Vision Building for Water-sensitive Planning

Towards a Livable, Harmonious, and Sustainable Peri-urban Community of Rejodani,

Sleman, Indonesia

POLYURBAN WATERS

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Sleman, Indonesia

About PolyUrbanWaters and this report

PolyUrbanWaters is a research and project network funded by the German Federal Ministry of Education and Research (BMBF) that consists of academic institutions, municipalities, local and national government agencies, civil society and private-sector stakeholders from Indonesia, Cambodia, Laos, Thailand, Vietnam and Germany. This report is an output of Vision Building process conducted in Sleman Regency, Indonesia as one of PolyUrbanWaters pilot projects.

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Executive Summary

Fast-growing cities and peri-urban areas in Southeast Asia face a rapid physical and socio-economic transformation from rural to urban functions. These peri-urban areas showcase a coexistence of rural and urban livelihoods, experiencing various challenges due to the rapid development, especially in urban water management. PolyUrbanWaters aims to generate a scientific understanding and develop practical tools that enable secondary and tertiary cities in Southeast Asia to integrate urban development and cross-sectoral water management effectively.

The PolyUrbanWaters Research and Development (R&D) Phase has entered the Vision Building process. This process translates the baseline study result into a fundamental understanding of the case study at sub-village level, serving as a pilot to actualize water-sensitive planning and build a strong water-sensitive community. The PolyUrbanWaters concept is the foundation for developing water-sensitive villages in Sariharjo village, which is further used to elaborate the more specific context of the pilot site in Rejodani I and Rejodani II Sub-Villages. This polycentric approach is structured around eight pillars: a) land use development, b) settlement development, c) stormwater management, d) wastewater management, e) water supply management, f) water catchment management, g) blue-green infrastructure management, and h) waste management.

The Vision Building process promotes participation and collaboration to co-create a shared vision for the future of water management by involving related stakeholders from different sectors and levels. It includes the community at the sub-village level, the government in village and regency level, the private sector, expertise, CSOs, and academics. Data collection method includes desk studies; interviews with key actors in water management; field observations, transect walk, and participatory mapping; focus group discussions; and consultative meetings with the government. The approach integrates statutory planning alongside the participatory process in developing the vision, ensuring that the proposed vision and activities align with the government's visions and programs. The vision building process is also supported by expert analysis, including rationalizing and quantifying the collected information and data, to ensure its relevance and accuracy, leading to measurable and rational action plans. Combining different approaches in the Vision Building process, from participatory approaches involving the community, technocratic approaches of government involvement, and expert analysis, the Vision Building process is expected to offer integrated solutions of water-sensitive planning and development.

The vision, "Towards Livable, Harmonious, and Sustainable Peri-urban Community", has been formulated for the Rejodani pilot site. This vision was then translated into three main strategies, including: (1) Ensuring affordable, healthy, and environmentally friendly settlement; (2) Ensuring affordable water safety; and (3) Ensuring water conservation and management. A masterplan to integrate the vision and strategies is developed to show how government plans and the community's vision could fit spatially. The masterplan development incorporates spatial planning and sectoral planning of the government, focusing on specific areas representing current challenges and addressing these challenges with feasible solutions to be implemented for future.

The three strategies were translated into a series of actions to be implemented from 2025 to 2030. The action plans under Strategy 1 include the provision of green open spaces, the establishment of a wastewater treatment plant and a solid waste processing site to support healthy settlements, and the construction of a reservoir to support agricultural preservation. Strategy 2 focuses on the expansion of the centralized pipeline network and the improvement of Pamdus (sub-village community-based water provision) infrastructure and management to ensure reliable access to safe drinking water. Strategy 3 involves the implementation of a sustainable drainage system by incorporating infiltration wells, infiltration trenches, and bioswales for stormwater management and to enhance water catchment. The list of action plans ensure the integration of Nature-based Solutions (NbS), which promote the utilization of natural features and processes in a sustainable manner to address socio-environmental challenges.

The implementation period of action plans—known as the 'transition pathway'—is a crucial period to transform the development in the pilot site by implementing water-sensitive planning towards a livable, harmonious, and sustainable community. To secure the implementation of action plans arranged, the vision building document is equipped with a list of stakeholder's commitments. This to guide the stakeholders to take the lead in driving the transformation. The successful execution of these commitments will ensure that the transition pathway not only meets its mid-term vision but also contributes significantly to Indonesia's long-term development vision and broader aspiration of achieving "Golden Indonesia 2045".

Vision Building for Water-sensitive Planning

Towards a Livable, Harmonious, and Sustainable Peri-urban Community of Rejodani,

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Chapter 1
Introduction

PolyUrbanWaters promotes water-sensitive planning in secondary and tertiary cities in Southeast Asia. The approach enables pilot cities in Southeast Asia to develop their capacities to incorporate polycentric management of urban waters to address the rapid urban transformation and wide-range of urban challenges. This supports more resilient, inclusive, and livable urban areas and contributes to the national and sustainability goals. The project has completed the baseline assessment and step forward to the vision-building phase.

Vision-building defines the aspiring future scenario using a water-sensitive approach. It identifies strategies and action plans to achieve the water-sensitive cities. Further, the vision building process acts as an engagement for stakeholders along the process to secure the implementation. The pilot area focuses at sub-village level in Rejodani I and Rejodani II, representing current urban water challenges in the region. It is an imperative area of water catchment and rich in water resources as it is located in the slopes of Mount Merapi. To accommodate the challenges of urban expansion while conserving resources and the environment, there is a need to shift from business-as-usual development practices to water-sensitive planning.

1.1 Background

The commitment to water-sensitive development in the Rejodani sub-villages, particularly through a polycentric water-sensitive approach, began in 2019 with the 'Sleman Background Study for Polycentric Approaches to the Management of Urban Water Resources in Southeast Asia,' prepared by UGM Planning, and the 'Water-Sensitive Communities, Sleman Regency: Feasibility Study and Pilot Site Selections' report by Kota Kita. Building on this, a detailed baseline study was conducted in 2021-2022, focusing on Sariharjo Village, a peri-urban area facing both challenges and opportunities. The baseline report highlighted the urgency of adopting water-sensitive development, especially in rapidly growing mid-sized cities across Indonesia, and emphasized the critical need for implementing water-sensitive development in Sariharjo.

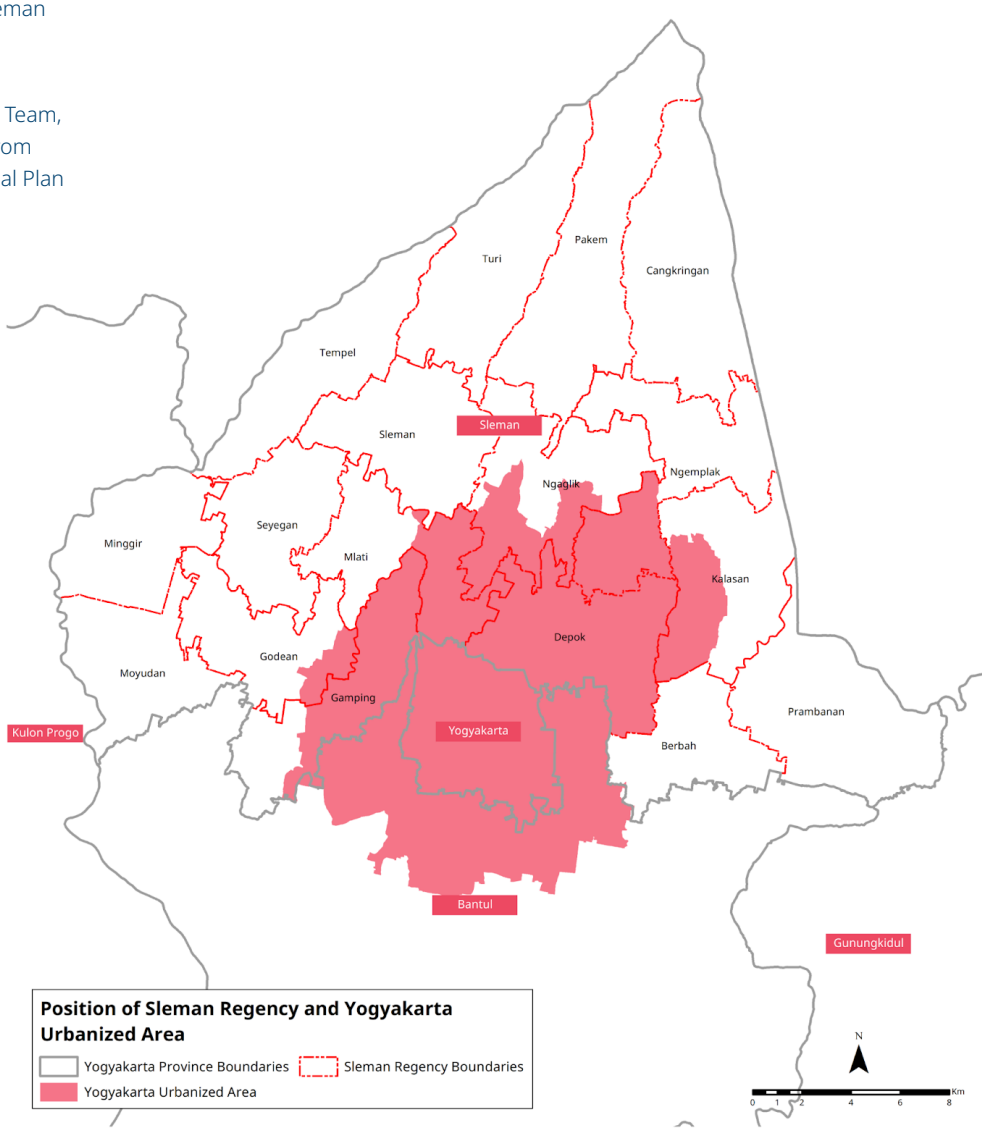
This vision building process is a continuation of the baseline study that has been conducted in Sariharjo village as a pilot area of the project. Referring to the Baseline Report "Towards a Sustainable and Water-Sensitive Sariharjo, Sleman - Indonesia," seven out of 16 sub-villages are characterized as peri-urban areas while the other nine sub-villages are categorized as urban areas. The pilot site for this vision building process was scaled down from the village level to the sub-village level to actualize water-sensitive planning and a solid water-sensitive community. It is

expected to bring more realistic vision-building results and steps that are sufficiently realistic to implement.

Rejodani I and Rejodani II sub-villages are the selected pilot areas, representing current urban water challenges in the region. The pilot site falls within peri-urban areas at the northern end of Sariharjo village. The pilot site exhibits peri-urban characteristics and the availability of rice fields and water catchment areas as well as the growing of the built environment. Rejodani was chosen for their urban transformation process, shifting from activities and sectors with low productivity to those with higher productivity, with significant land use changes to commercial activities and settlement areas. This overall transformation has resulted in water challenges, such as clean water scarcity, wastewater and solid waste management issues, increasing runoff, decreasing water infiltration, etc. The vision-building process identifies water-related problems and development challenges faced by the community, develop a shared vision and action plan that can mitigate future risk.

Figure 1.1. Position of Sleman Regency and Yogyakarta Urbanized Area

Source: PolyUrbanWaters Team, 2023 – Data Processing from Yogyakarta Province Spatial Plan 2019-2039



The community, which is defined as all residents in Rejodani, including residents in housing complexes and business groups, has demonstrated openness and willingness to engage with the concept of water-sensitive planning. This, coupled with identified issues in land use changes, settlement development, stormwater, wastewater, clean water supply, water catchment, green-blue infrastructure and solid waste, accentuates the urgency for a comprehensive study. The selected pilot site offers a unique opportunity to collaborate horizontally between sub-villages and vertically with the other villages, showcasing a model for ecological collaboration. As a fast-growing area, Rejodani presents opportunities to change the development of the sub-village to a more sustainable direction.

The urgency of this vision building lies in addressing the immediate and future water-related challenges associated with rapid urbanization, peri-urban characteristics, and community needs. Focusing on Rejodani I and Rejodani II as a pilot site, this vision building process aims to develop practical and realistic water-sensitive planning strategies that can serve as a blueprint for broader implementation in the region.

The whole process of vision building also brought a new understanding and knowledge that any activities or plan occurring outside Sariharjo Village will affect the village and vice versa. Therefore, it is important to think about a wider spatial setting in addressing water management and urban development. This requires support and commitment from the Sleman Regency Government because such issues naturally demand higher authority to implement planning/regulations in broader areas.

This vision building introduces the Nature-based Solutions (NbS) approach to the community and local government officials. Coupled with the polycentric approach, the inclusion of NbS is expected to enrich and improve the capacity of community members and local government officials to have a greater understanding of the management of peri-urban development. It was believed that by giving respect for the ecosystem and environment at large may benefit the local community in the long term.

Figure 1.2. Sariharjo showcases rural and urban characteristic

Source: PolyUrbanWaters Team, 2024

Figure 1.3. Rejodani Physical Features

Source: PolyUrbanWaters Team, 2024

1.2 Objective and Output

Objective

Using approaches of "water-sensitive urban planning" in Rejodani, the vision building aims to address upcoming development and sustainable (co-)management of green spaces, nature-based solutions, open space design, and water infrastructure development. Based on these foundations, the objectives of the vision building were formulated as follows:

- To identify and better understand the current challenges and opportunities in their areas;
- To formulate strategic solutions and future visions for their areas;
- To help local governments, both village and regency levels, in making policies and implementing activities based on the strategic solutions created.

Output

The outputs for the entire process are as follows:

- Mapping of the key features for Vision Building (identification of the characteristics, current challenges, and opportunities at the sub-village level);

- Vision statements and strategies (identification of community vision, initial solutions that include nature-based solutions (NbS) options);
- Water-sensitive action plan/transition pathways (identification of possible measures in addition to the regulatory framework, program, roadmap, and budgeting processes).

The results are expected to assist both community and local governments in gaining a better understanding and knowledge regarding water-sensitive villages, as well as raise awareness about water-sensitive approaches for future development in this area. Furthermore, the vision building process in Rejodani is expected to serve as a model of polycentric approaches of urban water management that can be adopted and implemented in other peri-urban areas facing similar challenges.

1.3 Conceptual Framework

The PolyUrbanWaters project is developing and demonstrating practice-relevant tools that enable municipalities to implement polycentric approaches for urban development and integrated, cross-sectoral water management. The PolyUrbanWaters concept is the foundation for elaborating on water-sensitive villages in Sariharjo Village, which is also used for vision development at Rejodani. The polycentric approach consists of eight pillars of land use development, settlement development, stormwater management, wastewater management, water supply management, blue-green infrastructure management, water catchment management, and solid waste management.

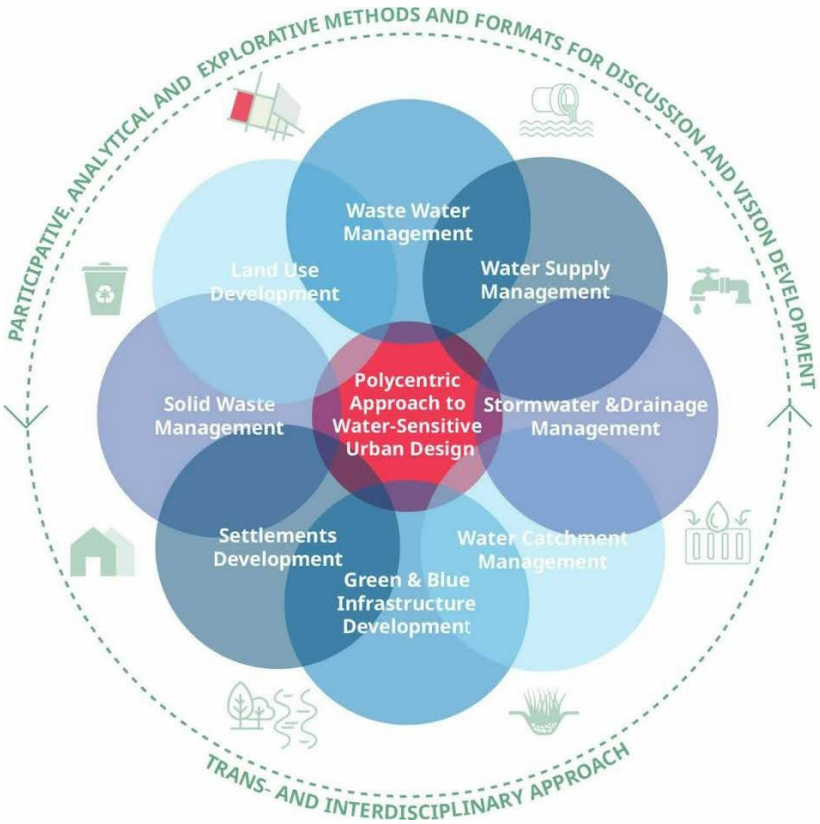


Figure 1.4.
PolyUrbanWaters Pillar
Source: PolyUrbanWaters Team

These pillars serve as the basis for identifying challenges and opportunities for the sub-villages through participatory activities, which also led to vision formulation.

