterdam. From 2023 to 2027, the focus will be on strengthening blue and green infrastructures and addressing vulnerable areas. The municipality has outlined this approach in the Implementation Agenda Biodiversity 2023-2027 (Appendix 7). By 2030, Rotterdam aims to maintain the quality of green areas and improve vulnerable areas according to the Nature Quality Map (Appendix 8).<sup>29</sup>

This map shows that biodiversity scores are particularly low in the more built-up urban neighborhoods. Tarwewijk is classified as one of these areas, indicating opportunities for biodiversity improvements in the neighborhood. Figure 8 (p. 22) illustrates the existing green spaces in Tarwewijk and their respective functions. The parks in Tarwewijk almost all serve a specific purpose, with the main functions being playgrounds, regular parks, sports parks, and dog-walking areas. Notably, the majority of these parks are designed primarily for human use. They consist predominantly of grass, paving, or concrete, with some trees scattered throughout. However, there is a lack of green structures that actively promote biodiversity.

To enhance greenery in Rotterdam, especially in vulnerable areas like Tarwewijk, the municipality has outlined six key focus areas for improvement:

1. Green close to home: Essential for residents, as they spend a lot of time in their street and neighborhood.
2. Green in the neighborhoods: Opportunities for greening, biodiversity, and climate adaptation by utilizing existing public space and traffic plans.
3. Revitalization of squares: Redesigning squares with more greenery, shade, water retention, and spaces for play and socializing.
4. Green routes along waterways: Connecting parks and natural areas through green routes for recreation and ecological connections.
5. Improvement of existing parks: Enhancing parks to accommodate growing demand and improve biodiversity.
6. Biodiversity and nurturing green spaces: Promoting species diversity to improve food security, air quality, and comfort, and address issues like extreme heat.<sup>30</sup>

Additionally, improving biodiversity in these neighborhoods requires the incorporation of native plants.<sup>31</sup> Native plant species for Tarwewijk are illustrated in Figures 9-11 (p. 23-24).

The Municipality of Rotterdam, in collaboration with HNS and Buiting, is currently developing a toolbox that provides a step-by-step guide for developers and designers to incorporate nature-inclusive practices into building projects and identify area-specific actions. The toolbox, as it stands so far, can be found in Appendix 9, while Appendix 2 contains an application of the step-by-step plan to Tarwewijk. This study outlines the key species present in Tarwewijk and describes the measures that can be taken to support those species.

<sup>24</sup> Zahra Ghofrani, Victor Sposito, and Robert Faggian, "A Comprehensive Review of Blue-Green Infrastructure Concepts," *International Journal of Environment and Sustainability* 6, no. 1 (2017), <https://doi.org/10.1680/icembgi.65420.003>.

<sup>25</sup> Ibid.

<sup>26</sup> Terry Hartig et al., "Health Benefits of Nature Experience: Psychological, Social and Cultural Processes," in *Forests, Trees and Human Health* (2011), 133, [https://doi.org/10.1007/978-90-481-9806-1\\_5](https://doi.org/10.1007/978-90-481-9806-1_5).

<sup>27</sup> Ibid., 156.

<sup>28</sup> Sierp De Vries et al., "Natural Environments—Healthy Environments? An Exploratory Analysis of the Relationship between Greenspace and Health," *Environment and Planning A* 35, no. 10 (2003): 1717–1731, <https://doi.org/10.1068/a35111>.

<sup>29</sup> Vincent Karremans, *Rotterdam, een rijke stadsnatuur: Biodiversiteitskader* (Biodiversiteitskader, 2023).

<sup>30</sup> Vincent Karremans, *Rotterdam gaat voor groen: De Groenagenda 2023–2026* (Groenagenda, 2023).

<sup>31</sup> Vincent Karremans, *Rotterdam, een rijke stadsnatuur: Biodiversiteitskader* (Biodiversiteitskader, 2023).





Figure 8. Existing Greenery in Tarwewijk and Its Function | Author's own work.



Figure 9. Tarwewijk's Native Plants | Source: Sander Groen, "Biodiversity" (Health and Care in Tarwewijk, 2024).

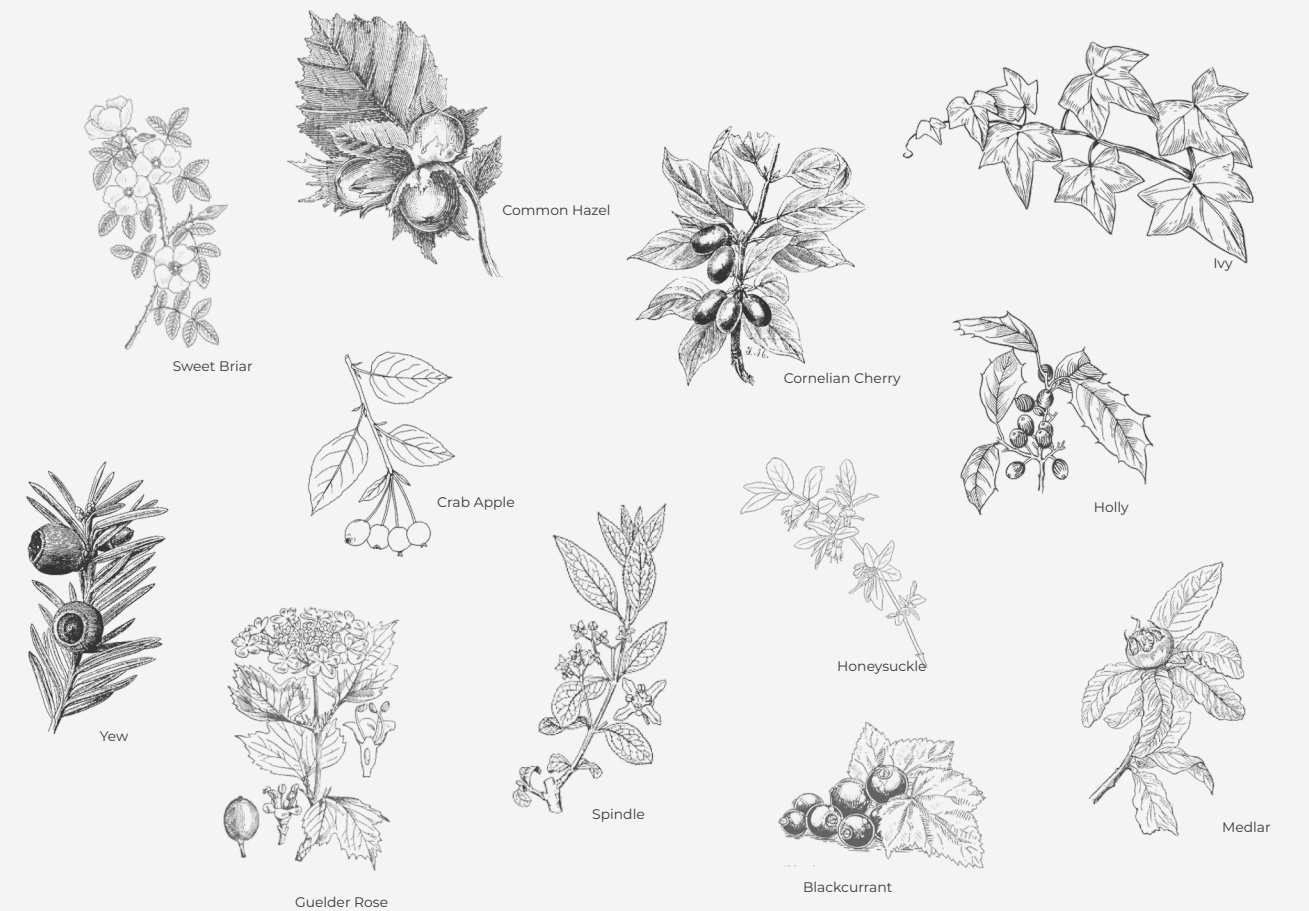


Figure 10. Tarwewijk's Native Shrubs | Source: Sander Groen, "Biodiversity" (Health and Care in Tarwewijk, 2024).





Figure 11. Tarwewijk's native trees | source: Sander Groen, "Biodiversity" (Health and care in Tarwewijk, 2024).

### 2.1.3. TARWEWIJK RESIDENTS' NEED FOR GREENERY

To enhance biodiversity in Tarwewijk, it is important to consider the specific needs and preferences of its diverse residents alongside municipal plans. Location research (Appendix 1) reveals that Tarwewijk is home to a variety of cultures. While literature (Chapter 2.1.1) highlights the positive impact of nature on well-being, not all groups may be aware of or prioritise this. To better understand residents' perspectives and experiences with green spaces, a site visit was conducted, including interviews with eight residents.