Strategies to achieve the vision are framed by grouping pillar-based visions. These strategies are being translated into action plans and activities in their respective timelines. The overall process leads to the development of a water-sensitive masterplan for the pilot site.

Figure 1.5.

Source: PolyUrbanWaters Team, 2024

1.4 Data Collection Method

Data collection methods for the vision-building process ensure the engagement of different stakeholders, emphasize water-sensitive planning, and secure alignment with local development plans. Vision Building is a key component of the PolyUrbanWaters approach, as it provides a structured and creative way to establish the needs, preferences, values, and aspirations of the stakeholders and translate them into a coherent and inspiring vision (Hara et al., 2016; UN-Habitat, 2012; Wates, 2000). The process promoted participation by intensely involving the community at the sub-village level, along with the government at the village level, the private sector, and the government at the regency level. The data collection process comprised five main methods to ensure the participation and commitment of the relevant stakeholders.

a. **Desk Study**. The aim of the desk study was to identify the current state of knowledge, gaps, challenges, and opportunities for integrating water-sensitive principles into the context of the pilot area (Hoyer et al., 2011). The preliminary activity of data collection entailed reviewing government planning documents, regulations, statistical reports, literature related to NbS approaches, community water-sensitive planning, best practices, and other data related to water management and urban development.

b. **Interviews**. Interviews helped to delve deeper into each government actor's role, providing valuable insights into the decision-making process and the challenges faced by different stakeholders in the context of urban water management. The interviewees include regency government officials, village government officials, and sub-village leaders who have different roles and perspectives on water management issues.

Figure 1.6. Interview with Sariharjo Village Head and Sub-village Head

Source: PolyUrbanWaters Team, 2023

c. **Field Observation, Transect Walk, and Participatory Mapping**. These field activity methods complement each other in examining land use patterns, identifying water sources and risks, pinpointing pollution hotspots, and observing water infrastructures and vegetation by also involving the community's perspectives.

Figure 1.7. Field Observation for Water Infrastructure

Source: PolyUrbanWaters Team, 2023

d. **Focus Group Discussion (FGD)**. A series of FGD aimed to assess the current issues, problems, and opportunities, co-develop the shared visions and strategies, and prioritize and align the proposed interventions with the government's planning. This workshop involved representatives from Rejodani, village, sub-district, and regency government, and private sectors.

Figure 1.8. Focus Group Discussion Milestones
Source: PolyUrbanWaters Team, 2024

- **FGD Challenges and Opportunities Identification**. This is a preliminary vision building for a water-sensitive scenario. It identified challenges and opportunities in the pilot area. The FGD were conducted in two separate sessions, the first with community members and the second with the private sector. Obtaining information about water-related issues and initiatives from the community and private sector perspective is important, as commercial activities and the development of new settlement areas drive the growth of the Rejodani peri-urban area.

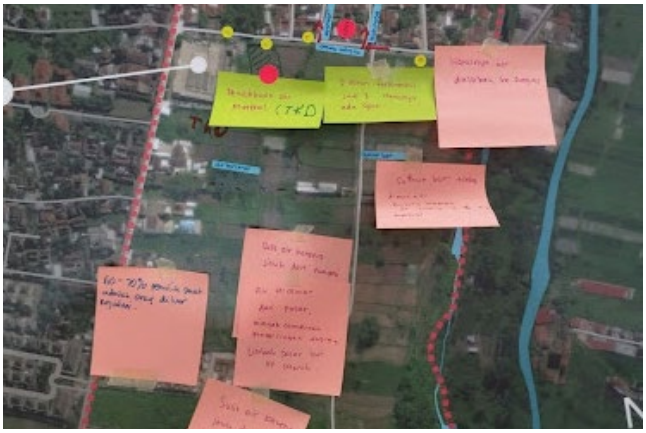


Figure 1.9. Identifying challenges and opportunities with community representatives
Source: PolyUrbanWaters Team, 2023

Figure 1.10. Focus Group Discussion with Private Sector in Rejodani
Source: PolyUrbanWaters Team, 2023

- **FGD Strategy and Solutions Identification**. The second workshop focused on community vision building and introduction to NbS. The purpose of this workshop was to co-produce a shared vision by the local stakeholders for their future within the water-sensitive scenario. This workshop assisted the community in identifying and addressing possible Nbs practices and the locations where they could be implemented.

Figure 1.11. Vision building at the community level and NBs Selection

Source: PolyUrbanWaters Team, 2023

- **FGD Clarification, Prioritization, and Alignment**. The last workshop aimed to align the community's vision and priorities with the local government's plans and policies. The stakeholders participating in the workshop are the representatives from the community, sub-village organizations, village government, sub-district government, and regency government. Participants contributed ideas to prioritize action plans and commitments in order to seek their support and collaboration for implementing proposed action plans.

Figure 1.12. FGD with multi-sector and level stakeholders

Source: PolyUrbanWaters Team, 2023

e. Consultative Meeting with Government.

The consultative meeting with the local authorities aimed to advocate for water-sensitive planning at higher levels of government and decision-makers, as well as share the lessons learned and best practices from the project with other stakeholders. This activity involved ensuring that water-sensitive planning was recognized and supported by the local government as part of their sustainable development agenda. This was also a strategic move in establishing water-sensitive planning as a potential approach for urban planning and water management.

Figure 1.13. Consultative meeting with Sleman Planning Agency

Source: PolyUrbanWaters Team, 2023

1.5. Data Analysis

Data obtained from the workshops is supported by confirmation through rationalization and quantification was needed. Rationalization in this report means that data can be elaborated in reasonable explanations, while quantification means that data can be measured so it will be easier to bring realistic and accurate interventions. That step aimed at re-evaluating the findings to ensure their relevance and significance to research or analysis objectives. The process of rationalization and quantification was conducted with a focus on three pillars: water supply management, stormwater & drainage management, and wastewater management. This process involved engineering calculations and analyses across these areas, resulting in a vision that is more precisely measurable, based on engineering principles as established in the literature.

However, it required supporting data from desk studies, interviews, field observations, transect walks, participatory mapping, and government standards. The analysis process utilized this supporting data, followed by triangulation with workshop results. Ultimately, this comprehensive approach led to the development of measurable and rational visions, strategies, and action plans.

1.6. Vision Building Timeline

The introduction process and commitment to water-sensitive development in Sleman, Indonesia began with the "Definition Phase" in 2020 – 21. Further, in 2021 – 22, a detailed "Baseline Assessment" was conducted at Sariharjo Village, a selected village in the peri urban area. The project continued with the "Vision Building" process that has been conducted in Rejodani I and II sub-villages as the pilot site.

A well-structured vision-building timeline is instrumental in ensuring implementation of strategic actions and effective stakeholder engagement. The vision building timeline, which spans from January 2023 to December 2024, commenced with the PolyUrbanWaters Symposium. In 2023, the vision building focuses on data collection and stakeholder engagement. Key activities included designing essential features for the process, selecting a pilot site, and organizing workshops (FGD 1 – 3). A workshop series gathering challenges, vision creation, and solution mapping, complemented by alignment to regency/local development goals. Input was also sought from government officials through consultative meetings. The series of activities led to analysis preoccupied with expert consultations to support in rationalizing and quantification of the data collected.

The milestone in 2024 begins with a master plan and action plan development. The subsequent activity is dissemination of vision-building report, commitment, and policy brief to the community in sub-villages, as well as to village and regency governments. To strengthen collaboration, an advocacy meeting with the Sleman Regent is held to gain support for implementation. Collectively, the process contributes to the refining of master plan and action plan for water-sensitive development. This stage culminates to the agenda of PolyUrbanWaters International Symposium 2024. The following activities are PolyUrbanWaters Guideline development and Digital Tool launch. In culmination of the milestones achieved, the initial draft of the Guideline will be formally presented to the government authorities.

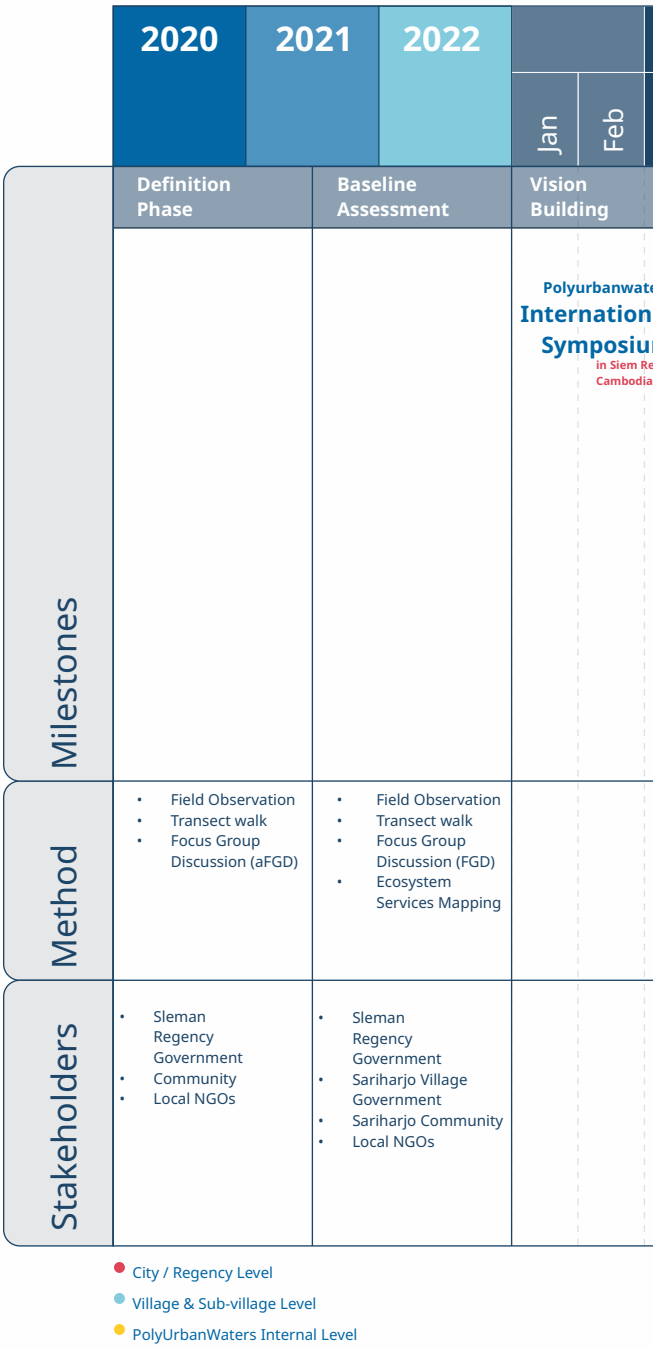
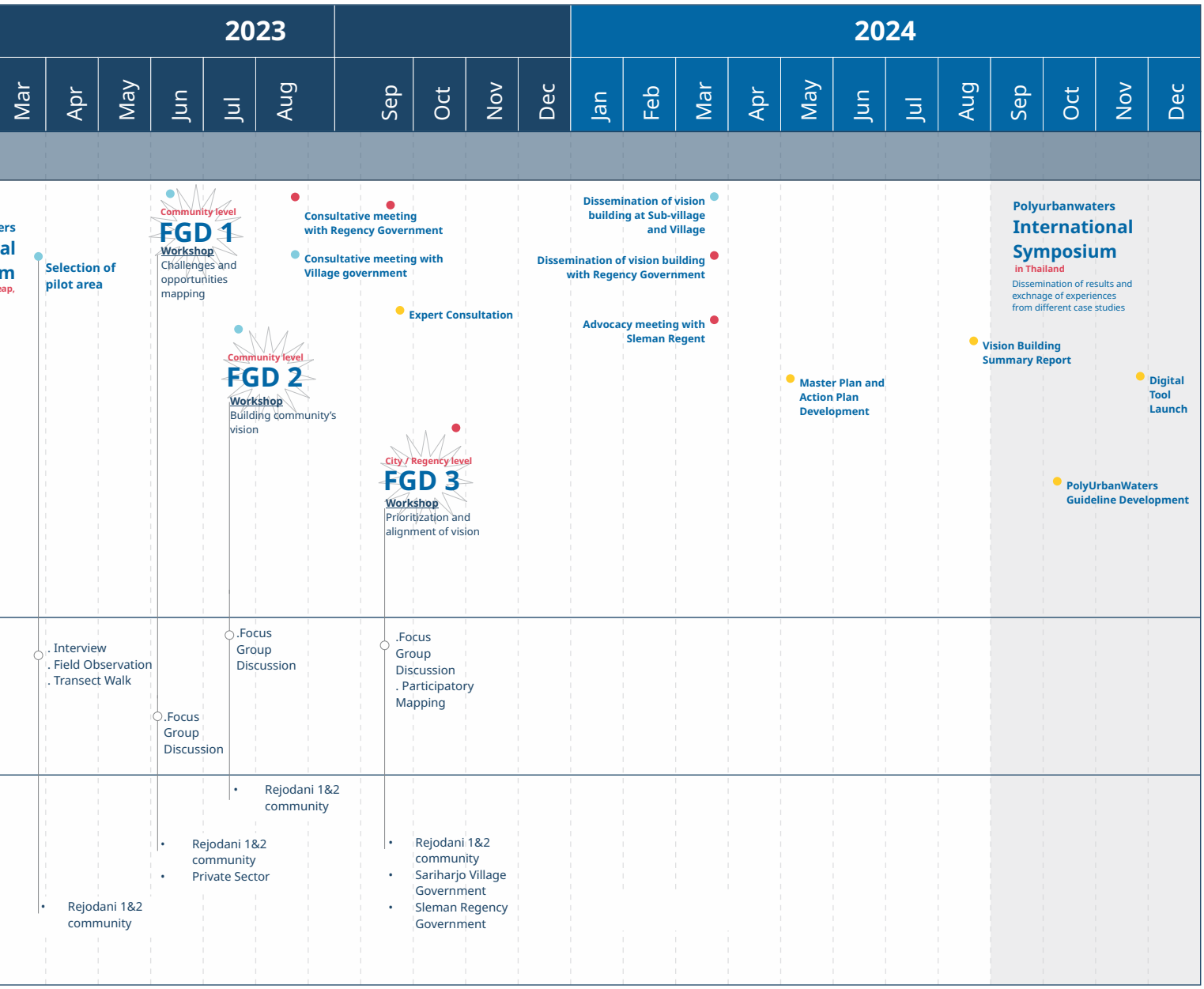


Figure 1.14. Vision Building Project Timeline

Source: PolyUrbanWaters Team, 2024



A new luxury housing cluster in the Rejodani stands in contrast to its surrounding agricultural areas. The availability of land and Rejodani's strategic location have made it attractive to newcomers.

Chapter 2
Rejodani Profile

The vision-building process treats Rejodani I and Rejodani II as a unified entity rather than separate entities. This perspective is crucial because water issues cannot be effectively addressed or analyzed based solely on administrative borders. Therefore, data such as built-up areas, development plans, and green-blue networks will be presented and analyzed as part of a comprehensive and interconnected system.

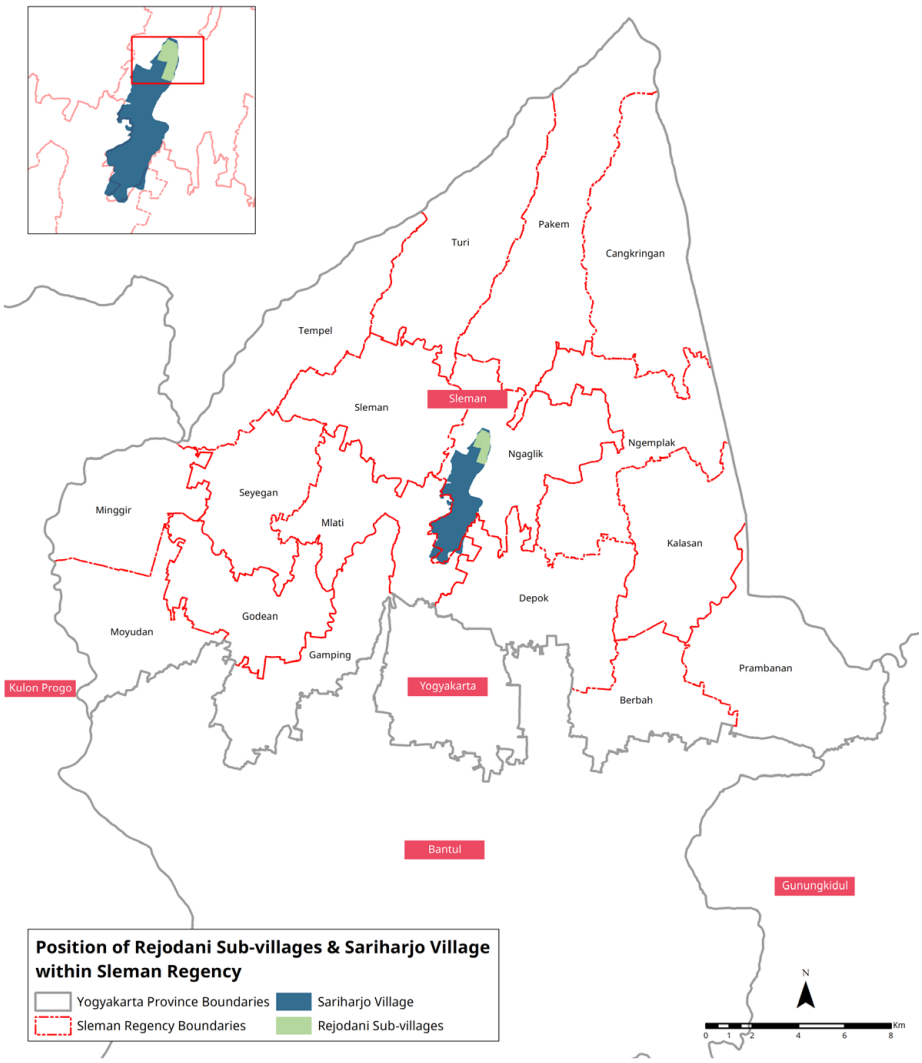


Figure 2.1. Position of Sariharjo Village within Sleman Regency

Source: PolyUrbanWaters Team, 2023

2.1. Brief Description of the Area

As briefly mentioned in Chapter I, the Rejodani pilot area consists of two sub-villages, Rejodani I and Rejodani II, situated in the northern part of Sariharjo Village (see Figure 2.1). Rejodani I borders Donoharjo Village to the north and west, Sardonoharjo Village to the east, and Rejodani II to the south. Meanwhile, Rejodani II borders Rejodani I to the north, Sardonoharjo Village to the east, Donoharjo Village and Ngetiran sub-village to the west, and Wonorejo sub-village to the south.

Both sub-villages fall within peri-urban characteristics based on building density, land use, building type based on user/character occupancy, building type based on structures, and accessibility.

Figure 2.2. Map of Pilot Site: Rejodani I and Rejodani II

Source: PolyUrbanWaters Team, 2023

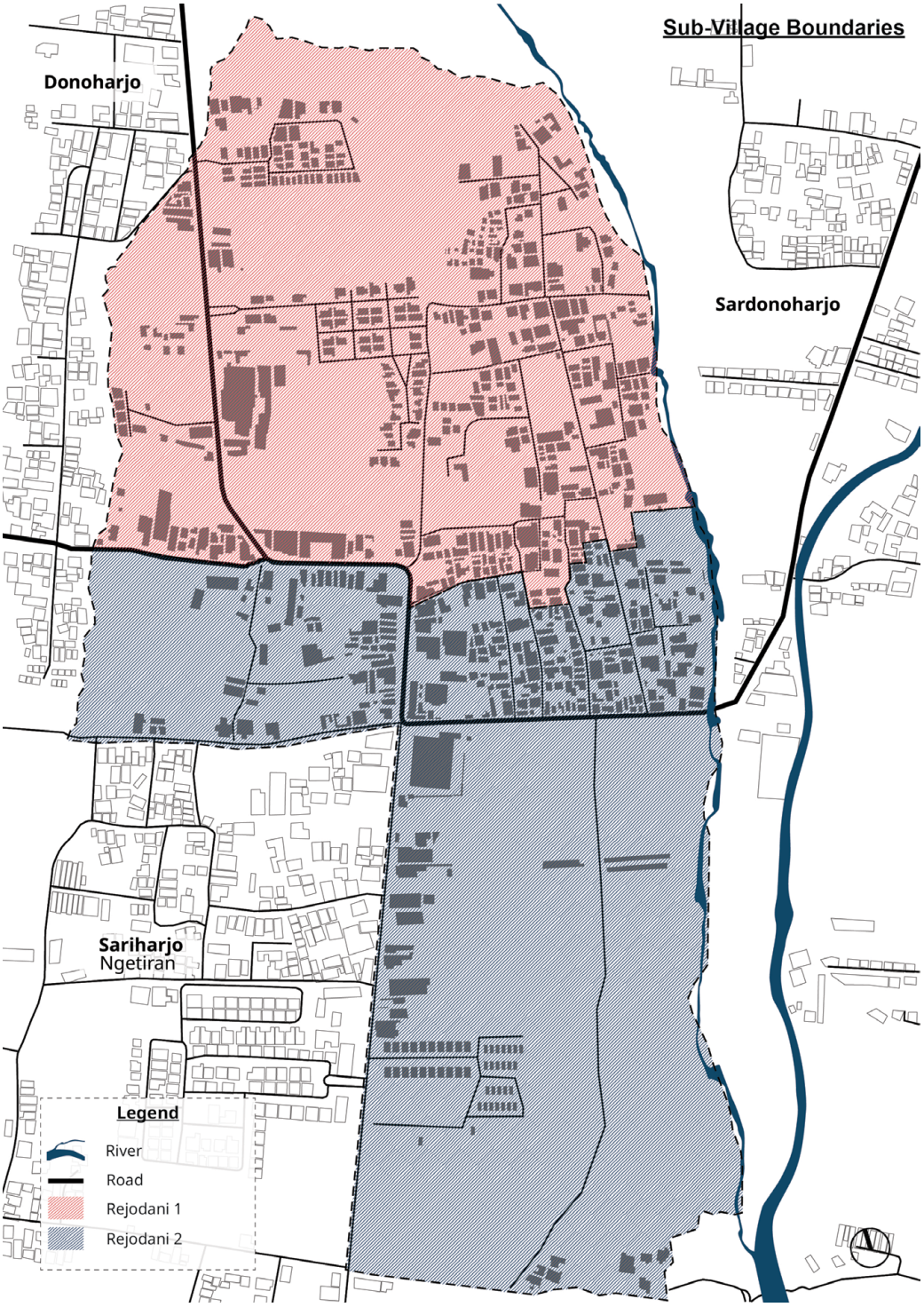


Figure 2.2. provides a closer look at Rejodani I and Rejodani II. Rejodani I covers an area of 32 hectares, while Rejodani II is slightly larger at 37 hectares, making a total area of 69 hectares for both sub-villages.

Figure 2.3. Map of Land Use in Rejodani I and Rejodani II

Source: PolyUrbanWaters Team, 2023

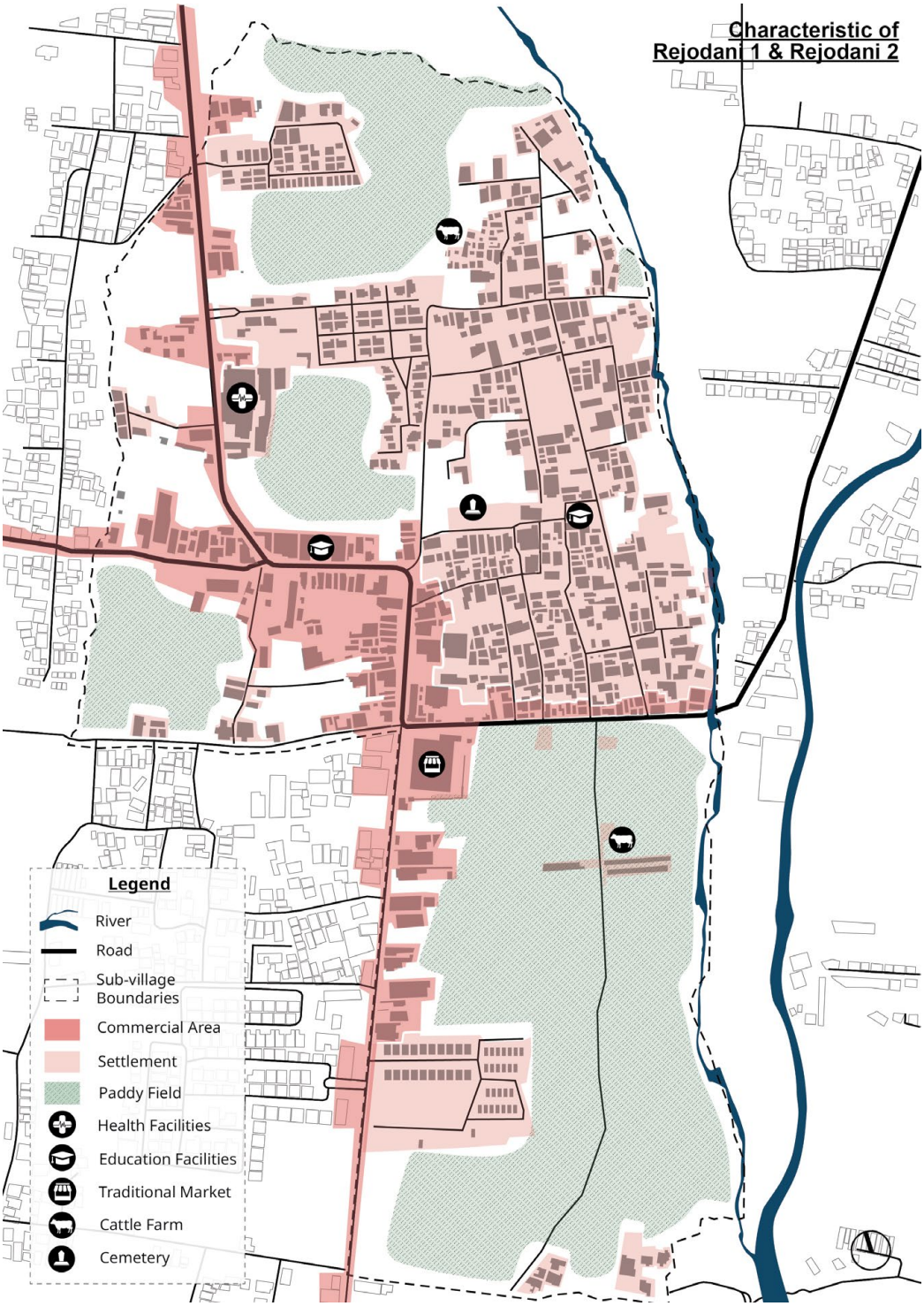


Figure 2.3 illustrates the general land use of Rejodani I and Rejodani II, which consists of public facilities, commercial and residential areas, and other nature areas, categorized as built-up and non-built up areas. The built-up areas consist mainly of commercial and residential zones, concentrated along the main roads (provincial and regency roads).

The built-up area in these sub-villages covers 30.68 hectares (43.89%) of the total area, with residential zones dominating at 22.94 hectares. Several main public facilities in this area consist of one hospital, one elementary school, one communal cattle farm, and one cemetery. A public market in Rejodani II serves the residents of Sariharjo Village and the neighboring villages and one communal cattle farm.

Non-built-up areas include water bodies, ponds, rice fields, and open spaces, totaling 39.22 hectares (56.11%) of the area, of which 30.68 hectares are rice fields.

Figure 2.4. Boyong River as one of nature landscapes serve as water resources and administrative border in Rejodani

Source: PolyUrbanWaters Team, 2023

The Boyong River, one of the main rivers in Sleman Regency, flows along the eastern side of Rejodani I and Rejodani II. This river also serves as the administrative boundary between these sub-villages and Sardonoharjo Village.

Figure 2.5. Rejodani, situated on the slopes of Mount Merapi, offering a view of the volcano from within the settlement

Source: PolyUrbanWaters Team, 2023

2.2. Natural Characteristics

Natural characteristics can be identified from the vegetation, topography, climate, nature landscapes and other natural conditions in the area. The topography of Rejodani in the category range between 279-330 meters above mean sea level (msl), based on the elevation models generated from remote sensing satellite Shuttle Radar Topography Mission (SRTM) with 30m resolution and Advanced Land Observing Satellite, Phased Array type L-band Synthetic Aperture Radar (ALOS PALSAR) with 12.5 m resolution (Figure 2.6). The elevation range gradually decreases towards the southern part of Sleman Regency following the natural landscapes of volcanic based landforms. Both sub-villages lie within the middle slope of Mount Merapi which peaks at 2,910 msl.

Figure 2.6. Topography map of Sleman Regency and Sariharjo Village shown as elevation model

Source: ITT, 2023, based on data from SRTM 30m, ALOS PALSAR 12.5m, DIVA GIS

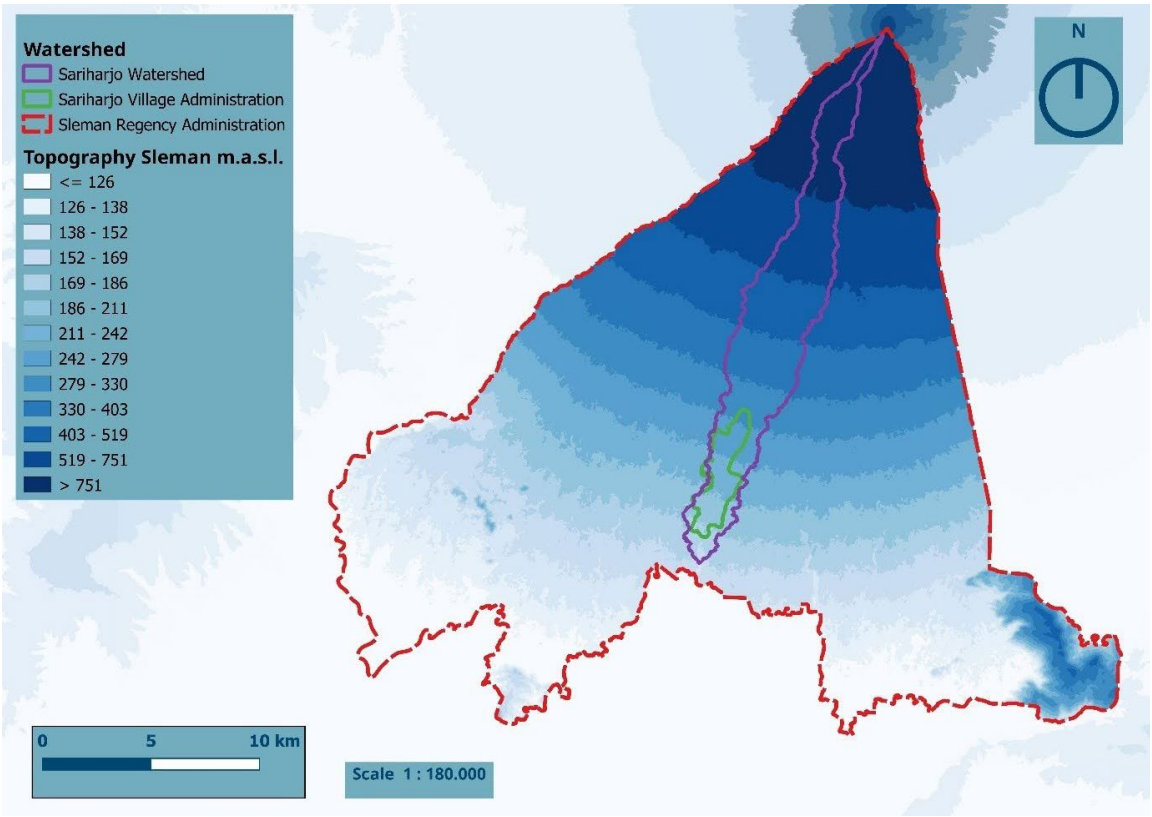
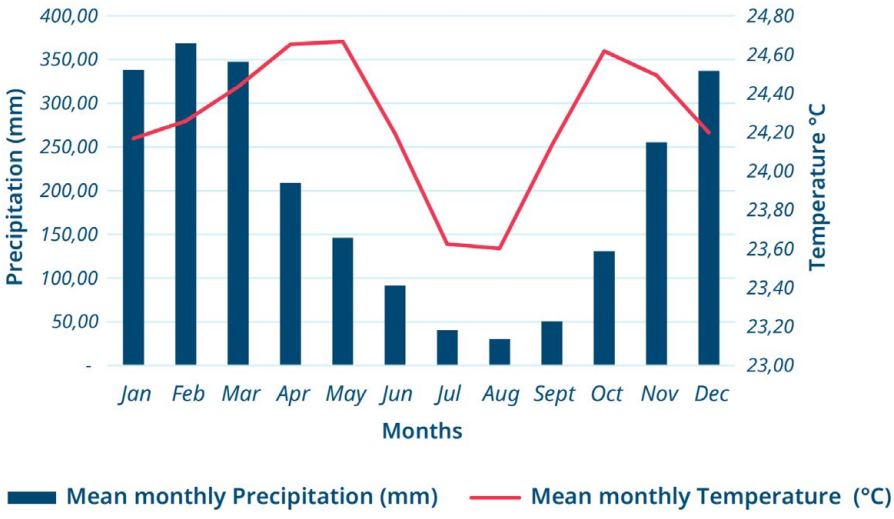


Figure 2.7 shows the climograph which displays the mean monthly precipitation and temperature for the whole Sleman Regency. Climograph used to compare climate conditions in a location or between different areas. The duration of data analyzes are between 1981-2021. Most tropical countries usually feature two different seasons which are rainy and dry seasons. Based on the climograph, the rainy season starts in October and lasts until April, while the dry season begins in April-May until October.