The conversations held with eight residents (Appendix 3, p. 6-7) indicate that they find green spaces in their environment highly important. Among them, people across a wide age range (approximately 20 to 70 years old) value nearby green areas for relaxation, health, and social activities. However, concerns about overcrowding, pollution, and safety limit the use of certain green spaces.

Many residents express a desire for more or improved green spaces, such as areas with less concrete and more natural elements like trees and bushes, emphasizing the importance of well-being and quality of life. Some prefer open grassy areas and multifunctional spaces that are not tied to specific uses. Others feel that the existing green spaces are sufficient but stress the importance of preserving them, particularly in light of new development projects.

There are concerns about the potential loss of green spaces due to urbanization. Residents hope for the integration of greenery into future developments to maintain livability in the neighborhood. Additionally, several residents express enthusiasm for the plans to develop Mandela Park at Maashaven, sharing their excitement and positive outlook on the project because it will provide more greenery, and the view from the park overlooking the water is highly appreciated.

#### 2.1.4. CONCLUSION

As outlined in Chapter 1.1, Tarwewijk is a neighborhood with health outcomes below the national average, which, combined with the fact that the municipality recognizes its vulnerability regarding biodiversity, highlights the urgent need for improvements in both human well-being and ecological diversity.

Literature shows that BGIs, such as parks, green spaces, and bodies of water, play a crucial role in enriching urban life by addressing environmental, social, physical, and psychological needs. These infrastructures provide essential ecosystem services, including improved air and water quality, climate regulation, and enhanced biodiversity, creating healthier and more resilient urban environments. Beyond environmental benefits, green and blue spaces foster community bonds by providing places for people to connect and build stronger social ties. They also offer mental health benefits, reducing stress, improving mood, and enhancing emotional resilience, while promoting physical health by encouraging active lifestyles. Notably, the quantity of green space has a greater impact on well-being than the specific type of greenery, emphasizing the importance of accessible and abundant green areas in neighborhoods like Tarwewijk.

The fact that the municipality recognizes the vulnerability of neighborhoods like Tarwewijk, particularly in terms of biodiversity, highlights the urgency of introducing interventions that address ecological challenges while maintaining the functionality of these spaces for residents. Fieldwork on green spaces in Tarwewijk shows that existing green structures, such as playgrounds, sports parks, and dog-walking areas, are primarily designed for human use, offering limited support for biodiversity. Additionally, research on Rotterdam's biodiversity guidelines shows that several key species in Tarwewijk play an important role in strengthening local ecosystems, with more details provided in Appendix 2.

The municipality acknowledges the vulnerability of areas like Tarwewijk, but it is equally important to involve local residents in the conversation. Conversations held with residents revealed that integrating greenery is important for this target group, as incorporating greenery into their neighborhood is highly valued.

Chapter 2.4 (p. 42), describes the guidelines that can be applied to improving residents' well-being, strengthening aesthetic quality, and supporting biodiversity.

## 2.2 Nature-Inclusive Co-Housing and Well-Being

This chapter explores how co-housing and nature contribute to residents' well-being at the building block scale by reviewing existing literature as a more in-depth supplement to the information provided in the theoretical framework (p. 7) and comparing it with theory-based fieldwork conducted in various case studies.

The fieldwork includes visits to five co-housing projects, interviews with residents, and surveys with 52 participants. Detailed survey responses can be found in the Fieldwork Booklet (Appendix 3), and pie charts summarizing the results for co-housing, nature, and shared spaces are presented in this chapter. The projects visited are Ecodorp Zuiderveld (Nijmegen), Kas en Co (Utrecht), Groene Mient (The Hague), De Warren (Amsterdam), and CW Delft, with detailed descriptions in the Fieldwork Booklet. This booklet contains more detailed information about the projects and the outcomes of the fieldwork research, and page 9 of the appendix elaborates on the choice of these projects. Transcripts of the conversations that support this data are available in Appendix 4.

The chapter first examines co-housing projects, followed by shared spaces and the role of nature, which is further explored through the lens of '14 Patterns of Biophilic Design'. This book describes how certain natural elements can be integrated to optimize health benefits. By reviewing this, it explores which elements align with the fieldwork and considers whether there are other elements relevant to the nature-inclusive co-housing case.

By integrating insights from both the literature review and fieldwork, this chapter aims to determine how design strategies for co-housing, nature, and shared spaces contribute to residents' well-being.

2.2.1. THE CO-HOUSING CONCEPT

Building on the theoretical framework (Chapter 1.2), this chapter provides a more detailed literature review on the positive health outcomes of co-housing. Literature suggests that co-housing is positively associated with health outcomes through psychosocial determinants like social support, sense of community, and physical, emotional, and economic security, as well as reduced social isolation.<sup>32</sup>

These four aspects from the literature are further explained in this chapter and later compared with the fieldwork conducted at the visited projects.

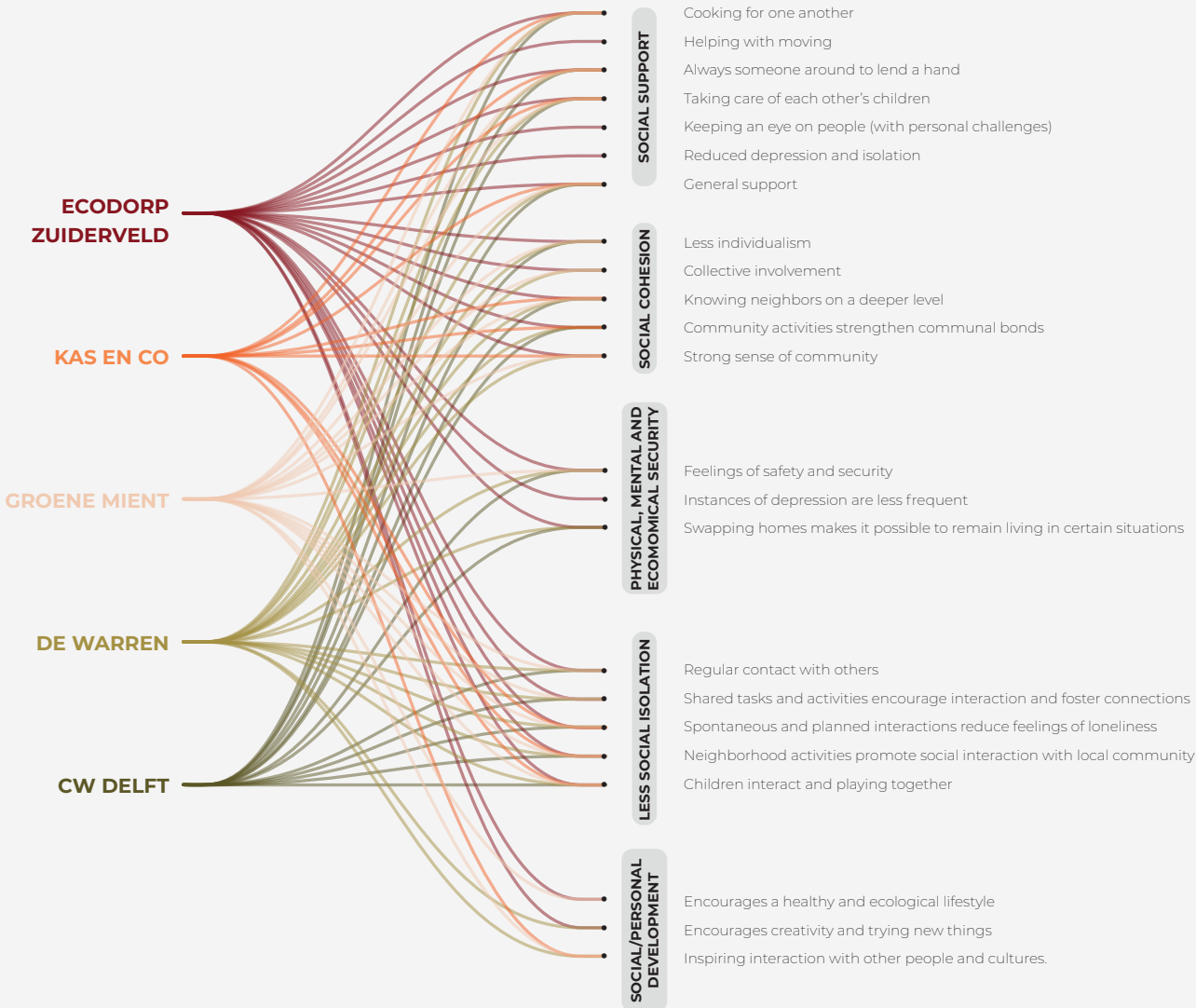


Figure 12. Each Project's Contribution to Enhancing Residents' Well-Being | Author's own work.