Figure 2..7. Climograph for Sleman Regency consist of precipitation and temperature data

Source: ITT, 2023, based on Funk et al., 2015; Muñoz Sabater, 2019



In accordance with Funk et al. (2015) and Muñoz Sabater (2019), shifting seasons were observed in several rainfall stations within Sleman Regency. The beginning of the dry season in 2000-2009 perceive to be 10 days earlier including Ngaglik Subdistricts (Firdauzi & Suarma, 2023). Meanwhile, the rainy season observed from 10-days rainfall during 1990-2019 starts consistently in October (3rd phase of the month). Based on climate classification from Oldeman which was generated from rainfall data in 1990-2019, climate in Sleman Regency categorized as type C3 which means 5-6 months of rainy season and 4-6 dry season consecutively (Oldeman, 1975). These agroclimatic zones have strong connection with crop patterns especially in Rejodani I where agricultural land is still present. Based on the type C3, the crop pattern recommendation should be paddy (1st period) and palawija (2nd period, avoid dry season).

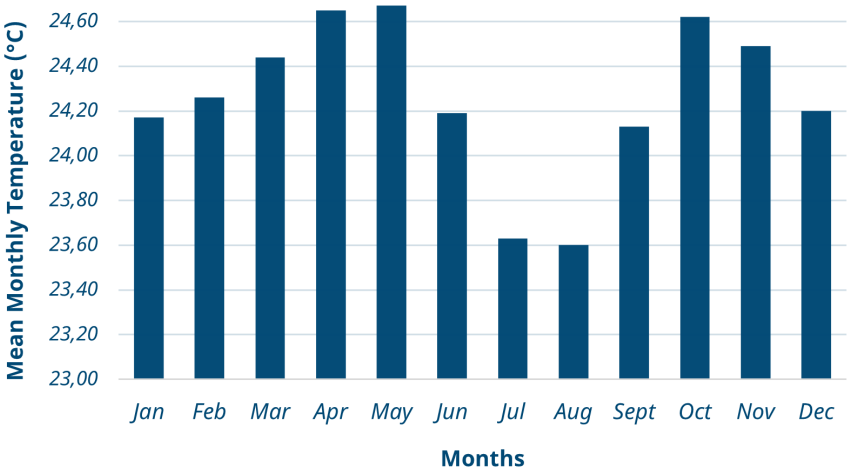


Figure 2.8. Mean monthly temperature temporal distribution in Sleman Regency between 1981-2021
Source: Muñoz Sabater (2019)

The mean monthly temperature in Sleman Regency between 1981 and 2021 (Figure 2.8.) ranges from 23.60°C in August until 24.67°C in May. This value is consistent with the climograph (Figure 2.7.) which explains that the dry season period is between May-October (lower temperature range) and rainy season October-May (higher temperature range).

2.3. Socio-Economic Description

Despite the significant physical changes in Rejodani, driven by economic development and the expansion of residential and commercial areas, the population growth has remained relatively modest. Based on interviews with the village government and housing developer, this is attributed to the fact that the owners of the new housing and commercial buildings are primarily from outside Rejodani.

Rejodani experienced population growth from 2017 to 2019, followed by a decline in 2020, reaching a low of 1,288 people in 2023. These fluctuations in population have influenced density dynamics in both sub-villages, as shown in Figure 2.9.

Figure 2.9. Rejodani I and Rejodani II Sub-villages Projected Population

Source: PolyUrbanWaters Team, 2024 – Data Analysis from Village Monograph Data

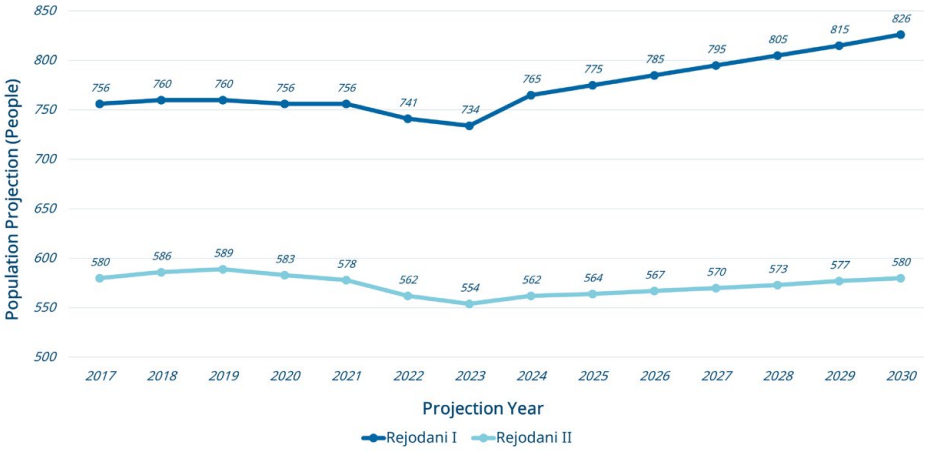


Figure 2.8 shows the existing and projected population of Rejodani 1 and Rejodani 2. Population projections were calculated to forecast future demand, supply, and resource needs for development. In this case, the projected population was calculated using a land use-based method. Projected population using this method reflects natural population growth and changes in land use patterns, particularly residential areas.

Figure 2.10. Occupations in Rejodani I and Rejodani II

Source: PolyUrbanWaters Team, 2024 – Data analysis from RPJMKal Sariharjo 2022-2027

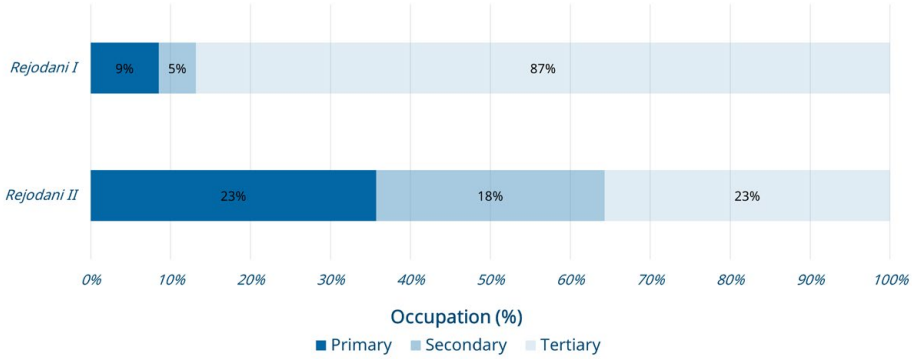


Figure 2.10. shows occupation of Rejodani residents. The majority of residents work as private employees, followed by those engaged in agriculture, fishery, plantation, and husbandry sectors, government employees, and manufacturing industries. The percentage of residents who work in the agriculture sector is less than those who work as private employees, government employees, and services combined. This occupational composition corresponds with the characteristics of a peri-urban area.

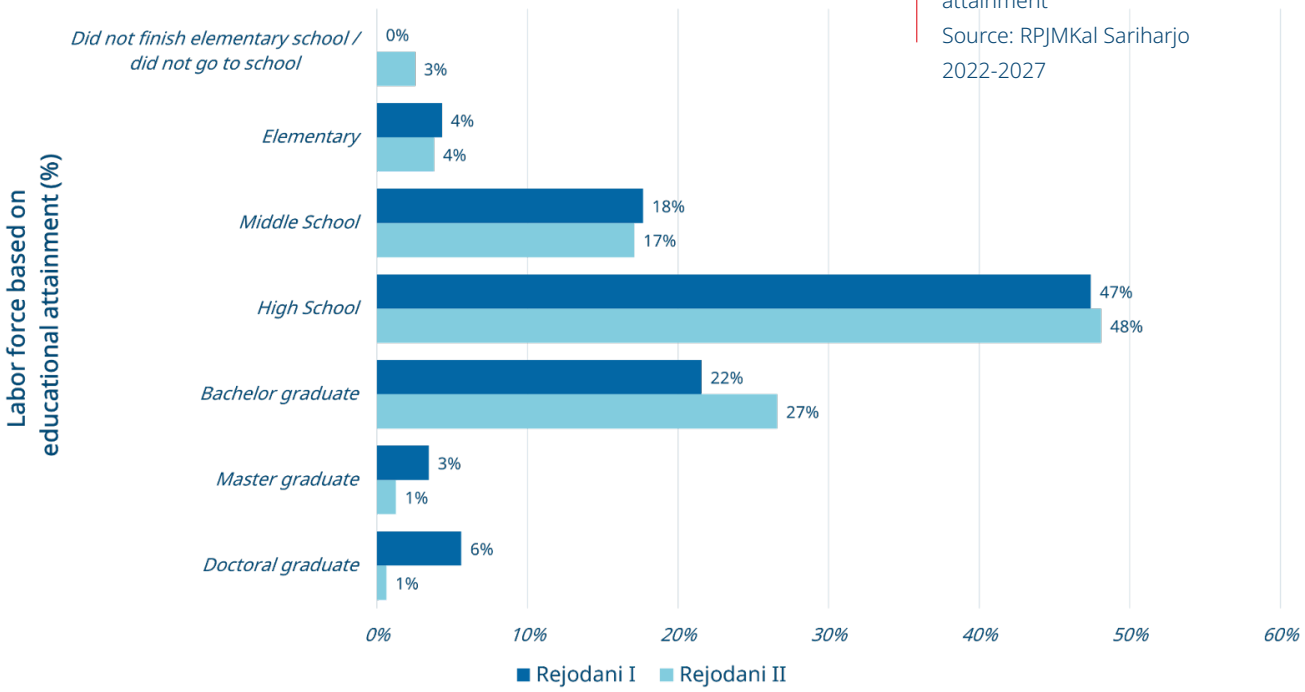
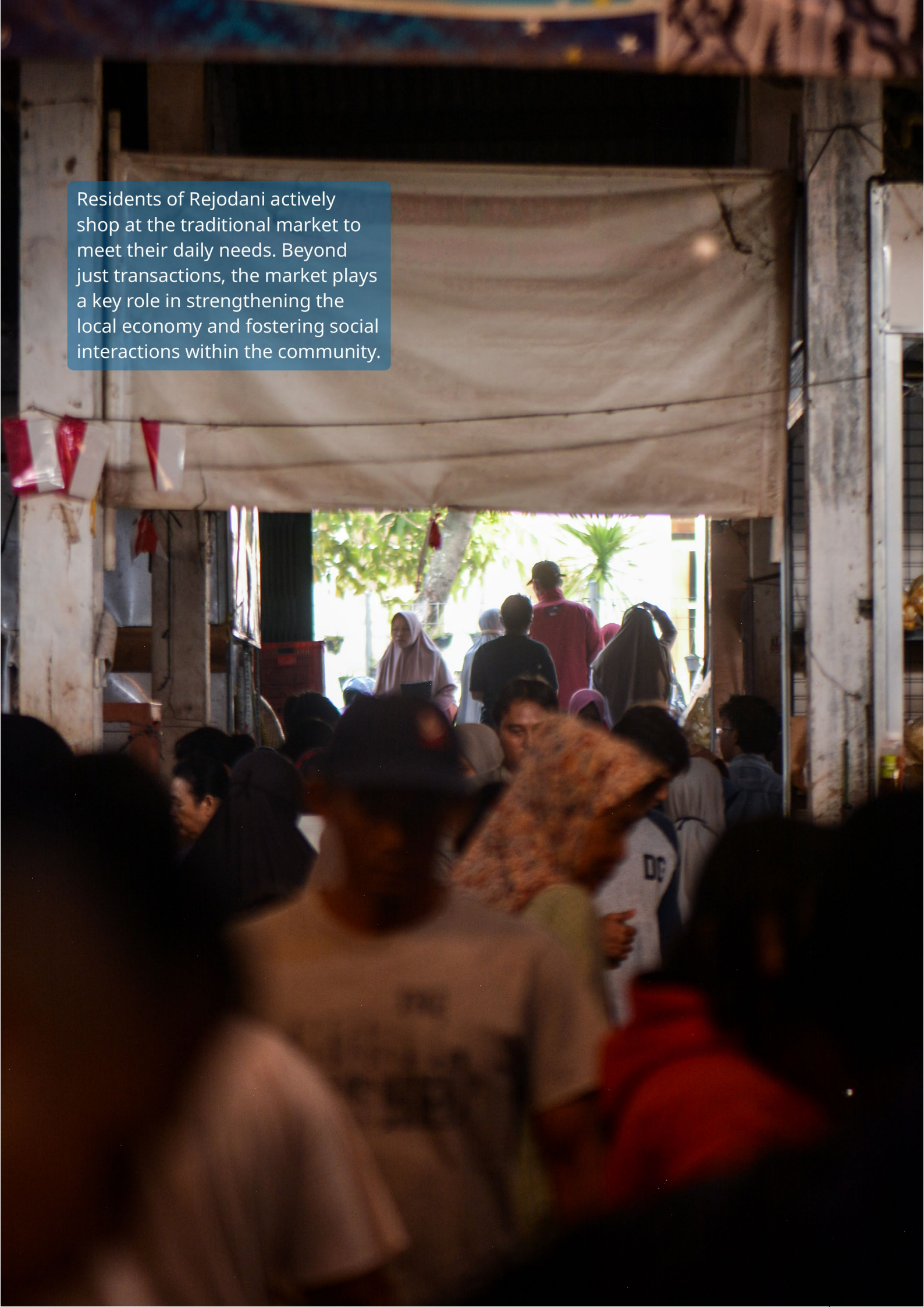


Figure 2.11. Labor force based on educational attainment
Source: RPJMKal Sariharjo 2022-2027

The labor force based in the pilot site mainly consists of individuals with high school, bachelor's, and middle school education levels (Figure 2.11.). The combined number of individuals graduating from higher education levels (bachelor's to doctorate degree) roughly equals those with a high school education. This indicates a relatively high level of education within the community of Rejodani. The community's solid educational foundation could enhance awareness of the importance of water-sensitive planning and contribute significantly to strategic plan development. This situation may ensure the continuation of the transformation process towards water sensitive planning through several measures. According to the Sariharjo Baseline Assessment report, incoming migrants usually belong to the middle class and are generally well-educated. It means they could assist Sariharjo Village and particularly Rejodani I and II to become a smarter community in appreciating implementation of vision development.

As education rises, fewer young people are interested in farming, leaving it to the older generation, posing challenges for the future of agriculture.



Residents of Rejodani actively shop at the traditional market to meet their daily needs. Beyond just transactions, the market plays a key role in strengthening the local economy and fostering social interactions within the community.

In Rejodani, 80% of residents use wells as their primary source of clean water. Each house has its own well, as shown in the picture. Additionally, some residents use piped water, which is sourced from wells and managed by the community.

Chapter 3

Challenges and Opportunities of Rejodani Area

Identification of the challenges and opportunities to implement the water-sensitive scenarios in Rejodani are identified by using the eight pillars of PolyUrbanWaters. Located in the peri-urban of fast-growing Yogyakarta Urban Agglomeration area, Rejodani is undergoing rapid development. There are two main key drivers which influence shifting rural to urban characteristics in these two sub-villages. First, population growth (which assumes natural population growth and those who are moving into these sub-villages), second, economic development (e.g. growing commercial activities which can be seen especially along the provincial road).