<sup>32</sup> Elyse Warner, Emma Sutton, and Fiona Andrews, "Cohousing as a Model for Social Health: A Scoping Review," *Cities & Health* 8, no. 1 (2024): 107–19, <https://doi.org/10.1080/23748834.2020.1838225>.  
<sup>33</sup> Ibid.  
<sup>34</sup> Ibid.

SECURITY

Co-housing offers physical, emotional, and economic security through safe and well-maintained neighborhoods, where residents can rely on social support to mitigate stress and loneliness. Shared amenities and financial benefits further contribute to residents' stability and protection.<sup>35</sup>

REDUCING SOCIAL ISOLATION

Additionally, co-housing plays a crucial role in reducing social isolation by promoting interaction and participation, an aspect that is particularly valuable for people who are more prone to loneliness. Through regular contact, shared tasks, and activities, co-housing supports residents in forming meaningful relationships and strengthens their social engagement. The combination of these factors enhances overall well-being, contributing to a higher quality of life and a supportive community environment.<sup>36</sup>

During fieldwork, all four points from the literature are observed in different ways. In addition to these four aspects, fieldwork also shows that living in a co-housing project can contribute to improving your social/personal development. The projects show that these aspects contribute to residents' well-being in various manners, as seen in the graph in Figure 12.

Figure 13 shows residents' responses to questions regarding co-housing in relation to well-being. These findings suggest that the majority of respondents have positive experiences with the community dynamics within their co-housing environments.

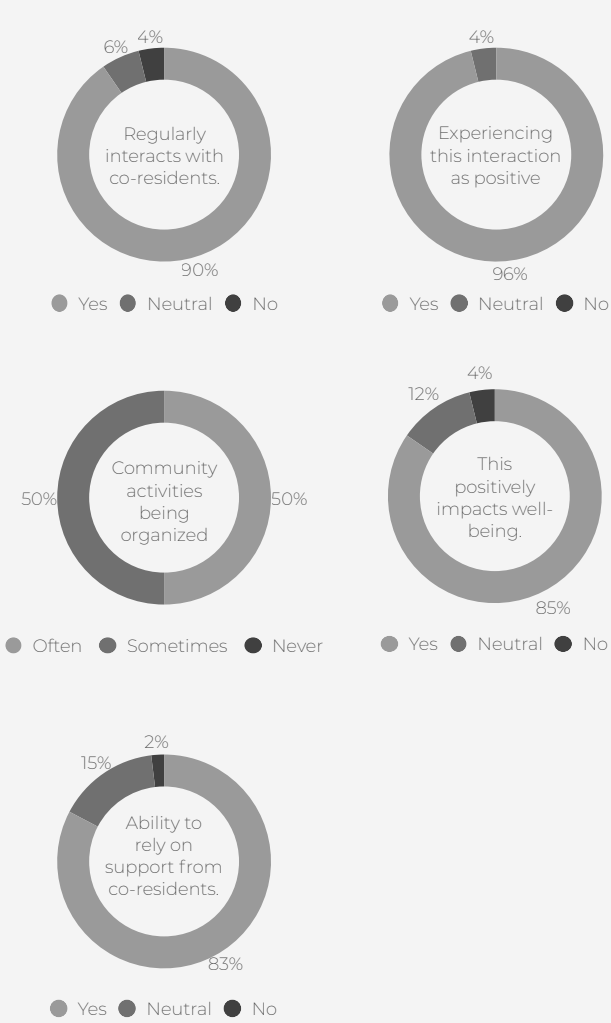


Figure 13. Pie Charts Showing Resident Responses on Co-Housing and Well-Being | Author's own work.

Regular contact and organized community activities contribute to a sense of connection and well-being. The fact that 85% of respondents note the positive influence of these activities on their well-being and can rely on neighborly support highlights the importance of social cohesion and mutual support in enhancing residents' overall well-being.

<sup>35</sup> Elyse Warner, Emma Sutton, and Fiona Andrews, "Cohousing as a Model for Social Health: A Scoping Review," *Cities & Health* 8, no. 1 (2024): 107–19, <https://doi.org/10.1080/23748834.2020.1838225>.  
<sup>36</sup> Ibid.

## 2.2.2. SHARED SPACES

The theoretical framework (p. 8) describes that shared spaces contribute to well-being by promoting social interaction and physical activity.

Fieldwork across various projects shows that shared spaces offer more than just places for social interaction and physical activity.

Pie charts in Figure 14 show that shared spaces are frequently used and generally experienced positively. These spaces are primarily used for activities, rather than relaxation, and promote social interaction. The graph in Figure 15 supplements information from visits, interviews, and surveys, illustrating how shared spaces positively impact residents' well-being in different ways. Research reveals that residents highly value these spaces as they extend their homes, enabling activities that may not be feasible in smaller living spaces.

However, the use of shared spaces varies between projects due to architectural and programmatic factors. Multifunctional spaces (Figure 16-17 (p. 32)) tend to host fewer diverse activities compared to function-specific spaces. Multifunctional spaces are often used for group activities like dining together or hosting guests, while function-oriented spaces allow for creativity, exercise, and DIY projects, encouraging residents to engage in a wider range of activities.

Transparency also encourages use, being able to see inside from the outside lowers the threshold for participation. Spaces with visual access are more likely to attract residents. The location and connection of shared spaces are key. Spaces well-connected to outdoor areas or circulation routes are used more frequently, while spaces off the main path are less utilized unless they serve a specific function.

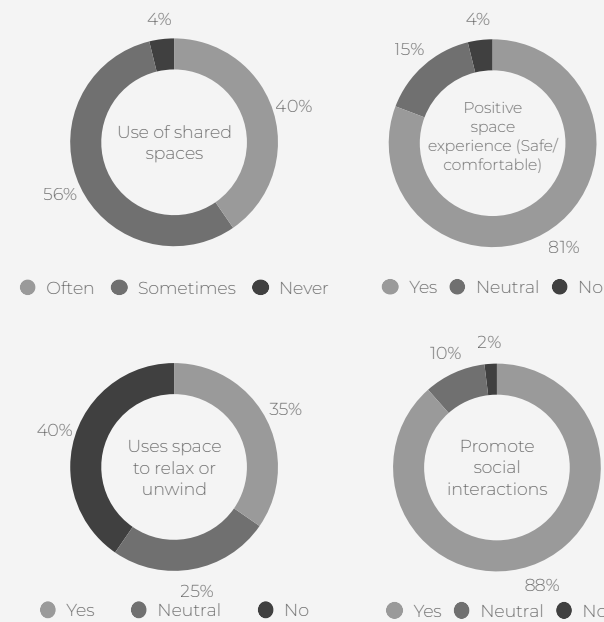


Figure 14. Pie Charts Showing Resident Responses on Shared Spaces and Well-Being | Author's own work.

Finally, the design and ambiance of shared spaces influence their use. Figures 18 and 19 (p. 32) show smaller, cozy shared spaces at De Warren, which encourage occupancy, while Figure 17 (p. 32) shows the communal space at Kas en Co, which is perceived as less inviting. Large, bare spaces (such as the one at Kas en Co, with approximately 186 m<sup>2</sup> for 32 households) are less inviting than well-furnished, thoughtfully designed areas. Dividing larger spaces into smaller, cozier zones can increase usage.

In line with the latter, '14 Patterns of Biophilic Design' describes that spaces that offer privacy and retreat, such as areas for rest, reflection, reading, or meditation, are most effective when enclosed or modular. These spaces provide intimacy and protection. Design elements like adjustable shades, lower ceilings, softer lighting, and comfortable furnishings enhance their calming nature, creating a sanctuary within the built environment.<sup>37</sup> Further details on interior design are provided in Chapter 2.3.1 (p. 39).