The two main drivers are directly affecting two pillars combined (Land Use Development and Settlement Development), due to increasing land demand for residential and economic development brings land use change from agricultural to built-up areas. Afterward, changes in Land Use and Settlement Development's pillars are also creating challenges to other six pillars (Solid Waste, Wastewater, Stormwater, Water Catchment, Water Supply, and Blue-Green Infrastructure). However, these six pillars also

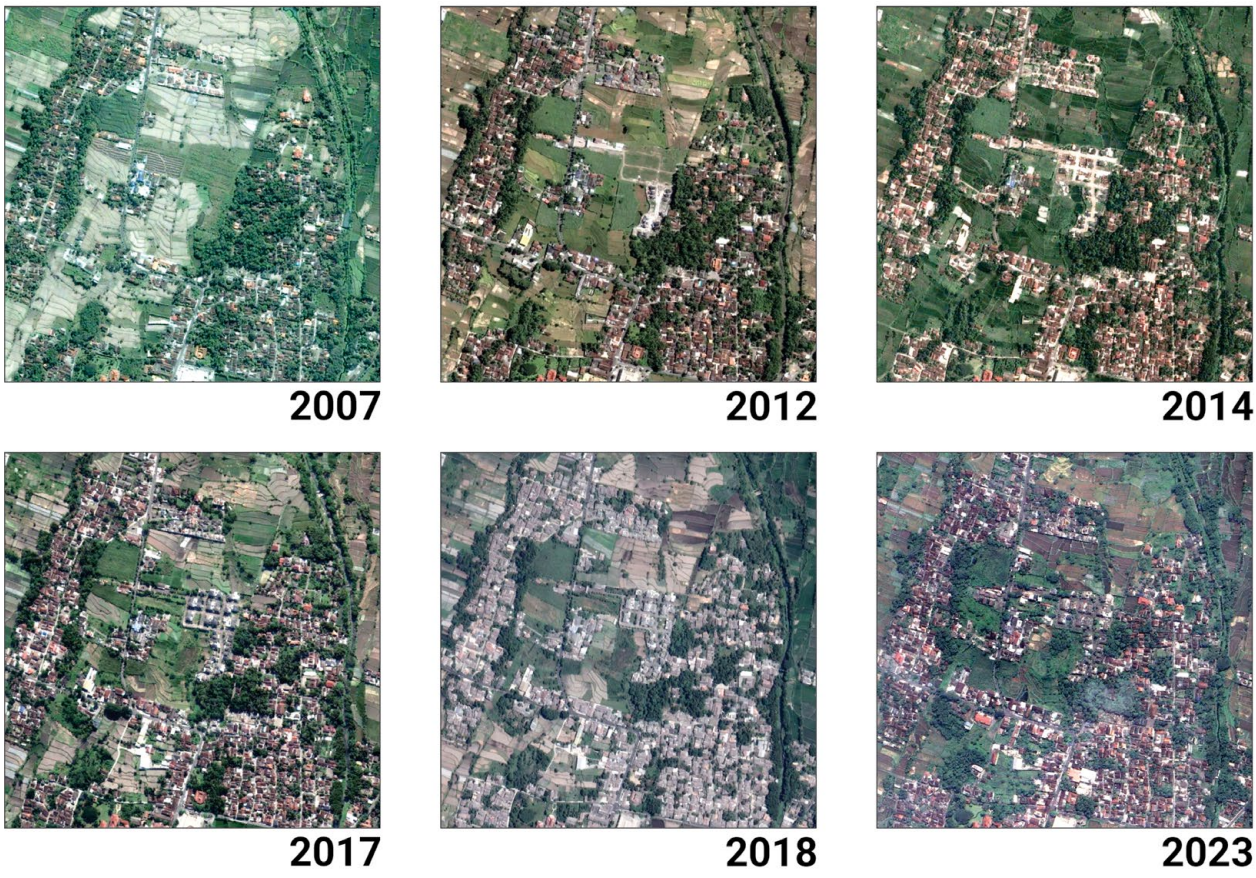
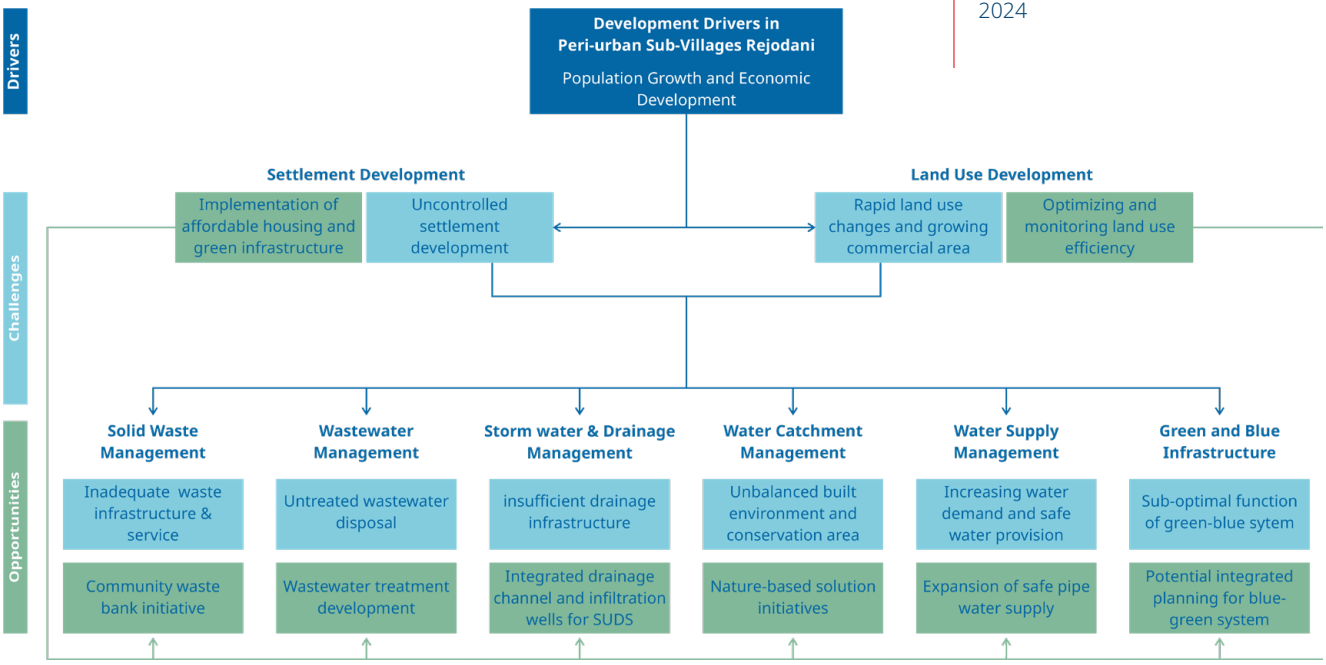


Figure 3.1. Land use changes showcases the massive conversion from non-built to built-up area
Source: PolyUrbanWaters Team, 2024 - Data processing from Google Timelapse

present some opportunities to deal with each challenge. The framework of the challenges and opportunities formulation is illustrated in Figure 3.1. Aspects presented refer to the Conceptual Framework mentioned in Chapter I (see Figure 1.4).

Figure 3.2. Challenges and Opportunities Formulation

Source: PolyUrbanWaters Team, 2024



3.1. Land Use Development

Land use development is driven by the two main factors, economic development and population growth, changing the sub-village from rural to urban characteristic areas. This growth correlates with the increasing land demand for residential and economic activities, resulting in land use conversion from non-built-up areas, such as agricultural land, to built-up areas. Environmental degradation, particularly the diminishing capacity of water infiltration areas, has emerged as a pressing concern.

Challenges

- **Rapid Land Use Changes**

  Over the past three years, observable developments have transformed these sub-villages, with agricultural land and vacant land being replaced by business establishments and the construction of new gated community complexes, such as Patra Residence, and the current gated community including Vasco Residence and Citra Residence.

- **Growing of Commercial Activities Along the Main Road**

  Business entities tend to lease Village Treasury Land along main or provincial roads, while residential construction typically involves purchasing land from individual landowners.

Figure 3.3. New Gated Community Development built in Rejodani II with a total of 62 units

Source: PolyUrbanWaters Team during field observation, 2024

Opportunities

In addition to those two main challenges of land use development in Rejodani, some opportunities also contribute to the land use changes:

- **Zoning regulation to control massive land use change**

  Implementing and enforcing Central Sleman's Detailed Spatial Plan (RDTR Sleman Tengah), which regulates zoning to manage land use conversion and preserve green space.

- **Availability of Village Treasury Land (TKD)**

  Undeveloped areas which part of Rejodani Village Treasury Land (TKD) present potential for strategic and sustainable development addressing both residential needs and environmental conservation.

- **Mixed-use development**

  Optimizing land use efficiency through mixed-use zones where residential and commercial spaces coexist.

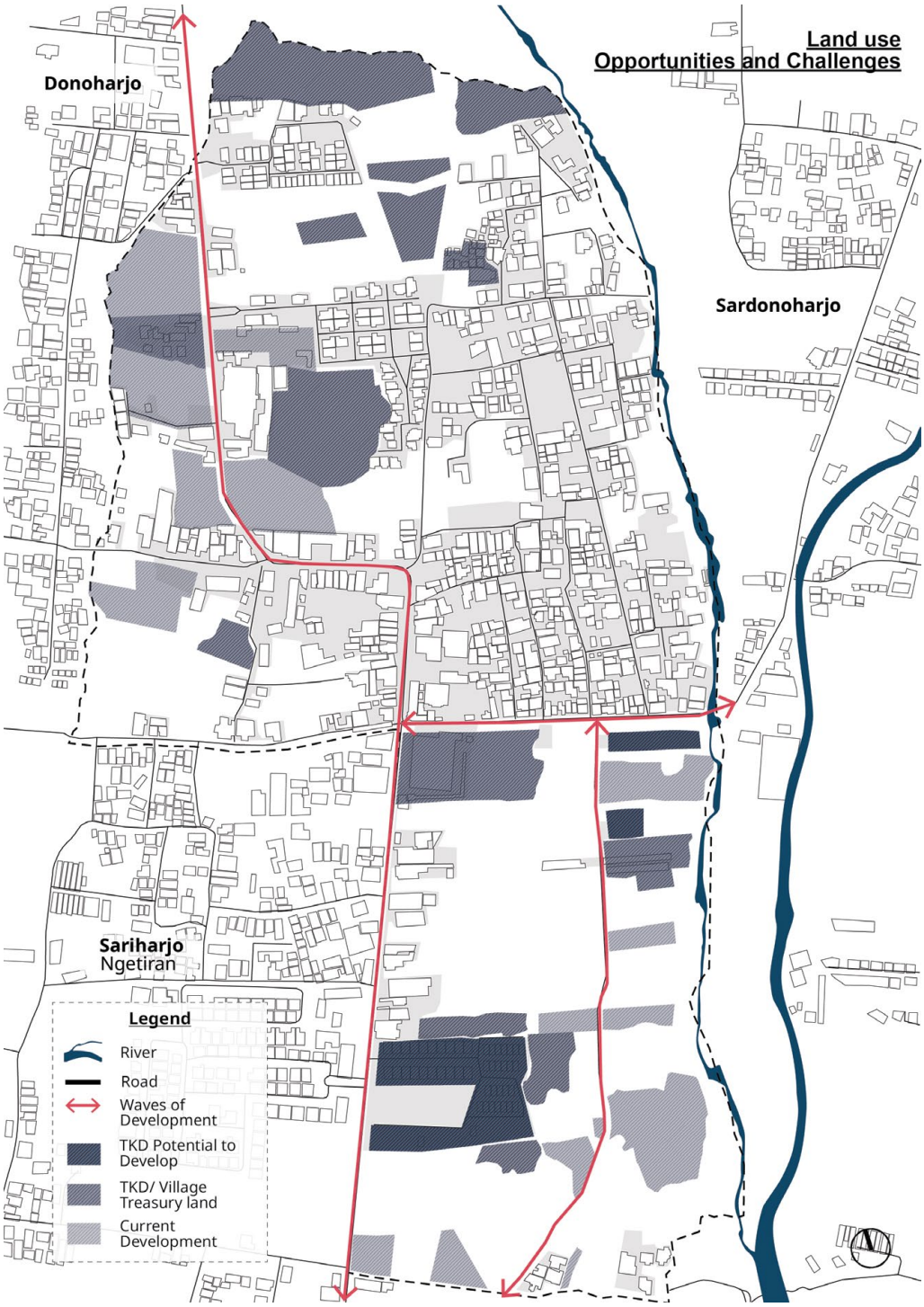


Figure 3.4 Land Use Opportunities and Challenges

Source: PolyUrbanWaters Team, 2024

3.2. Settlement Development

As stated earlier, Rejodani is located in the peri-urban area of the Yogyakarta Urbanized Area, which currently experiencing rapid urbanization. This growth has attracted housing developers seeking opportunities to build new housing complexes in Rejodani, including gated communities. These development of new settlement poses some challenges including social segretation between residents and current traditional settlements.

Challenges

- **Settlement Densification**
  As the population grows, there is increasing demand for housing, particularly in traditional settlements in Rejodani. Communities will likely build houses on their land, leading to higher residential density.

- **Increase impermeable surface due to built-up areas development including settlement**
  Residential growth contributes to more impervious surfaces, worsening environmental issues by increasing stormwater runoff and affecting decreasing of groundwater levels.

- **Social Segregation between the new gated community and traditional housing residents**
  The concentration of gated and closed housing complexes for upper-middle-class neighborhoods may spatially isolate these developments from the broader community. The upper middle class communities tend to be more individually and limited involvement in social activities of traditional residents.

- **Expanding needs for clean water, wastewater management, and solid waste infrastructure**
  Population growth with the consequences of new settlement and housing needs, increase the demand of other basic amenities such as clean water, solid waste disposal services, waste water services and other water related services.

Figure 3.5 New Housing Development in Rejodani II built in 2024

Source: PolyUrbanWaters Team, 2024

Figure 3.6 Gated Community in Rejodani I characterized by a closed perimeter of walls and fences

Source: PolyUrbanWaters Team, 2024

Opportunities

- **Implementing vertical residential program of government**

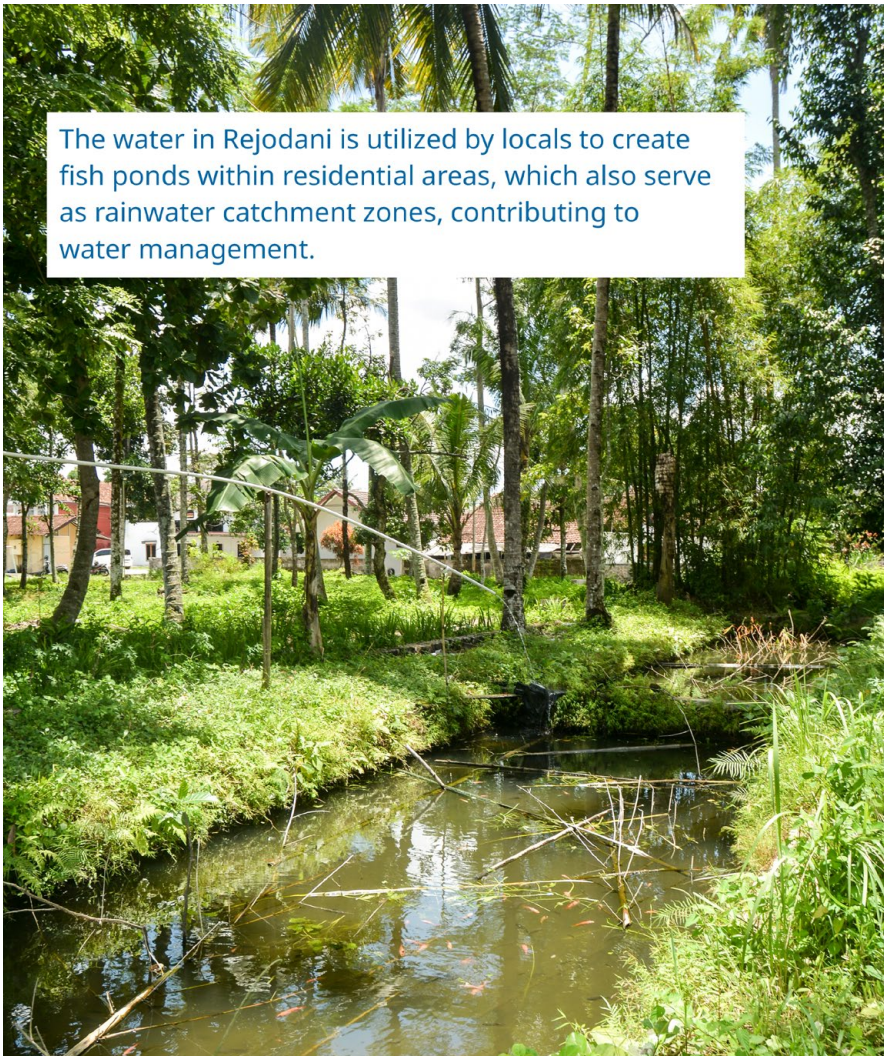
  Exploring vertical housing options that complement the government's flat program. This approach maximizes land use efficiency, addresses increasing housing needs, settlement densifications, reduces pressure on infiltration areas, and efficiently manages rising demands for solid waste and wastewater services in Rejodani.

- **Public spaces development as a social interaction space and ecosystem services**

  Providing public spaces such as public parks that serve as community centers that encourage interaction and build a sense of community among residents of new housing complexes and existing settlements.

- **Expanding the current green infrastructure development of the areas**

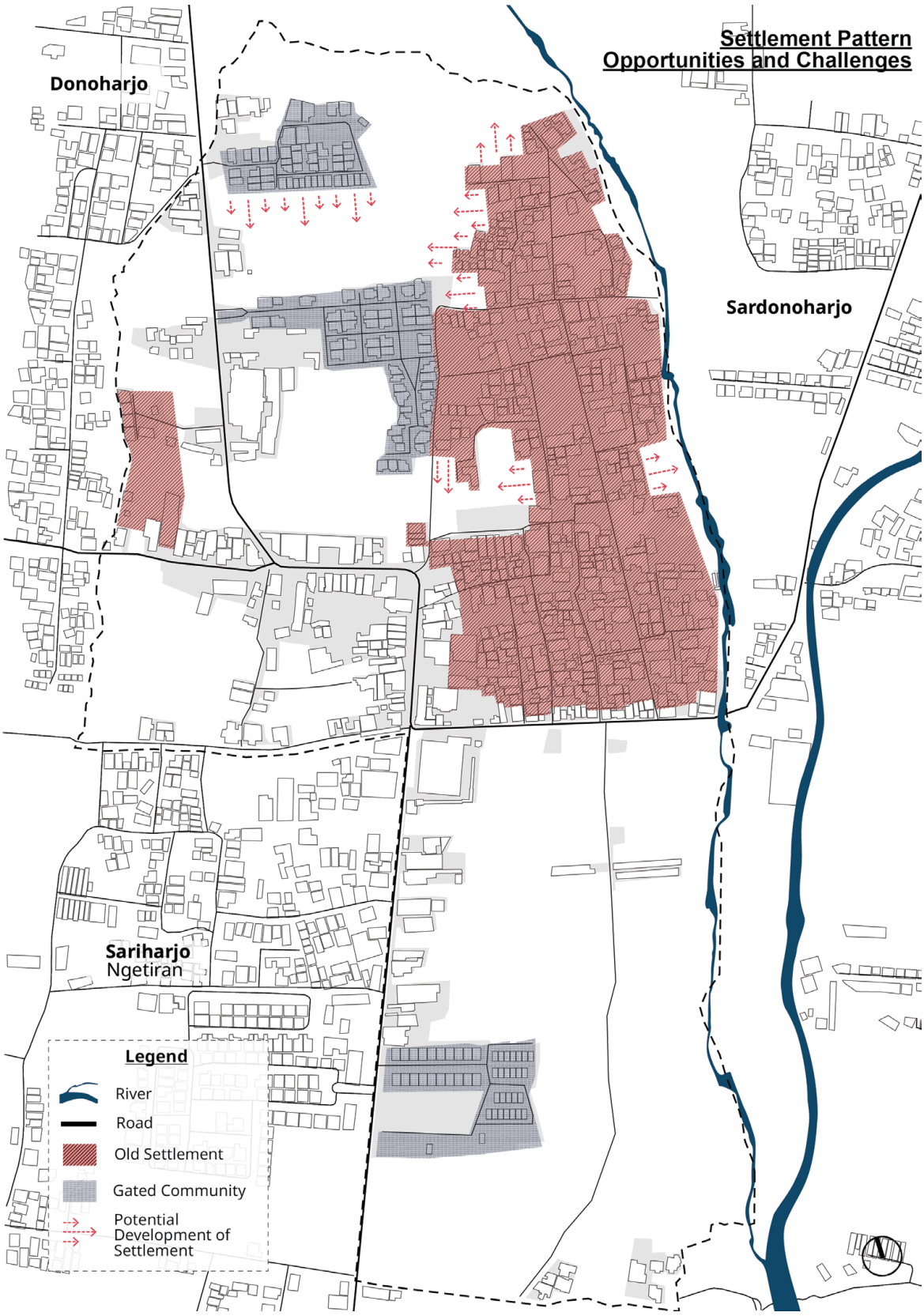
  The residents of Rejodani have been implementing a green infrastructure development in some areas by developing permeable pavements and infiltration trench. This initiatives need to be extended such as in the new development areas to mitigate the negative effects of increased impervious surfaces.



The water in Rejodani is utilized by locals to create fish ponds within residential areas, which also serve as rainwater catchment zones, contributing to water management.

Figure 3.7 Settlement Development Opportunities and Challenges

Source: PolyUrbanWaters Team, 2024



3.3 Stormwater Management

The planned rainfall in Rejodani with a 10-year return period, calculated using the Gumbel Method, indicates a design rainfall of 169.81 mm/h for Rejodani I and 163.47 mm/h for Rejodani II. Design/planned rainfall shows the intensity and frequency of rainfall for designing drainage infrastructure, ensuring they can handle these peak intensities to prevent flooding and infrastructure damage.

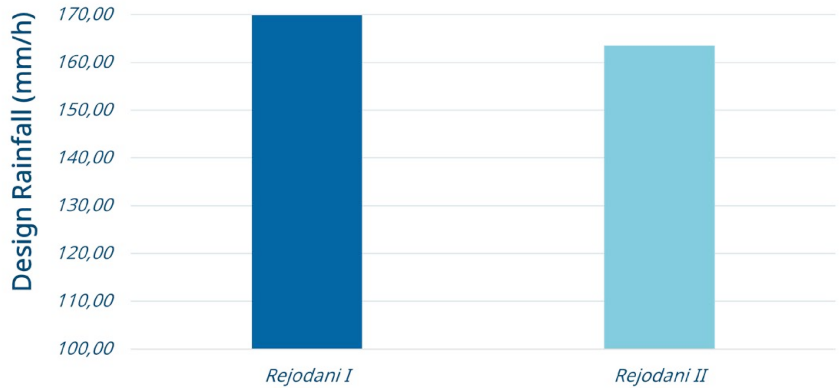


Figure 3.8 Design Rainfall (mm/h) with a 10-year return period in Rejodani
Source: PolyUrbanWaters Team, 2024

As for the runoff volume, in Rejodani I, the roof rainfall volume is 29.36 m^3, and the surface rainfall volume is 44.56 m^3. For Rejodani II, these values are 23.98 m^3 and 27.69 m^3, respectively. These volumes indicate the total amount of rainwater collected or expected, informing the capacity of water management systems.

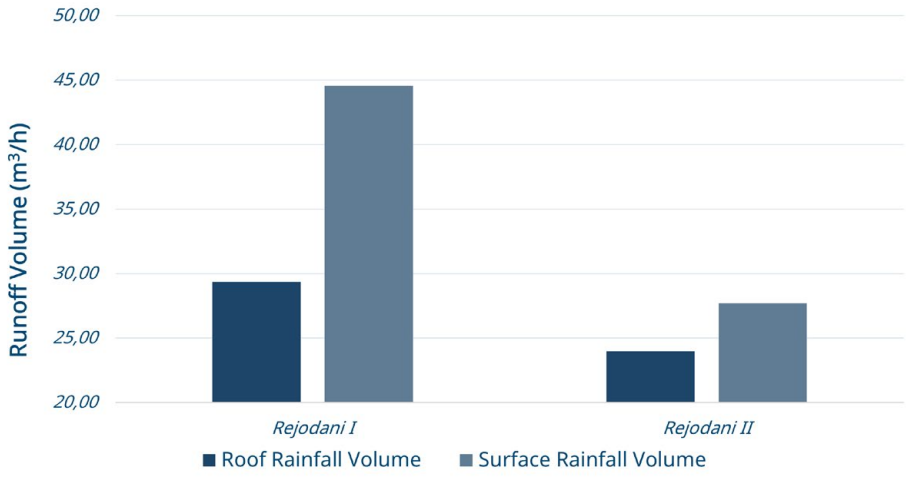


Figure 3.9 Runoff Volume (m3/h) in Rejodani
Source: PolyUrbanWaters Team, 2024

The stormwater management infrastructure in Rejodani primarily includes drainage channels and infiltration wells. Drainage channels are widely established throughout the area, with a total capacity of 5.17 m^3/hour (Polyurbanwaters team, 2024). Additionally, several infiltration wells are strategically placed, including along the main road in Rejodani I RW 1 RT 1 and at the yard of Rejodani Mosque. These wells facilitate rainwater infiltration into the ground, reducing surface runoff. Some of the infiltration wells are financed through village funds (Dana Desa), while others are funded by the community itself.

Currently, Rejodani I has 30 infiltration wells and Rejodani II has 16, each with a diameter of 1 meter and a depth of 3 meters. However, these wells are insufficient in number and capacity, resulting in excess runoff that leads to inundation. The areas impacted by inundation include those near the Rejodani market and the T-junction on Palagan Road.

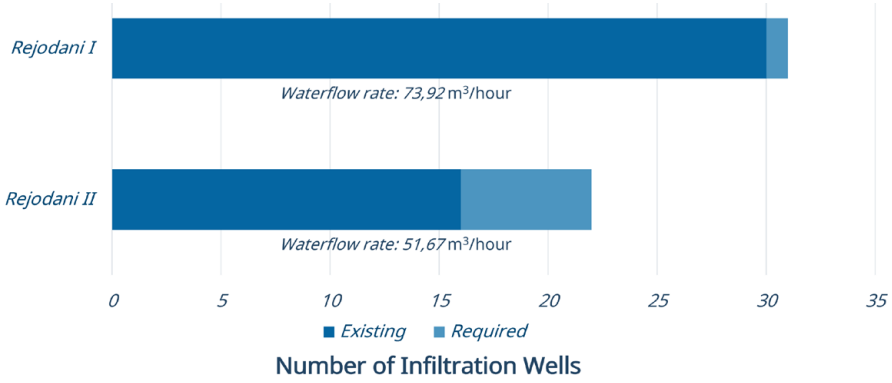


Figure 3.10 Existing and Required Number of Infiltration Wells

Source: PolyUrbanWaters Team, 2024

Challenges

- **Insufficient and inadequate drainage capacity**

  The insufficient and inadequate drainage capacity cause the overflow and inundation in several areas, mainly during the intense rainfall.

- **Several areas have a high risk of inundation**

  High-risk areas include Rejodani market, its surroundings, and various points along main roads.

- **Inadequacy of existing infiltration wells**

The inadequacy of existing infiltration wells, yet its construction diverges

Opportunities

- **Utilize the current channels to develop integrated drainage systems**

  Rejodani can leverage existing channels for an integrated drainage system across various sections.

- **Combined drainage channels and infiltration wells in one area**

  The community has unintentionally combined drainage channels and infiltration wells in a specific area which serves an adaptable model for replication in other locations.

- **Moving drainage channels from road sides to middle**

  To discourage residents from disposing greywater directly into the drainage channel, promoting a cleaner and more sustainable environment.

Figure 3.11 Integrated drainage and infiltration wells to prevent flooding

Source: PolyUrbanWaters Team, 2024

(a) Infiltration Well in Neighborhood Road

(b) Drainage Channel in the Middle of the Road

(c) Boyong River used as Primary Drainage System in Rejodani

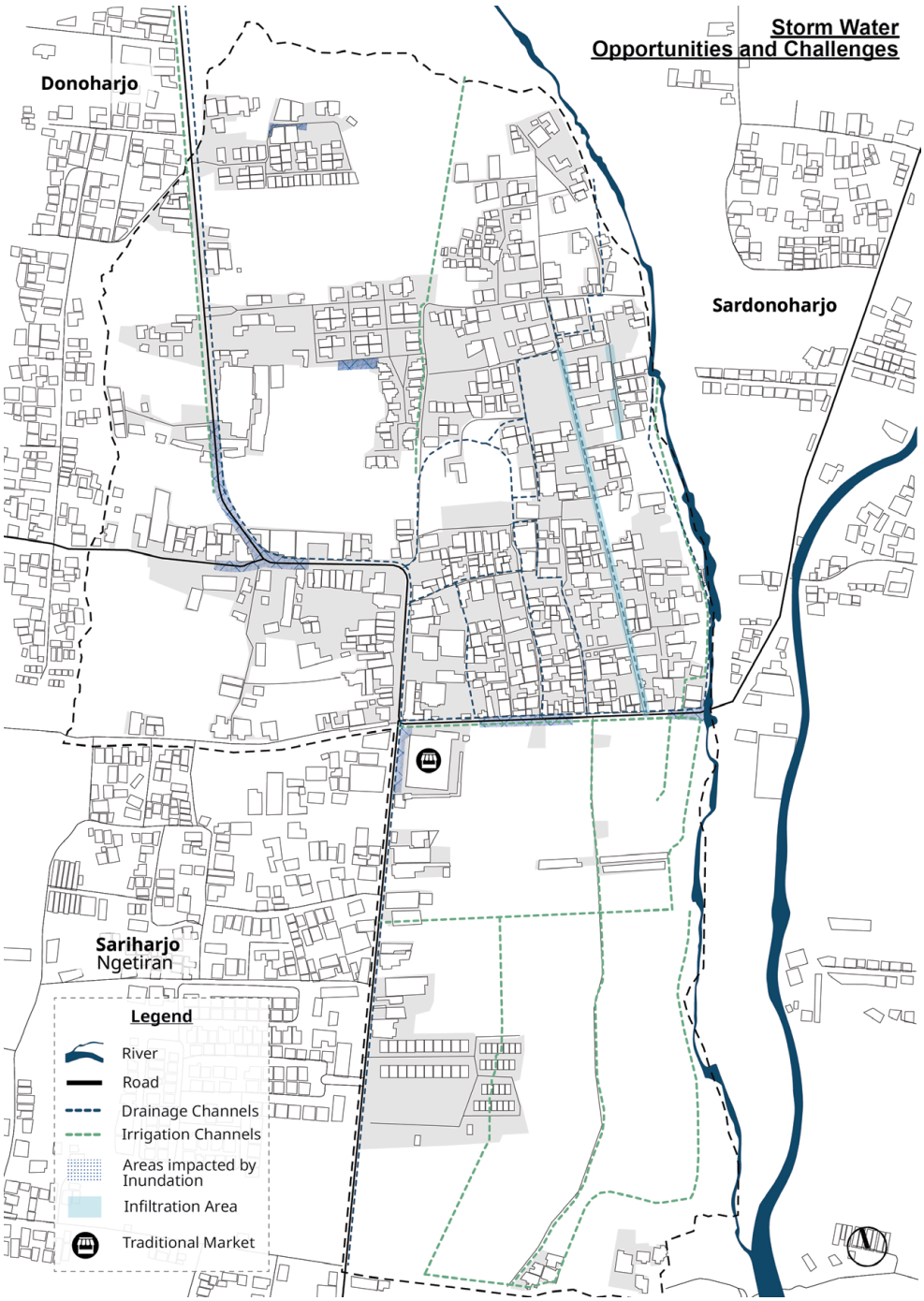


Figure 3.12 Stormwater Development Opportunities and Challenges

Source: PolyUrbanWaters Team, 2024

3.4 Wastewater Management

Wastewater includes excess water from the kitchen sink, laundry, bathroom floor drains, and toilets. Water from the sinks, laundry and floor drains is managed separately from sewage from toilets, which typically flows into septic tanks or soak pits, while other sources flow into infiltration wells or drainage systems.

Wastewater management issues in Rejodani highlight three main sources: domestic households, communal cattle farms, and small-scale industries, with little remarks on commercial activities. Concerns during FGD often revolve around the discharge of untreated wastewater directly into drainage systems. There is a gap between communities' need for standardized infrastructures and the currently available wastewater facilities, including the needs of communal wastewater treatment plants.

In 2024, the water demand at Rejodani 1 is calculated to be 2,38 liter/second. Of this, 80% of it or 1,904 liter/second is generated as wastewater. This is nearly double from the situation in Rejodani 2, where a water demand of 1,21 liter/second results in 0.96 liter/second wastewater. Among 255 households in Rejodani 1, 64 households (25,1%) have improved septic tanks, while the remaining 191 households or 74,9% have relied on soaked pits for decades. In Rejodani 2, 187 households mostly rely on a soaked pit and no improved septic tanks have been constructed.