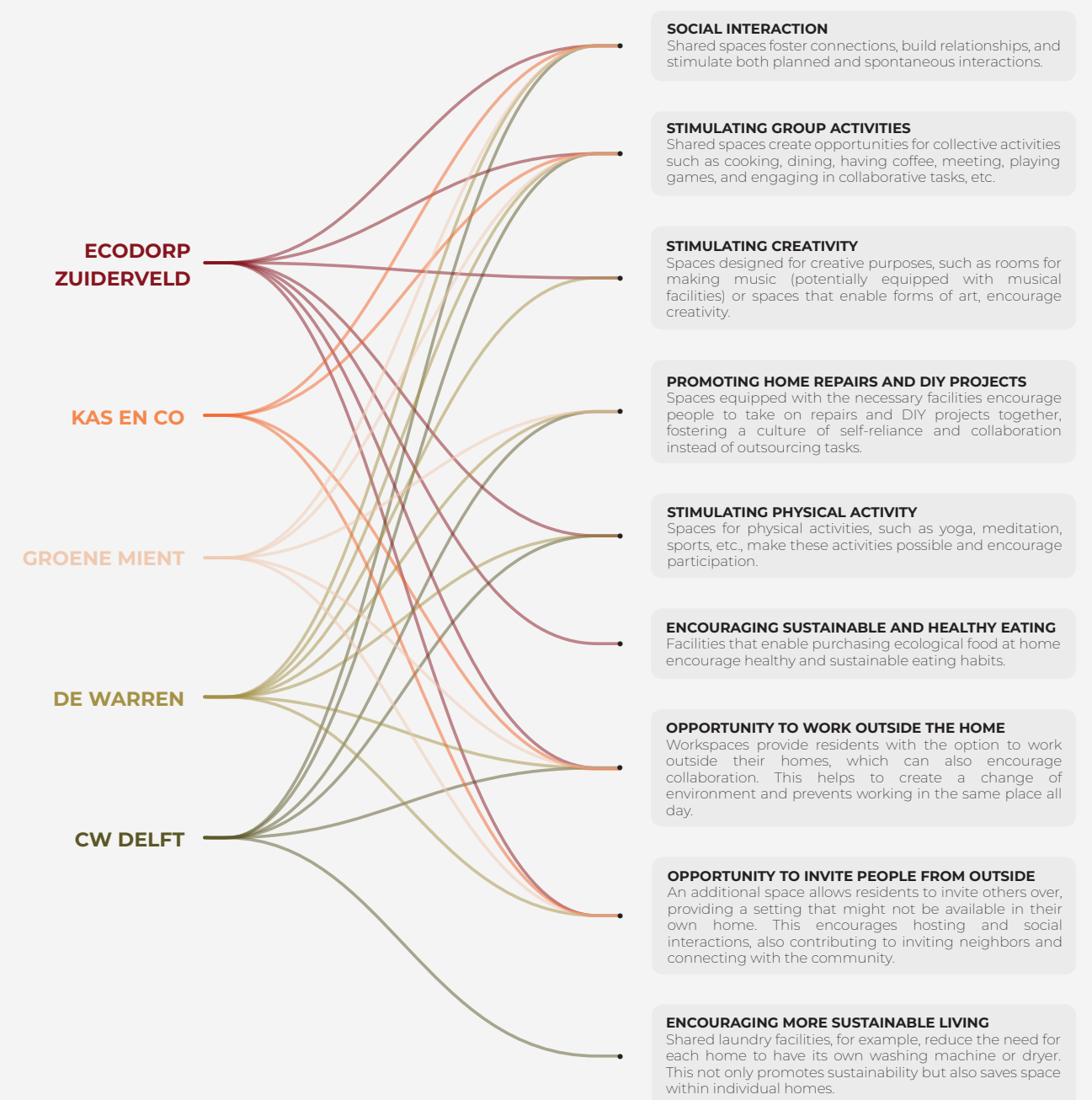


Figure 15. Contribution of Each Project's Shared Spaces to Positively Influencing Residents' Well-Being | Author's own work.

Additionally, specific functions within shared spaces can promote healthier lifestyles and community engagement. One of the most important functions appears to be having a shared kitchen (Figure 20 (p. 32)). Furthermore, an in-house shop (Figure 21 (p. 32)) offering healthy and ecological products can encourage residents to adopt healthier habits. A café or similar hospitality facility can foster interactions between residents and the wider neighborhood.

Thermal and acoustic qualities also affect shared space success. Poor thermal insulation can deter use in colder months, while inadequate soundproofing can impact the comfort of adjacent homes. For noisy functions, standard building regulations may not be sufficient. Lastly, designing with future flexibility in mind can add adaptability. Creating a shared space within a housing unit that can later be transformed into a regular dwelling allows for accommodation of changing housing

<sup>37</sup> Terrapin Bright Green, 14 Patterns of Biophilic Design: Improving Health & Well-Being in the Built Environment (Terrapin Bright Green, n.d.).





Figure 16. Image of the Shared Multifunctional Spaces at Groene Mient, The Hague | Author's own image.



Figure 17. Image of Shared Living Space at Kas & Co | Author's own image.



Figure 18. Image of a Shared Living Space at De Warren, Amsterdam | Author's own image.



Figure 19. Image of a Shared Living Space at De Warren, Amsterdam | Author's own image.



Figure 20. Image of Shared Kitchen at Ecodorp Zuiderveld | Author's own image.



Figure 21. Image of In-House Shop at Ecodorp Zuiderveld | Author's own image.

### 2.2.3. NATURE

In Chapter 2.1.1, literature highlights how BGIs enhance urban life by providing environmental, social, physical, and psychological benefits. These benefits are not only applicable at the urban scale but also at the building block scale. To explore this, fieldwork was conducted on projects incorporating nature into their design.

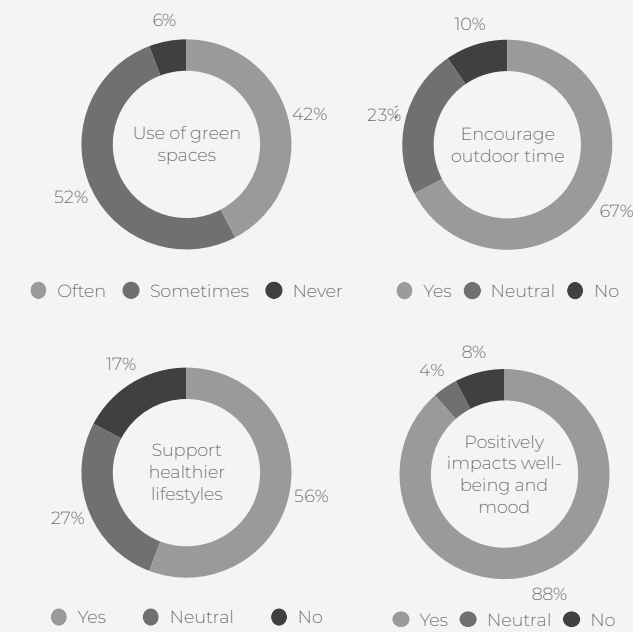


Figure 22. Pie Charts Showing Resident Responses on Green Spaces and Well-Being | Author's own work.

Survey responses related to nature, shown in Figure 22, reveal that green spaces are highly valued for promoting outdoor activity, healthier lifestyles, and improved well-being and mood. These findings, supported by textual survey explanations and resident conversations, align with literature, demonstrating the positive impact of green spaces on social cohesion, mental health, and physical health in the cases studied. Figure 23 illustrates how each project contributes to these aspects.

Fieldwork uncovered additional benefits not mentioned in the reviewed literature, such as mood improvement through observing plants and animals, healthy eating encouraged by vegetable gardens, and outdoor play for children. These findings further reinforce the positive contributions of green spaces to well-being.

Mental health aspects like stress reduction and emotional resilience, noted in the literature, did not explicitly emerge in fieldwork but may still be present. As shown in Figure 23, nearly all projects address well-being aspects, though emphasis varies, likely due to differences in green space design.

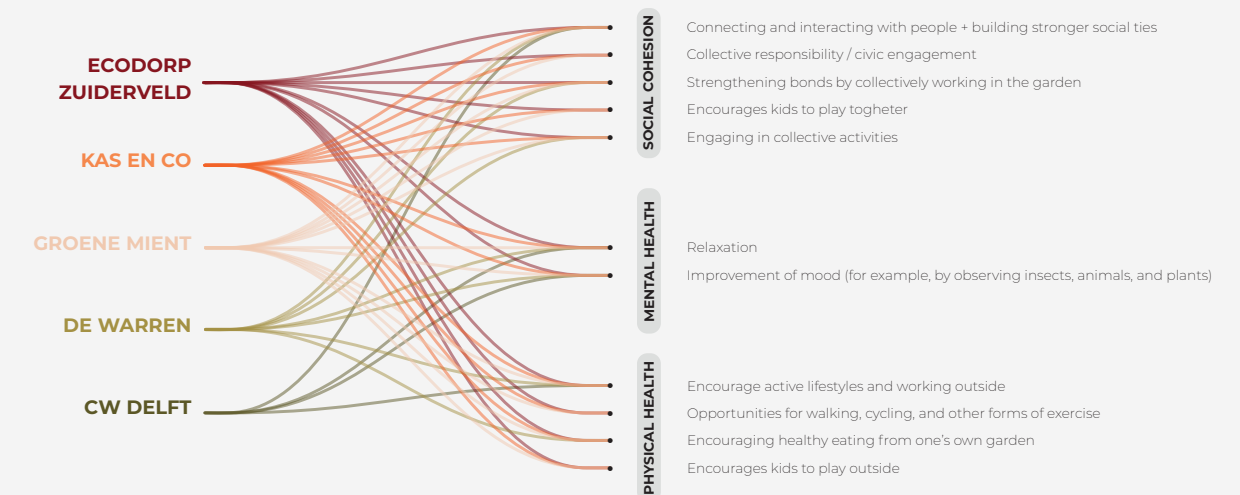


Figure 23. Contribution of Each Project's green Spaces to Positively Influencing Residents' Well-Being | Author's own work.



Comparisons of surveys and interviews reveal that some green spaces are less effective, influenced by factors like their relationship to buildings, size relative to homes, public or private access, layout, and functions (Figures 25–30, with further details provided in Appendix 3). Figure 24 outlines these differences across projects. Smaller green spaces, like those at Kas en Co (Figure 27), tend to be less effective, because people are more likely to feel watched here. While multifunctional spaces with features such as vegetable gardens, seating areas, quiet zones, fire pits, wadi systems and play equipment (e.g., Groene Mient, Figure 25, and Ecodorp Zuiderveld, Figure 26) are more successful.

Residents highly value lush, biodiverse greenery. In line with this, ‘14 Patterns of Biophilic Design’ emphasizes that authentic, biodiverse environments are preferred over sheer plant quantity. It highlights the importance of multisensory connections, such as nature sounds and fragrant plants that attract birds.<sup>38</sup>

Centrally located, cohesive green spaces, partially surrounded by homes with back doors opening onto them and logical routes (Figures 25 and 26), see higher use and foster interaction.

Conversely, residents with decent private outdoor spaces separate from shared areas (Figure 27) often prefer their private spaces. Semi-private spaces adjacent to homes and the presence of water are also desirable.

The literature review of ‘14 Patterns of Biophilic Design’ highlights spatial arrangements that resonate with human instincts, such as exploring, seeking refuge, and connecting with surroundings. These designs combine thoughtful configurations with natural analogues to create dynamic environments.

Spaces with a strong sense of ‘prospect’ feel open and freeing while offering safety and control. Features include expansive views, sightlines of at least six meters, low hedges or partitions under 107 cm, and transparent materials for visual continuity. Savanna-like ecosystems with shade trees, water, and human habitation enhance this connection.

In contrast, ‘refuge’ spaces provide privacy and intimacy for rest, reflection, or meditation. These enclosed or modular spaces balance the openness of prospect with areas of protection and retreat.<sup>39</sup>

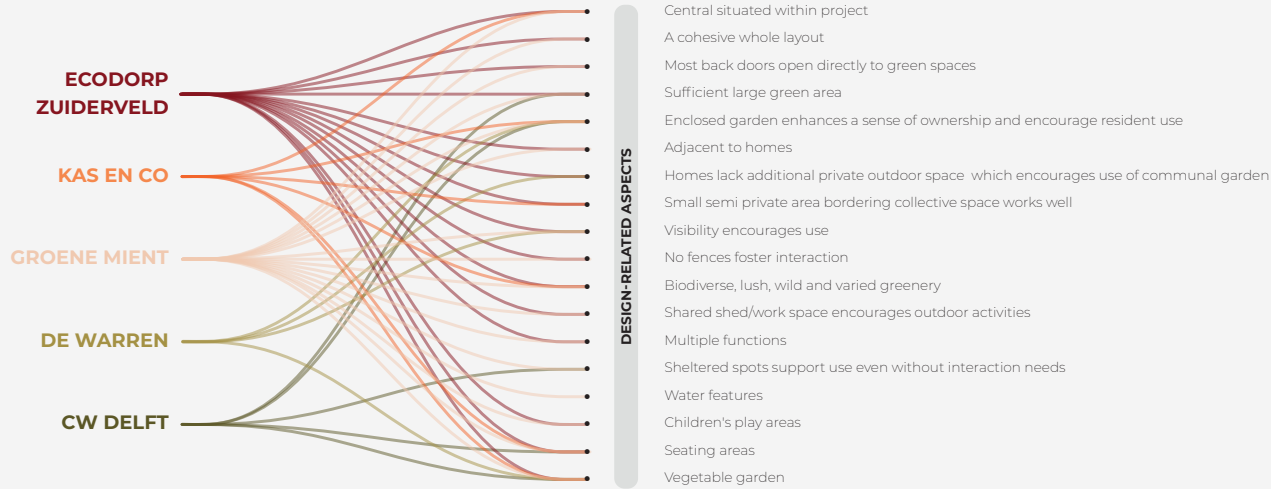


Figure 24. Design-Related Aspects Per Project that Contribute to the Effectiveness of Green Spaces” | Author’s own work.

<sup>38</sup> Terrapin Bright Green, *14 Patterns of Biophilic Design: Improving Health & Well-Being in the Built Environment* (Terrapin Bright Green, n.d.).  
<sup>39</sup> Ibid.



Figure 25. Analysis Drawing of Groene Mient's Green Space 1:2000 | Author's own image.

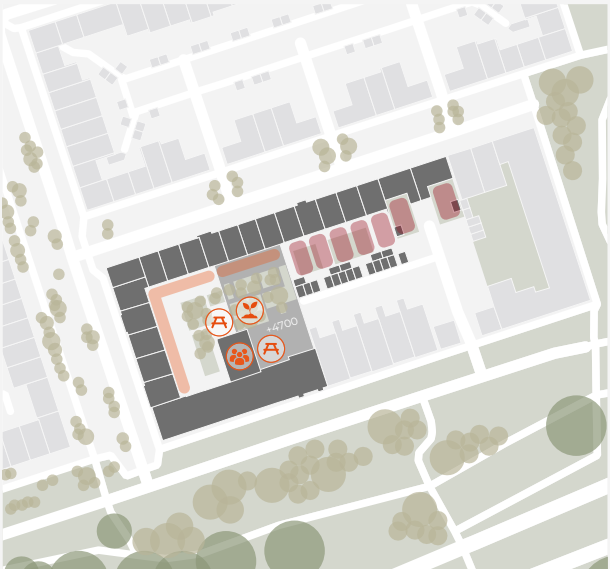


Figure 27. Analysis Drawing of Kas & Co's Green Space 1:2000 | Author's own image.



Figure 29. Analysis Drawing of CW Delft's Green Space 1:2000 | Author's own image.

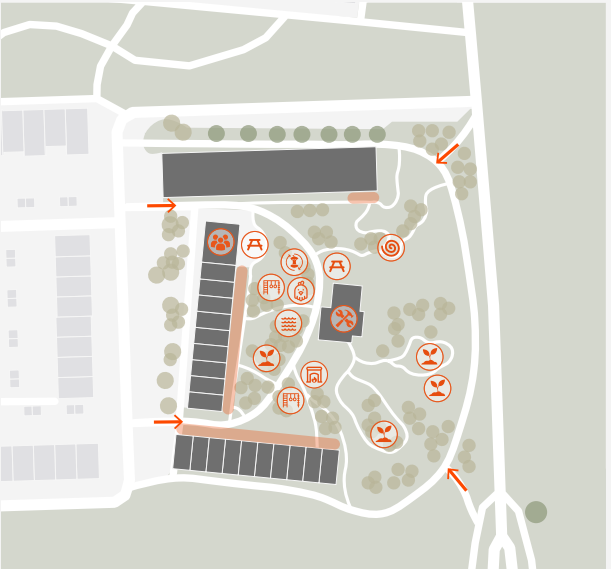


Figure 26. Analysis Drawing of Ecodorp Zuiderveld's Green Space 1:2000 | Author's own image.