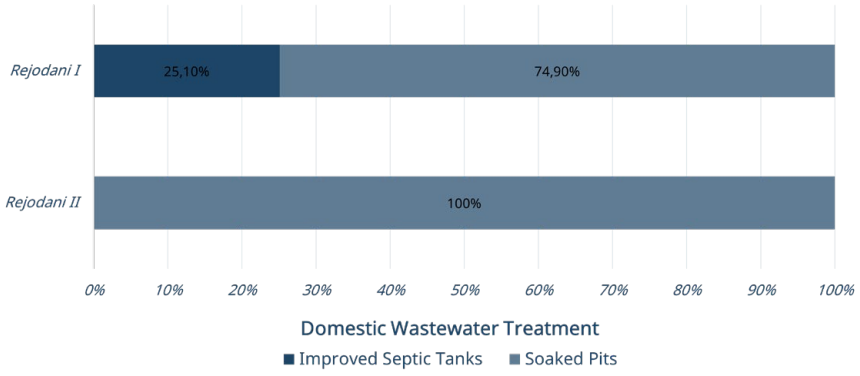


Figure 3.13 Existing Domestic Wastewater Treatment

Source: PolyUrbanWaters Team, 2024

The communal cattle farm at Rejodani 1 Sub-Village currently accommodates 20-30 cows and 40 goats. Unfortunately, production has been declining due to a decrease in the number of breeders. Additionally, spatial planning has designated Rejodani 1 for settlement purposes, making the cattle farm unsustainable. In contrast, Rejodani 2 accommodates 27-30 cows. According to the 2024 spatial planning, Rejodani 2 will remain designated for sustainable food crops until 2043. The communal cattle farms at both locations generate 496 liters of sludge and flushing water per day, with no treatment currently in place.

The Rejodani market generates 0,08 liter/second or 2,88 m3/day of wastewater during its 10 operational hours. This wastewater includes runoff from meat and fish cutting traders, and it is discharged directly into open drainage canals in the front of the market without any treatments.

Challenges

- **Misconceptions and Awareness Gaps in Domestic Wastewater Management**

  Lack of awareness contributes to direct discharge of domestic wastewater. The majority of residents are unaware of the necessity to regularly dislodge septic tanks, posing significant risks of contaminating clean water wells and groundwater.

- **Livestock Wastewater Management**

  Improved management practices are needed to prevent livestock wastewater flows into rice fields and to manage the sale of cow dung as fertilizer.

- **Industrial Wastewater Concerns**

  Persistent issues in industries like Sogan Batik include complaints about wastewater odor, despite effective treatment of chemical materials. While decentralization has reduced some problems, home production of tofu and tempe still leads to untreated wastewater discharge.

Figure 3.14. Synthetic wastewater from Batik Industry

Source: PolyUrbanWaters Team, 2024

Figure 3.15. Untreated wastewater from Tofu and Tempe home industry

Source: PolyUrbanWaters Team, 2024

- **Market Wastewater Concerns**

  Rejodani market sanitation centers constructed for domestic use, none of the meat and fish traders connect their wastewater to existing septic tanks. During the dry season various complaints about wastewater odor, solid waste were raised in nearby neighborhoods; those remains occur to this date. Market operators confirmed untreated market wastewater and discharged it into the drainage canal.

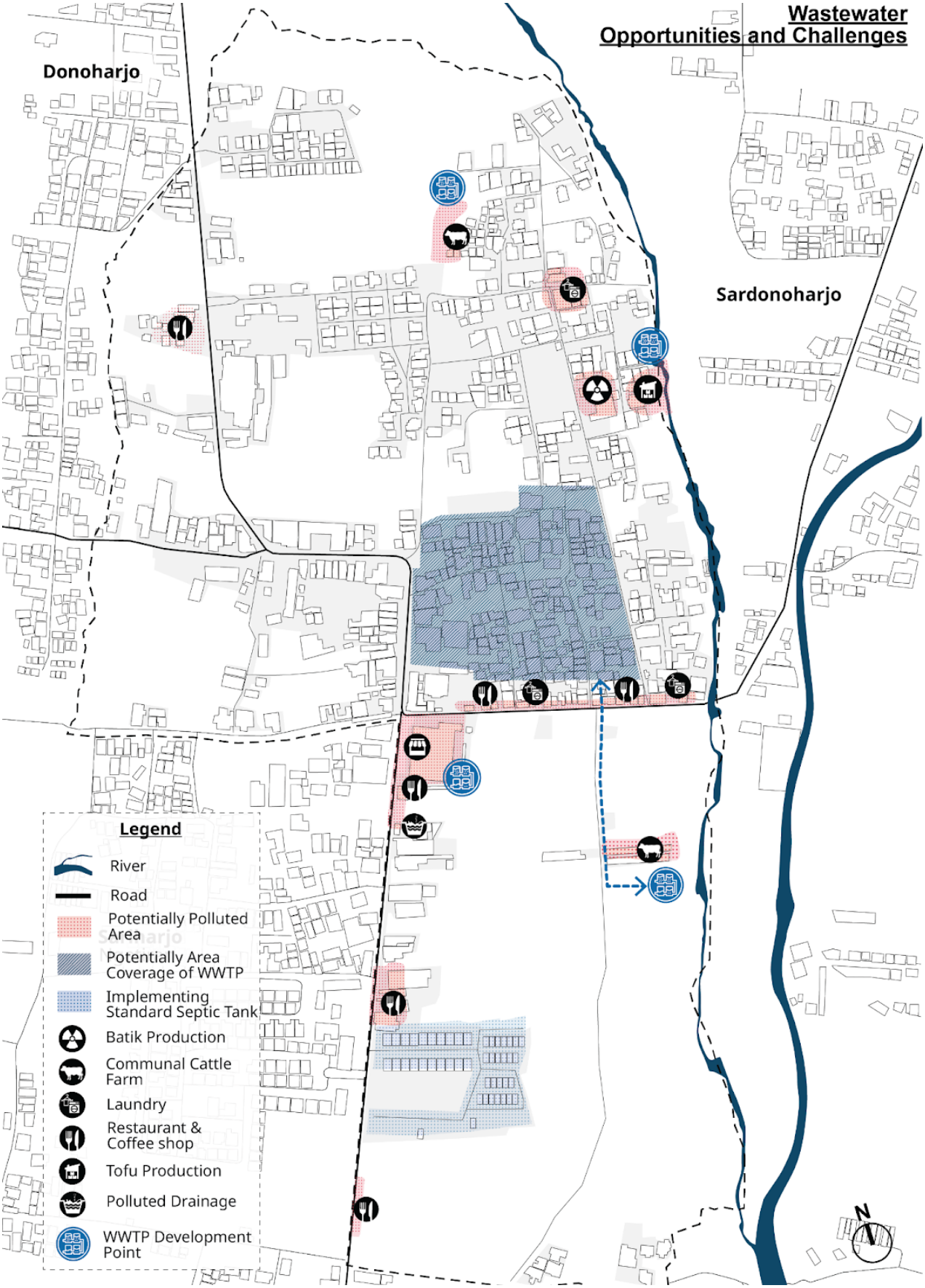
Figure 3.16. Untreated wastewater at Rejodani's market
Source: PolyUrbanWaters Team, 2024

Opportunities

- **Awareness to Improve Septic Tank Construction**
  Community representatives acknowledge issues with non-watertight septic tanks. New houses are advised to keep septic tank outlets at least 10 meters away from shallow wells, though enforcing this rule's effectiveness remains uncertain.
- **Sanitation Improvements through Communal or Centralized WWTP**
  There is a recognized need to enhance the sanitation system, potentially through the establishment of communal wastewater treatment plants or connections to centralized regional systems.
- **Upgrading Communal Cattle Farm**
  Initiatives at Rejodani I cattle farms have shown that small design improvements can enhance wastewater management, such as tilting waste channels in goat pens, reflecting a community-driven environmental approach.
- **Biodigester Implementation**
  Biodigester has the potential to be applied on cattle farms offering improved waste processing capabilities and the potential to convert waste into energy for community use.

Figure 3.17. Untreated wastewater from cattle farm
Source: PolyUrbanWaters Team, 2024

Figure 3.18. Wastewater Opportunities and Challenges
Source: PolyUrbanWaters Team, 2024



3.5. Water Supply Management

Water for domestic use in Rejodani primarily comes from shallow wells, community-based pipe networks (PAMDUS), and centralized pipe networks (PDAM). In 2024, in Rejodani I, 56.08% of households use shallow wells, 27.06% use a combination of shallow wells and PAMDUS, and 16.86% use PDAM. In contrast, all households in Rejodani II rely on individual shallow wells. PAMDUS managed by community groups where users pay a monthly fee IDR 10,000 for access. Newer developments connect to PDAM where the residential area are near the main road where the pipe from PDAM are available, with tariffs ranging from IDR 3,600 – 4,500 per cubic meter, depending on housing type. However, both shallow wells and PAMDUS fall short of meeting standardized water supply needs, underscoring the importance of accelerating PDAM expansion.

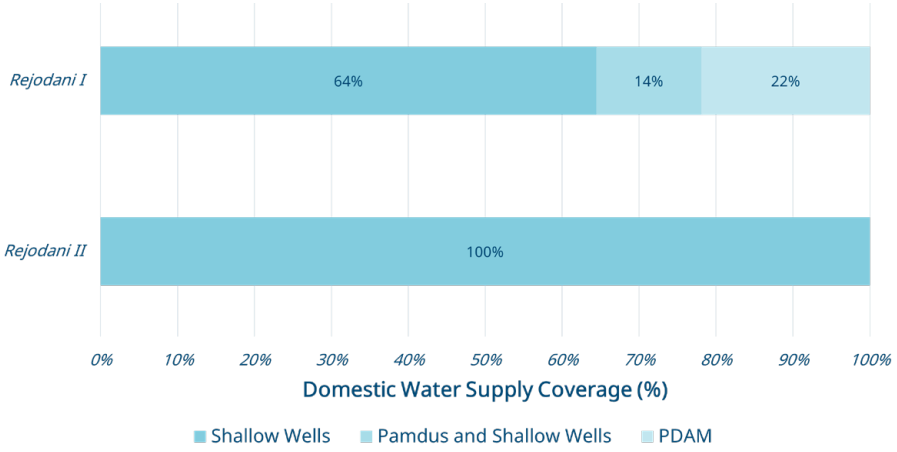


Figure 3.19 Domestic Water Supply Coverage (%) in Rejodani
Source: PolyUrbanWaters Team, 2024

Given the current condition of PAMDUS, where the water source flow rate is decreasing and the infrastructure is limited in terms of both space and maintenance, the number of PAMDUS customers will be maintained at the same level until 2030. This means that with the population growth in the Rejodani I area, the service coverage of PAMDUS will continue to decline until 2030. By 2030, in Rejodani I, the PDAM usage will increase by approximately 3.5% and the expected shift from wells to PDAM is 2.2%. Meanwhile, in Rejodani II, the PDAM usage will increase by approximately 3.2% and the expected shift from using wells to PDAM being 2.7%.

Figure 3.20 Water supply resources in Rejodani
Source: PolyUrbanWaters Team, 2024

(a) Individual shallow well for domestic use

(b) Pamdus reservoir and distribution pipeline network

(b) Pamdus reservoir and distribution pipeline network

Challenges

- **Shallow wells are deemed unsustainable, posing health, and environmental risks**

  Shallow wells in Rejodani face decreasing water levels due to land conversion and loss of water catchment area, making them unreliable. They are also vulnerable to contamination from pit latrines and atmospheric pollutants. See figure 3.21 for areas with bad water quality.

- **PDAM water is unused in traditional housing due to the absence of a pipe network in their areas**

  The households in traditional housing do not use PDAM water source because there is no existing pipe network that reaches their areas. They also perceive their current water source, which is the well, as sufficient for their needs.

- **PAMDUS faces challenges in inadequate management of the water supply**

  PAMDUS is lacking in sufficient infrastructure and technical capacity to ensure the delivery of safe water to communities. PAMDUS operators struggle with inadequate equipment, skills, and knowledge, leading to poor service quality including low water pressure, frequent interruptions, and contamination risks.

Opportunities

- **The existing PDAM primary network enables opportunity for expansion**

  The PDAM has the potential to expand its network to traditional settlements in Rejodani, leveraging its existing primary network that traverses the Rejodani main road.

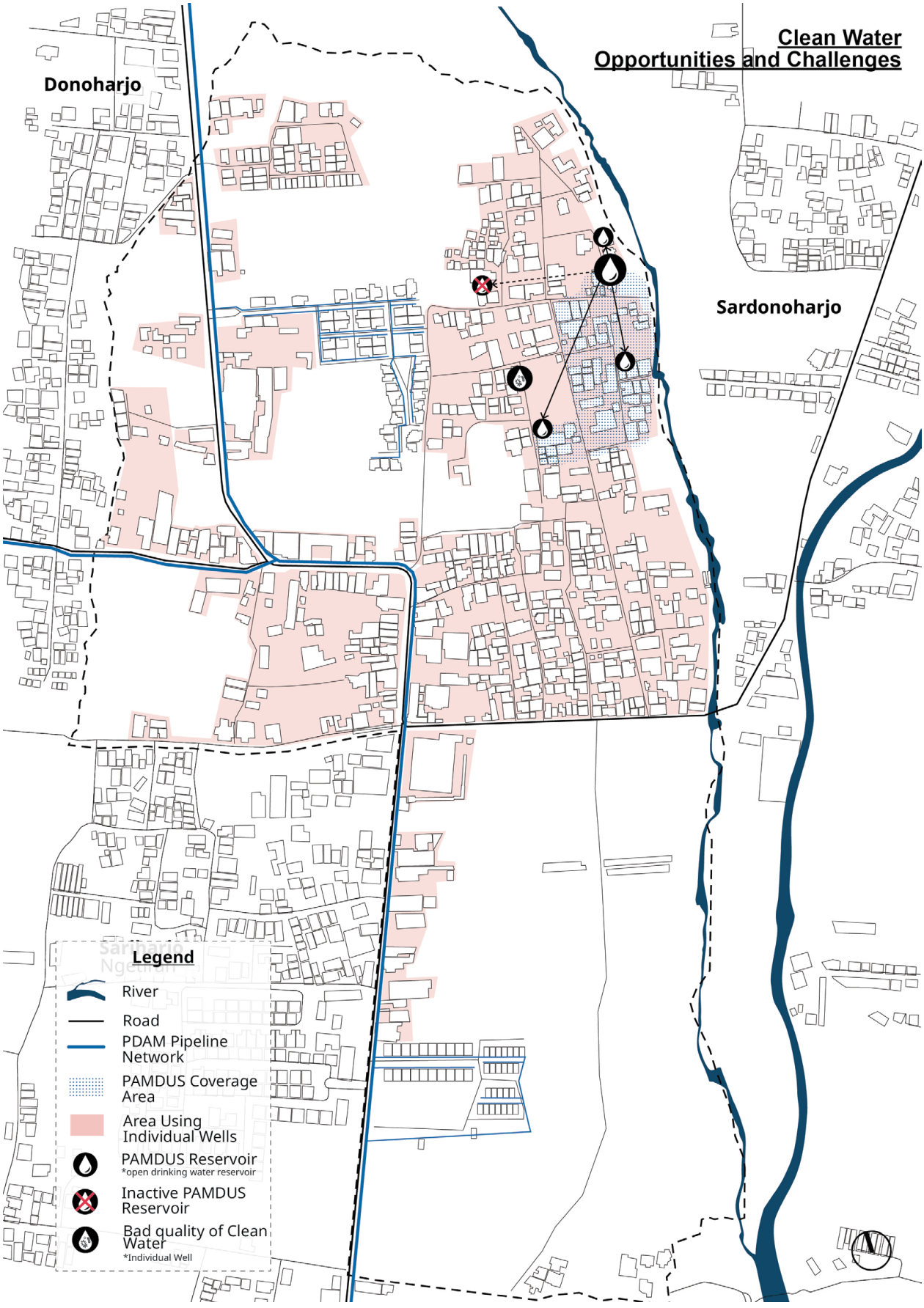
- **Community are aware the importance of a secure pipe network for reliable and safe water supply**

  The Rejodani community recognizes the need to transition from unsustainable shallow wells to a piped network for accessing safe and reliable water, understanding the associated health and environmental risks.

- **PAMDUS aims to enhance its institutions capacity for better water management**

  PAMDUS management acknowledges the need for water quality tests and increased technical capacity and institutional enhancement.

Figure 3.21 Water Supply Opportunities and Challenges
Source: PolyUrbanWaters Team, 2024



3.6. Water Catchment

In line with the typical peri-urban landscape, Rejodani still retains open fields, often characterized as undeveloped plots or yards. Despite lacking intentional planning, these spaces fulfill a crucial role as catchment areas. However, increasing development pressure is causing an increase in impervious surface area's size and changing the catchment area's behaviors and functions. The ongoing transformation underscores the delicate balance between urban expansion and preserving essential environmental functions in Rejodani. Adaptation strategies through NbS needs to be introduced in order to safeguard the water catchment role not limited to Rejodani I and Rejodani II yet for the whole Sariharjo Village.

Land use in Rejodani is expected to undergo land conversion from non-built-up area to built-up area. In 2030, the built-up area is predicted to cover 51.56% of the total area in Rejodani. The expansion of built-up area must be controlled and balanced with the provision as well as preservation of infiltration areas to maintain groundwater and prevent water scarcity.