Figure 28. Analysis Drawing of De Warren's Green Space 1:2000 | Author's own image.

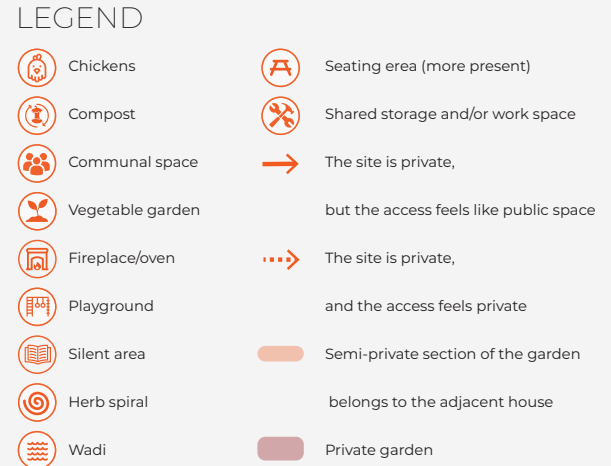


Figure 30. Legend in support of analysis drawings

#### 2.2.4. CONCLUSION

Reviewed literature, compared with the findings from fieldwork on five co-housing projects, shows that co-housing environments are positively associated with improved health outcomes through psychosocial determinants such as social support, sense of community, physical, emotional, and economic security, and reduced social isolation, as well as social/personal development. These factors collectively enhance residents' well-being and contribute to a higher quality of life.

#### SOCIAL SUPPORT

Co-housing fosters an environment where residents actively support one another. This support system reduces feelings of isolation and depression, as neighbors can help each other with various tasks, look after one another, or care for children. The constant availability of assistance strengthens general support networks, promoting emotional and mental well-being.

#### SOCIAL COHESION

Living in co-housing promotes social cohesion and a sense of community by encouraging deep connections between neighbors. Through shared decision-making and participation in communal activities, residents experience a decrease in individualism and build a strong sense of belonging.

#### SECURITY

Co-housing provides physical, emotional, and economic security. Safe and well-maintained neighborhoods, combined with social support, help mitigate stress and loneliness. Shared amenities and financial benefits contribute to residents' stability. Opportunities such as home-swapping within the community also enable greater residential flexibility.

#### REDUCING SOCIAL ISOLATION

Co-housing is instrumental in reducing social isolation by encouraging spontaneous and planned interactions through shared tasks and activities. These interactions help residents form meaningful relationships and strengthen social engagement. Surveys reveal that 85% of respondents reported positive experiences with community activities, highlighting the significance of social cohesion and mutual support in enhancing overall well-being.

#### SOCIAL/PERSONAL DEVELOPMENT

Co-housing encourages healthier, more ecological lifestyles, stimulates creativity and experimentation, and fosters inspiration through the exchange of ideas, lifestyles, and cultures among residents. Although the variation of different cultures in the visited projects is on a small scale, it is highly appreciated wherever it does occur. Residents also express a strong desire to live alongside people from different cultures.

#### Shared Spaces

The well-being aspects described above are closely linked to shared spaces, making these spaces essential to the success of co-housing projects in enhancing well-being. They foster social interaction, reduce isolation, and offer opportunities for both relaxation and activity. Surveys indicate that these spaces are widely used and highly valued, functioning as extensions of private homes. They facilitate activities that may not be feasible within individual living spaces, making smaller homes more practical.

Shared spaces, when designed effectively, offer a wide range of benefits. Chapter 2.4 (p. 42) discusses the design aspects to consider when integrating a shared space.

#### Nature

In addition to communal indoor spaces, shared green spaces contribute positively to well-being by offering environmental, social, physical, and psychological benefits. As previously discussed in Chapter 2.1.1 BGIs positively impact urban areas, and this effect extends to the building block scale as well. Field research shows that the majority of respondents actively use green spaces, appreciating their role in promoting outdoor activities, healthier lifestyles, and improved mood. Green spaces are crucial in fostering social cohesion, as they encourage interactions, collective responsibility, and civic engagement. These spaces offer opportunities for both children and adults to engage in shared activities, helping to strengthen bonds and bring communities closer together. Moreover, green spaces have a significant impact on mental health by creating relaxing environments that improve mood and contribute to psychological well-being. From a physical health perspective, these areas promote active lifestyles, encourage outdoor play, and can even foster healthier eating habits.

Certain design aspects are crucial for green spaces to function effectively. Chapter 2.4 (p. 43) discusses the design considerations for integrating a green space into a co-housing project.

Nature-inclusive co-housing combines shared spaces and green structures to create a supportive, interactive, and health-promoting environment. By fostering social cohesion, reducing isolation, and encouraging ecological and creative lifestyles, co-housing significantly contributes to residents' well-being. Thoughtful architectural and landscape design considerations (details provided in Chapter 2.4 (p. 42-43)) are key to maximizing these benefits, ensuring that co-housing remains a sustainable and adaptable solution for enhancing quality of life.

# 2.3. The Dwelling and Well-Being

This chapter examines how individual dwellings within co-housing projects impact residents' well-being, focusing on two key aspects: the connection between dwellings and nature, and the relationship between dwellings and shared spaces. It refers back to the reviewed literature from the theoretical framework (p. 8) and compares it with fieldwork (detailed findings are available in Appendix 3) conducted in the same case studies discussed in Chapter 2.2. The chapter first explores the connection between dwellings and nature, followed by their relationship with shared spaces. As in Chapter 2.2, the dwelling is also further explored through the lens of '14 Patterns of Biophilic Design.

## 2.3.1. DWELLING IN RELATION TO NATURE

The literature review in the theoretical framework (p. 8) highlights the importance of the connection between the dwelling and nature. Supporting this, survey data, shown in Figure 31, support these findings. Textual responses and interviews reveal that residents value natural light and green views. Many describe views of greenery as a luxury, citing benefits like encouraging outdoor activity, enjoyment of nature, and increased socialization. Living rooms adjacent to gardens are particularly appreciated for providing direct access to nature and outdoor spaces.

Design plays a vital role. Paths close to windows may lead residents to close curtains, reducing the view's benefits. Buffer zones like semi-private gardens enhance privacy while maintaining outdoor connections. Fieldwork confirms that homes bordering shared outdoor spaces encourage community interaction, but disconnected private outdoor areas can reduce shared space use. A balance between private and communal areas, with strong visual and physical connections to greenery, is key to fostering interaction and well-being.

The book '14 Patterns of Biophilic Design' emphasizes the importance of green views, recommending low window frames for visibility while seated, operable windows for fresh air and natural sounds, and alternative natural elements like trees or water features for spaces without direct green views. Varied lighting, with daylight from multiple angles, direct sunlight, and moonlight or starlight, enhances the experience.

Connections to natural systems, such as bird nesting boxes, animal habitats, and rainwater storage, promote sustainability and strengthen ties to nature.

Interior design inspired by biophilic principles integrates natural shapes, patterns, colors, and materials to create an indirect connection to nature. Biomorphic designs mimic natural forms, with motifs like the Fibonacci sequence or Golden Ratio applied to surfaces such as floors, walls, and furniture. Elements like textured glass, muntin bar patterns, or intricate furniture details further enhance the natural aesthetic. A natural color palette, particularly green, reinforces a connection to the outdoors. Authentic materials like wood, stone, and natural fibers foster a tactile link to nature. Using real materials over synthetic ones enriches the sensory experience, creating visually pleasing and grounded spaces. <sup>40</sup>

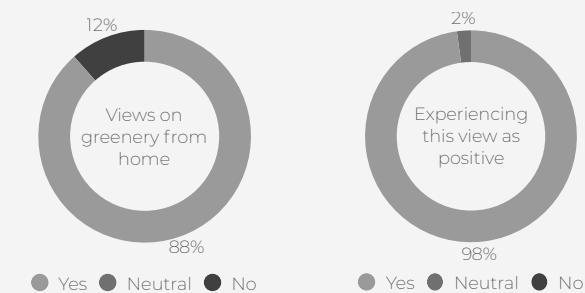


Figure 31. Pie Charts Showing Resident Responses on Having Views on Greenery from Their Home | Author's own image.

<sup>40</sup> Terri Peters and Anna Halleran, "How Our Homes Impact Our Health: Using a COVID-19 Informed Approach to Examine Urban Apartment Housing," *Archnet-IJAR: International Journal of Architectural Research* 15, no. 1 (2021), <https://doi.org/10.1108/ARCH-08-2020-0159>.



2.3.2. DWELLING IN RELATION TO SHARED SPACES

The literature review in the theoretical framework (p. 8) highlights that flexible layouts are crucial for well-being-focused design, since they support multifunctional use

Conversely, fieldwork shows that shared spaces in co-housing, designed for specific functions like work, exercise, music, or art, reduce the need for multifunctional rooms within homes. Locating these spaces nearby but outside individual dwellings makes smaller homes feasible, encouraging shared space use and fostering community interaction.

Literature and fieldwork emphasize the importance of sound insulation, particularly for homes near communal spaces. Enhanced soundproofing, exceeding standard regulations, improves living comfort by minimizing noise disruptions from shared spaces.

Studio apartments or units with communal entryways are valued for promoting social interaction and a sense of community. And surveys on the visibility of shared spaces from homes (Figure 32) indicate that views of these spaces do not significantly enhance social interaction.

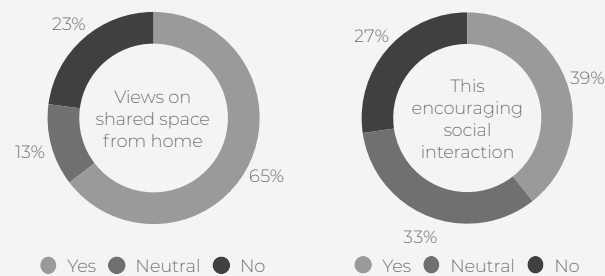


Figure 32. Pie Charts Showing Resident Responses on Having Views on Shared Spaces from Their Home | Author's own image.

2.3.3. CONCLUSION

Reviewed literature states that individual dwellings play a critical role in shaping residents' well-being, and this is confirmed by fieldwork research, particularly through their design and connection to nature. Having a connection to nature is essential for optimizing a dwelling to positively influence well-being. Both literature and fieldwork underscore the profound impact of natural light, views of greenery, and direct access to outdoor spaces on residents' well-being. It affirms that these elements are not just aesthetically pleasing but also instrumental in fostering a connection to nature, encouraging outdoor activity, and promoting social interaction. Additionally, having direct access to nature from the home can reduce stress, while seeing others in outdoor spaces further encourages residents to step outside and socialize. This also contributes to a stronger connection with nature. Chapter 2.4 (p. 43) outlines design guidelines that can support these benefits.

Fieldwork shows that while views of shared spaces from within the home are appreciated, they do not necessarily encourage social interaction on their own. However, shared spaces with specific functions, such as workspaces, areas for physical activity, or creative spaces for music and art, reduce the need for multifunctional rooms within the home, making smaller homes more feasible. This shift encourages the use of communal spaces, fostering both interaction and a sense of community.

2.4 Conclusion

This research emphasizes that designing a healthy living environment is a multi-faceted approach spanning various scales, each playing a vital role in enhancing the overall well-being of Tarwewijk residents.

In neighborhoods like Tarwewijk, where health challenges and environmental concerns intersect, integrating nature and co-housing principles across various scales can create a supportive, resilient, and healthier environment. These elements not only improve the quality of life for individuals but also foster social cohesion, a sense of community, and biodiversity, key factors for long-term well-being.

To address this, designers can incorporate various guidelines applicable at different scales to enhance residents' well-being.

At the urban scale, **biodiversity** can be enhanced through the integration of BGIs. This also fosters social cohesion, improves mental health, and encourages active lifestyles, all of which contribute to overall well-being. The Tarwewijk neighborhood can greatly benefit from targeted improvements in BGIs, aligning ecological strategies with the community's needs.

At the building block scale, the inclusion of **co-housing**, along with **shared and green spaces**, can further enhance well-being by fostering social support and cohesion, reducing social isolation, promoting physical, emotional, and economic security, and supporting personal and social development. Shared green spaces positively impact residents' mental and physical health by providing opportunities for outdoor activity, relaxation, and social interaction.

Finally, at the dwelling scale, a **connection to nature** within individual homes can help optimize circadian rhythms, reduce stress, and promote social interaction.

The remainder of this chapter will explain the considerations that should be taken into account when developing these guidelines and Figure 34 (p. 43) gives an overview of the specifications.

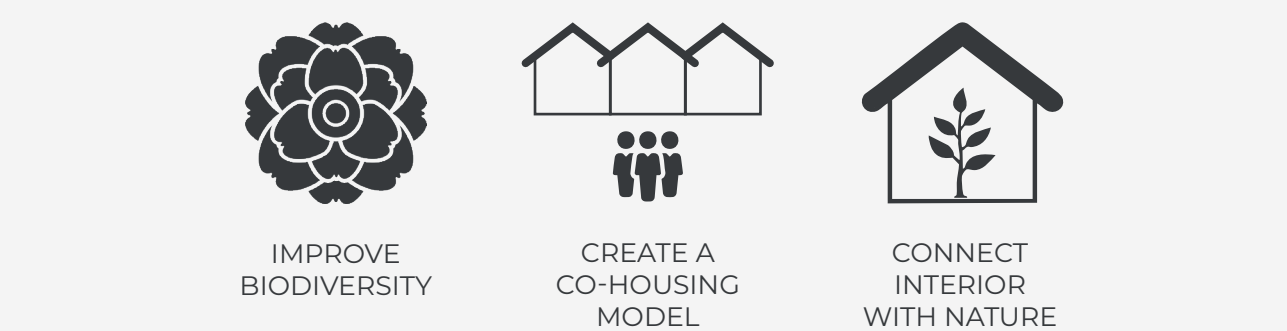


Figure 33. Design Guidelines | Author's own image.

### 1. IMPROVE BIODIVERSITY

To improve biodiversity, BGIs can be integrated into the built environment to enhance the neighborhood. By prioritising biodiversity, a balance can be achieved between human needs and ecological health, creating multifunctional green spaces that serve both residents' desires and the broader goal of ecological sustainability. Future developments must align with Rotterdam's biodiversity guidelines, focusing on incorporating BGIs that strengthen ecological connections, particularly in vulnerable areas like Tarwewijk. This involves improving existing structures, prioritising ecological diversity, forming an interconnected green network, and developing additional green spaces close to residential areas.

Key actions to improve biodiversity include revitalizing public squares, preserving and enhancing existing green structures, planting native species, protecting mature trees, and creating space for large vegetation to thrive. In Tarwewijk, particularly in the area around the northern part of Polslandstraat, there are key species that require special attention. These include the swift, holly blue butterfly, hedgehog, long-eared owl, and common pipistrelle bat. Specific measures to support these species can be found in Appendix 2.

Including residents' input is crucial. By acknowledging that they value integrating greenery into their neighborhood, whether in the form of multifunctional parks or natural elements like trees and shrubs, development projects can not only enhance biodiversity but also align with the needs and priorities of the community. By combining ecological strategies with social engagement, neighborhoods like Tarwewijk can become greener, healthier, and more resilient.

### 2. CREATE A CO-HOUSING MODEL

To optimize the well-being aspects of a co-housing model, communal and green spaces should be integrated.

#### COMMUNAL SPACE

The design and functionality of shared spaces directly affect their effectiveness. Multifunctional spaces support group activities like dining or working, while dedicated spaces for specific functions encourage creativity, exercise, and DIY projects. These spaces, especially when well-equipped, provide the greatest benefits. Key factors such as transparency, location (along the route and connected to outdoor and circulation spaces), and ambiance further influence their use. Ambiance is important, cozy and thoughtfully designed spaces are more inviting and encourage frequent use, whereas large, generic spaces tend to be less effective. Smaller, intimate spaces, especially those designed for relaxation, work better when they feature adjustable shades, lower ceilings, adaptable/softer lighting, and comfortable furnishings, creating a sanctuary within the built environment.

Shared kitchens are the most used and social spaces in co-housing projects, making them essential in any design. Additionally, features like in-house shops with healthy products or cafés can promote healthier habits and strengthen connections with the broader neighborhood.

Thermal and acoustic qualities also impact shared spaces. Proper insulation ensures comfort year-round, while soundproofing minimizes noise disturbances. Adaptable designs that allow spaces to transform in the future ensure long-term functionality.

#### GREEN SPACE

To maximize the benefits of greenery in residential projects, several design strategies should be considered. First, the size (details provided in Appendix 3) and functionality of the green spaces play a crucial role. Spaces that serve multiple functions, such as vegetable gardens, play areas, fire pits, seating areas, wadi systems, and quiet zones, are more effective in promoting interaction and well-being. Additionally, the relationship between green spaces and buildings is critical: enclosed, centrally located, cohesive spaces with logical routes that are easily accessible from homes (such as through back doors from the living room) are more successful. The presence of semi-private spaces adjacent to shared green areas further encourages use while still providing privacy, unlike having a separate private outdoor area. Moreover, design features that prioritise biodiversity, such as lush, wild greenery, are highly valued. It is important to create spaces with expansive views and connections to nature that offer openness and freedom, while also providing areas for privacy and retreat, ensuring a balance between openness and security. Spaces that allow for both exploration and seclusion are essential for well-being.

### 3. CONNECT INTERIOR WITH NATURE

Designing homes with natural elements and thoughtful spatial arrangements can greatly improve residents' physical and mental health. Strategically placed low windows that maximize natural sunlight from multiple angles, offer views of nature, and allow for ventilation and natural sounds enhance well-being. Positioning bedrooms to face the morning sun helps regulate sleep-wake cycles.

Access to outdoor spaces directly from the living room encourages connection with nature. However, a path running alongside windows facing green spaces may lead residents to keep curtains closed, reducing the view's benefits. A buffer zone can improve privacy while maintaining the outdoor connection. Additionally, incorporating nature-inclusive elements such as green roofs, green walls, and habitats for wildlife is essential.

The integration of biophilic design principles, such as natural forms, patterns, and colors, strengthens this connection, as do details like textured glass, muntin bar patterns, intricate furniture details, and authentic materials.

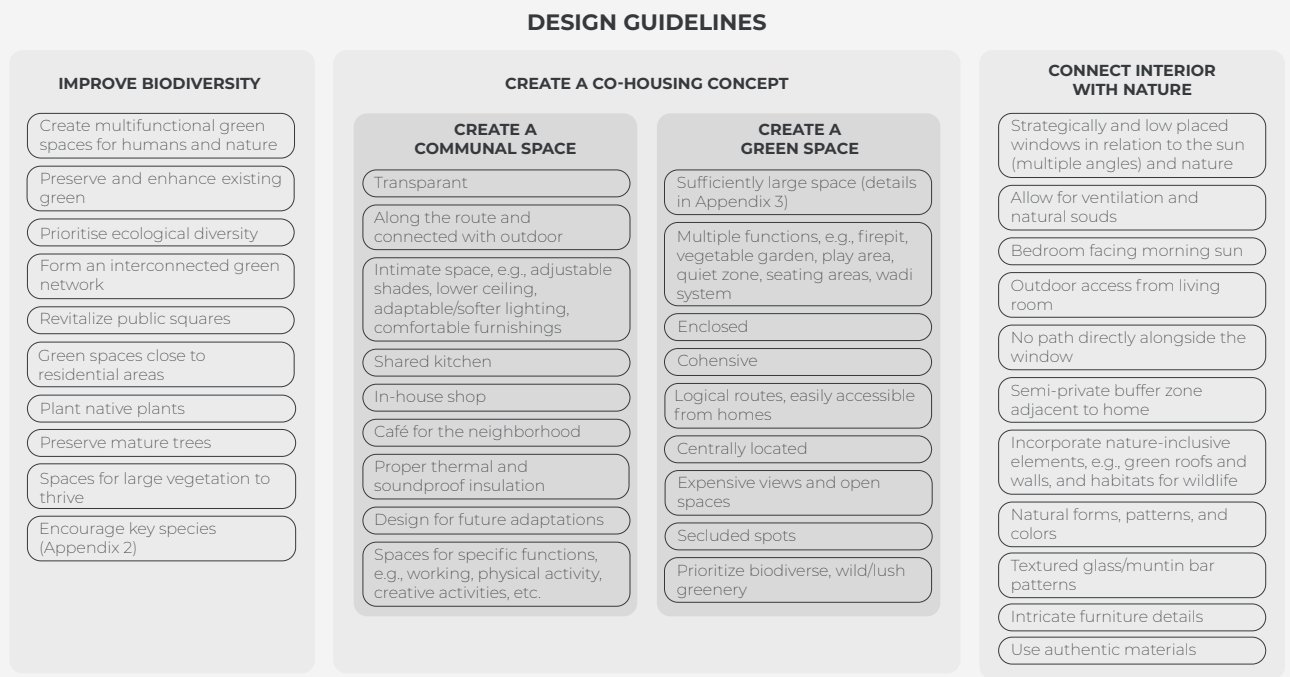


Figure 34. Design Guidelines and Specifications | Author's own image.

## 2.5 Discussion

The research is divided into three scales, which works effectively overall. However, some scales occasionally delved into greater detail, causing overlap with others. While not necessarily an issue, this could sometimes lead to repetition or confusion.

The municipality of Rotterdam's biodiversity-related documents positively influenced Chapter 2.1.2. While the toolbox provided useful guidelines, its incomplete state required additional data collection, leading to varying levels of detail. The continued development of the toolbox will be worth reviewing in the future. During the interviews conducted for Chapter 2.1.3 on Tarwewijk residents' need for green spaces, conversations were sometimes hindered by language barriers and differences in knowledge, leading to limited results. Distributing surveys might have been more effective.

Chapter 2.2 was successful due to well-prepared fieldwork questions based on literature, leading to valuable comparisons. The interviews and surveys provided extensive information, which was then compared with the literature. Using the same survey for each project allowed for consolidating all responses, creating an overall picture of the five projects. This resulted in insights into effective design strategies, with some aligning with the literature and others offering new perspectives.

The early-scheduled fieldwork limited the theoretical groundwork for Chapter 2.3, leaving some questions underdeveloped. A stronger foundation could have added depth, but prior research on biophilic design provided valuable insights.

The three guidelines, derived from the research, are quite general, but their detailed descriptions include sub-guidelines that will be useful tools throughout the continuation of the graduation project. They are drawn from both literature and fieldwork, making them robust and versatile.

Further exploration of Tarwewijk's cultural diversity could have revealed ways to make co-housing projects more inclusive, since project visits highlighted the need for greater diversity, often seen as a challenge, which would be valuable to address in future co-housing projects for multicultural neighborhoods. Demand for co-housing is high, as shown by overwhelming applications for existing projects, underlining the need for further research and increased availability. Additionally, a deeper dive into Tarwewijk's history, particularly Polslandstraat, would have been insightful, examining past success factors could have informed future design strategies. The fact that some interviewed residents mentioned living healthier due to having vegetable gardens highlights the value of further research into the health benefits of urban farming.

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## 3.2 Figures

**Figure 2.** News article | Centraal Bureau voor de Statistiek. “Tevredenheid met Sociale Leven Nog Niet op Niveau van Voor Corona.” Last modified July 29, 2024. <https://www.cbs.nl/nl-nl/nieuws/2024/31/tevredenheid-met-sociale-leven-nog-niet-op-niveau-van-voor-corona>.

**Figure 3.** News article | Centraal Bureau voor de Statistiek. “Jongvolwassene Negatiever Over Eigen Gezondheid.” Last modified June 4, 2024. <https://www.cbs.nl/nl-nl/nieuws/2024/23/jongvolwassene-negatiever-over-eigen-gezondheid>.

**Figure 4.** News article | Centraal Bureau voor de Statistiek. “Obesitas Afgelopen 40 Jaar Verdrievoudigd.” Last modified March 4, 2024. <https://www.cbs.nl/nl-nl/nieuws/2024/10/obesitas-afgelopen-40-jaar-verdrievoudigd>.

**Figure 9.** Tarwewijk’s Native Plants | Presură, Anton, et al. “Health and Care in Tarwewijk,” 2024.

**Figure 10.** Tarwewijk’s Native Shrubs | Presură, Anton, et al. “Health and Care in Tarwewijk,” 2024.

**Figure 11.** Tarwewijk’s Native Trees | Presură, Anton, et al. “Health and Care in Tarwewijk,” 2024.

# 04 APPENDICES

## Appendices

Appendix 1. Tarwewijk Analysis

Appendix 2. Toolbox Application

Appendix 3. Fieldwork Booklet

Appendix 4. Transcripts

Appendix 5. Polslandstraat Analysis

Appendix 6. Biodiversity Framework

Appendix 7. Implementation Agenda Biodiversity 2023-2027

Appendix 8. Nature Quality Map

Appendix 9. Toolbox Nature-inclusive Rotterdam