Challenges

- **Decline in water catchment area adversely affecting ground and surface water conditions**

  The decline of the water catchment area due to the expansion of built-up areas.

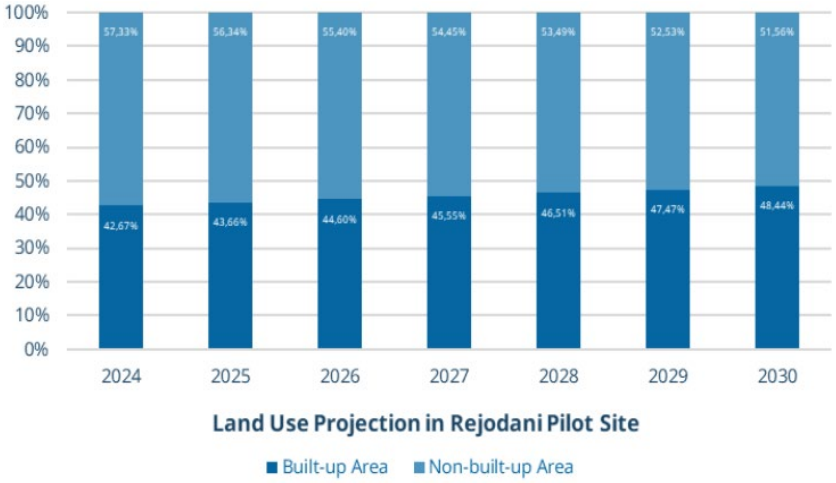


Figure 3.22 Land Use Projection in Rejodani Pilot Site, 2024-2030
Source: PolyUrbanWaters Team, 2024

- **The irrigation canals run dry during the dry season**

  Local farmers facing prohibitively high operational costs for field wells. As a result, many farmers opted not to work on their rice fields during this period.

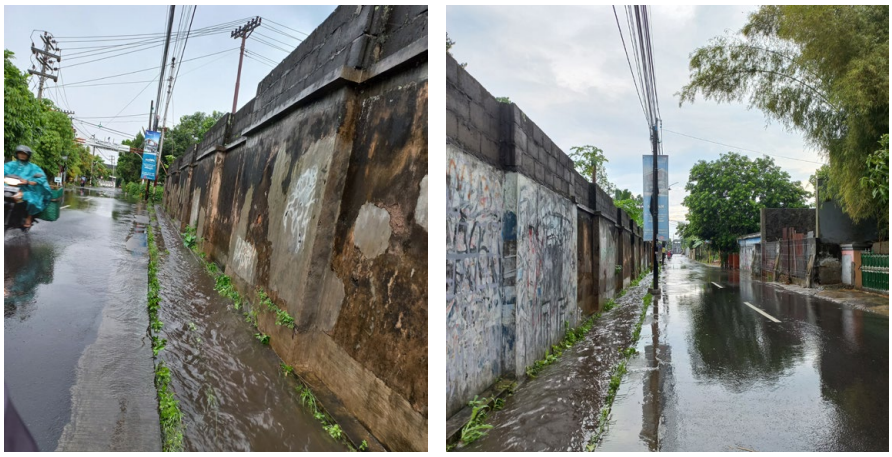


Figure 3.23 Overflowing Drainage in Local Road – Unbalanced built environment and conservation area could decreased the catchment function as natural recharge area and increase the surface runoff

Source: PolyUrbanWaters Team, 2023

Opportunities

- **The community collaboratively committed to preserve catchment function in residential areas**

  The community is proactively addressing the challenges posed by urban development on water absorption.

- **Construction of infiltration wells**

  Through the construction of infiltration wells strategically positioned to enhance rainwater infiltration, residents are ensuring the replenishment of local aquifers.

- **Use of water-absorbent materials**

  Beyond regulating surface runoff, these materials play a crucial role in maintaining groundwater levels, showcasing the community's holistic approach to sustainable water management.

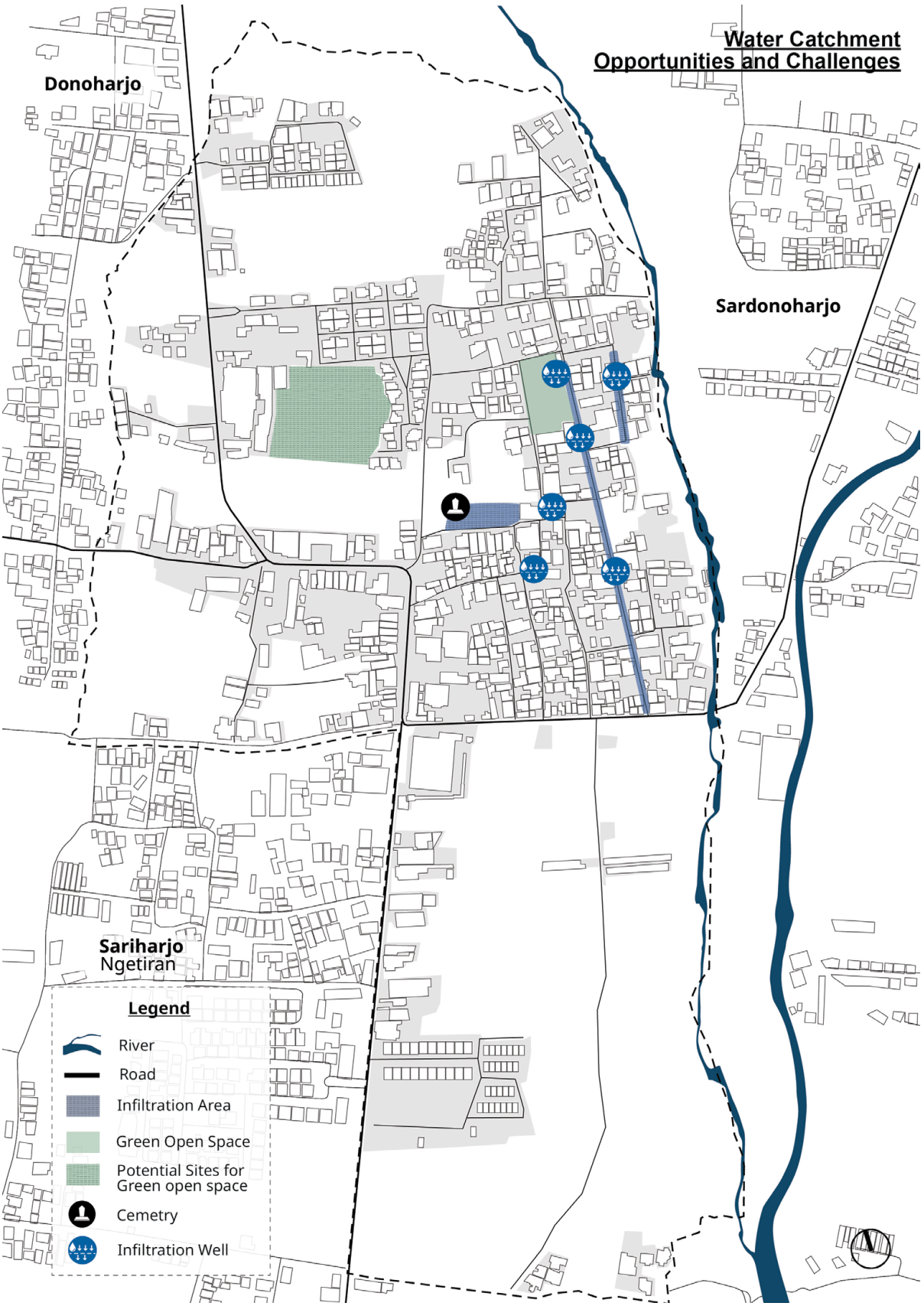
- **Initiating NbS selection at household or community level**

  The selection of NbS could be initiated by the household level or sub-village community group based on the issue to be solved. Oftentimes, certain NbS are able to perform as catalyst for more than one issue in a designated area.

Figure 3.24 Integrated drainage system by combining infiltration wells and drainage channels, initiated by the community to manage water run-off

Source: PolyUrbanWaters Team, 2024

Figure 3.25 Water Catchment Opportunities and Challenges
Source: PolyUrbanWaters Team, 2024



3.7. Blue-Green Infrastructure Management

Despite experiencing transitions from rural to peri-urban, Rejodani still holds significant green and blue spaces. However, these areas are not fully integrated, limiting their potential to enhance environmental quality and community well-being. Green and blue spaces offer opportunities for conservation, recreation, and environmental protection. Several efforts have been undertaken to convert empty land into green open spaces and protect river borders with green belts. That was because the community is somehow aware of the impact triggered by global phenomena e.g. global warming, climate change and extreme weather. However, fully optimizing and integrating these areas remains a challenge, especially in terms of effective design.

Challenges

- **Suboptimal Functioning of Blue-Green System**
  Without integrated planning, housing developments can lead to drainage issues and increase runoff.
- **Understanding Complex Challenges of Poorly Designed Infrastructure**
  Recognizing that issues arise from multiple interacting factors can potentially cause varied scales of impacts, such as urban flooding, if the infrastructures are poorly constructed and/or connected.
- **Formulating Suitable Infrastructures**
  It is crucial to assess existing infrastructure (adequate in quantity, its type and distribution) as well as maintenance costs to resolve the issue effectively.

Opportunities

- **Community-Driven Transformation of Vacant Land**
  The community collaboratively converts privately or community owned vacant land into green open spaces for communal use, under the supervision of village government.
- **Stakeholders Awareness of Environmental Issues**
  Stakeholders are becoming more aware of global environmental issues like climate change and extreme weather.

- **Supplementary Support and Partnership**

  Lack of knowledge transfer from the authority in fact provides an opportunity for the community to seek supplementary information and requirements from alternative sources e.g. television program, documentary program, relevant channel or social media account, and/or initiate partnership with third party.

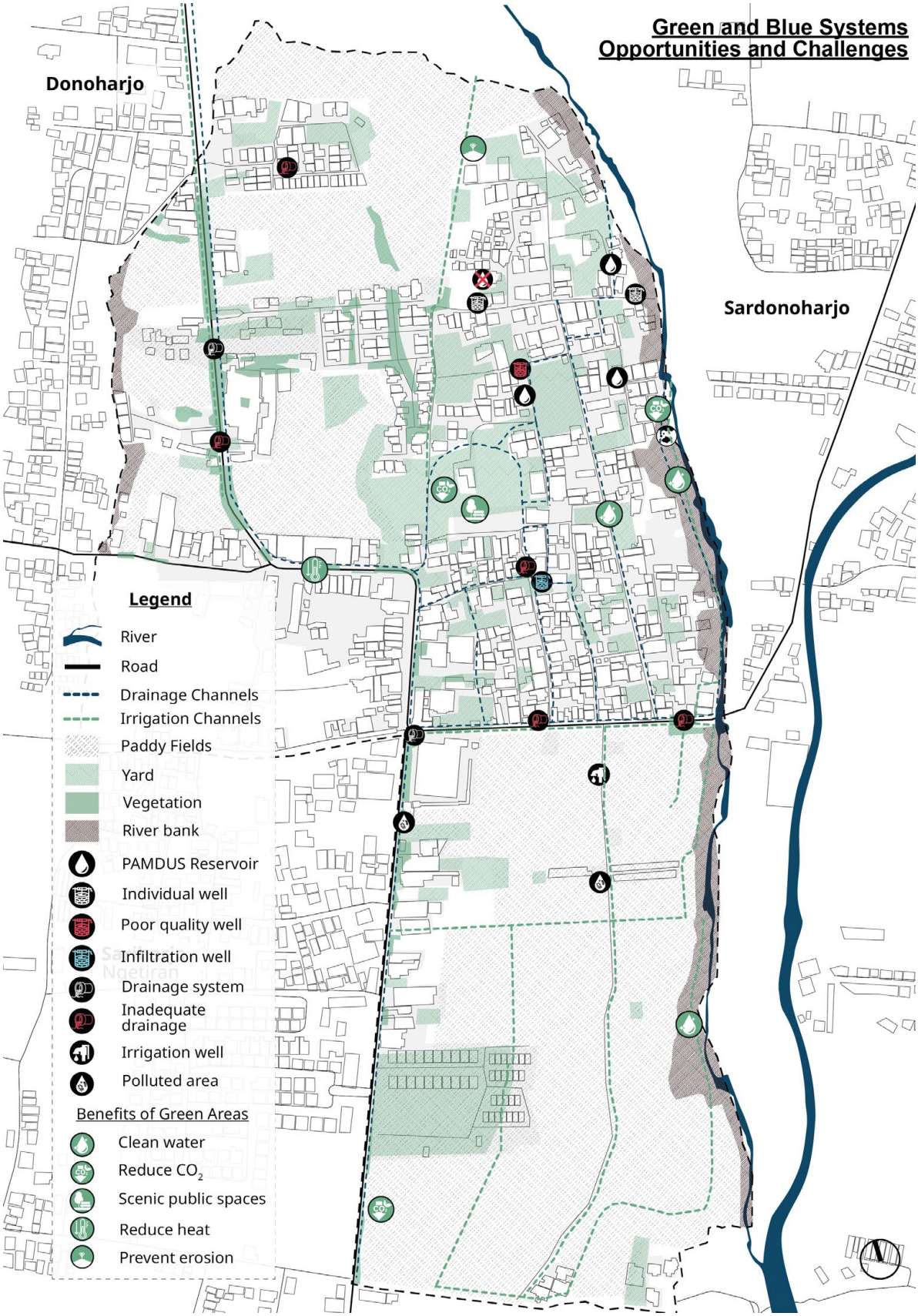
- **Implementing NbS in the neighborhood area**

  The community has implemented NbS in several areas, including features for water absorption, erosion protection, and organic waste processing.

Figure 3.26 Green vacant land in Rejodani 1, which some of the land utilized as communal public spaces of resident.

Source: PolyUrbanWaters Team,

Figure 3.27 Blue-Green Infrastructure Opportunities and Challenges
Source: PolyUrbanWaters Team, 2024



3.8. Solid Waste Management

Solid waste generation comes from various sources, including households, public services, businesses, agriculture, and cattle farms. In Sleman, solid waste management is divided into two categories: waste handling (collection and transportation) and waste reduction. The Piyungan Landfill (TPA/Tempat Pembuangan Akhir Piyungan), serving as final waste disposal site for Yogyakarta City, Sleman Regency, and Bantul Regency, faced several challenges, including overcapacity that led to its temporary closure from July 23, 2023, to September 5, 2023, as per Governor's Letter No. 658/8312 dated July 21, 2023. This closure impacted solid waste handling processes in many temporary disposal sites, including one in Lempongsari, although private waste handling providers that primarily serve business entities continue to operate. This situation drove the community to illegally dump their unseparated solid waste around the agricultural area of Rejodani 2.

In response, the Sleman Regent issued Circular No. 035.2023, appealing to the public to separate organic and non-organic solid waste and to process it independently at the household level. Suggested methods include using segregated organic waste for animal feed, composting with "Jugangan" (mini landfill) method, or making it into an eco-enzyme solution. Inorganic solid waste can be collected at the TPS3R (solid waste processing site with reduce, reuse, and recycle system) waste banks, and private waste collectors. There is also a community initiative called the Solid Waste Bank di Rejodani (Bank Sampah) that handles inorganic solid waste. This waste bank service covers 276 households in Rejodani 1 and 171 households in Rejodani. However, only 25 households are actively participating after its location was moved to a new location with 600 m2 of dedicated land to support their activities.

Challenges

- **Non-separation of solid waste at the household level**

  Despite the Sleman Regent Circular Letter (Surat Edaran/SE) No. 030/2022 on solid waste separation and reduction at the household level, the community still lacks awareness to practice solid waste separation.

- **Absence of community socialization in solid waste separation and reduction**

  While socialization has been advocated by the regency government to be conducted in the sub-district and village levels, there has been no community socialization conducted so far in Rejodani.

- **Dumping of solid waste in plastic bags by outsiders near agricultural areas**

  This illegal dumping act requires the Rejodani community to organize clean-up activities to address this issue.

- **Costly and non-segregated waste collection services for Rejodani market**

  Rejodani market uses third party services to collect their solid waste with high service fee. Besides, both Rejodani Market and its third party waste collection service haven't implemented a waste segregation system.

Figure 3.28 Rejodani Traditional Market

Source: PolyUrbanWaters Team, 2024

Opportunities

- **Community initiatives to expand waste bank services**

  Rejodani Wastebank was moved to a new location of 600 m2. This waste bank serves two sub-villages, covering over 400 households. From the latest focus group discussion, waste activists initiated adding chicken coops as tools for treating organic waste from households in the new location.

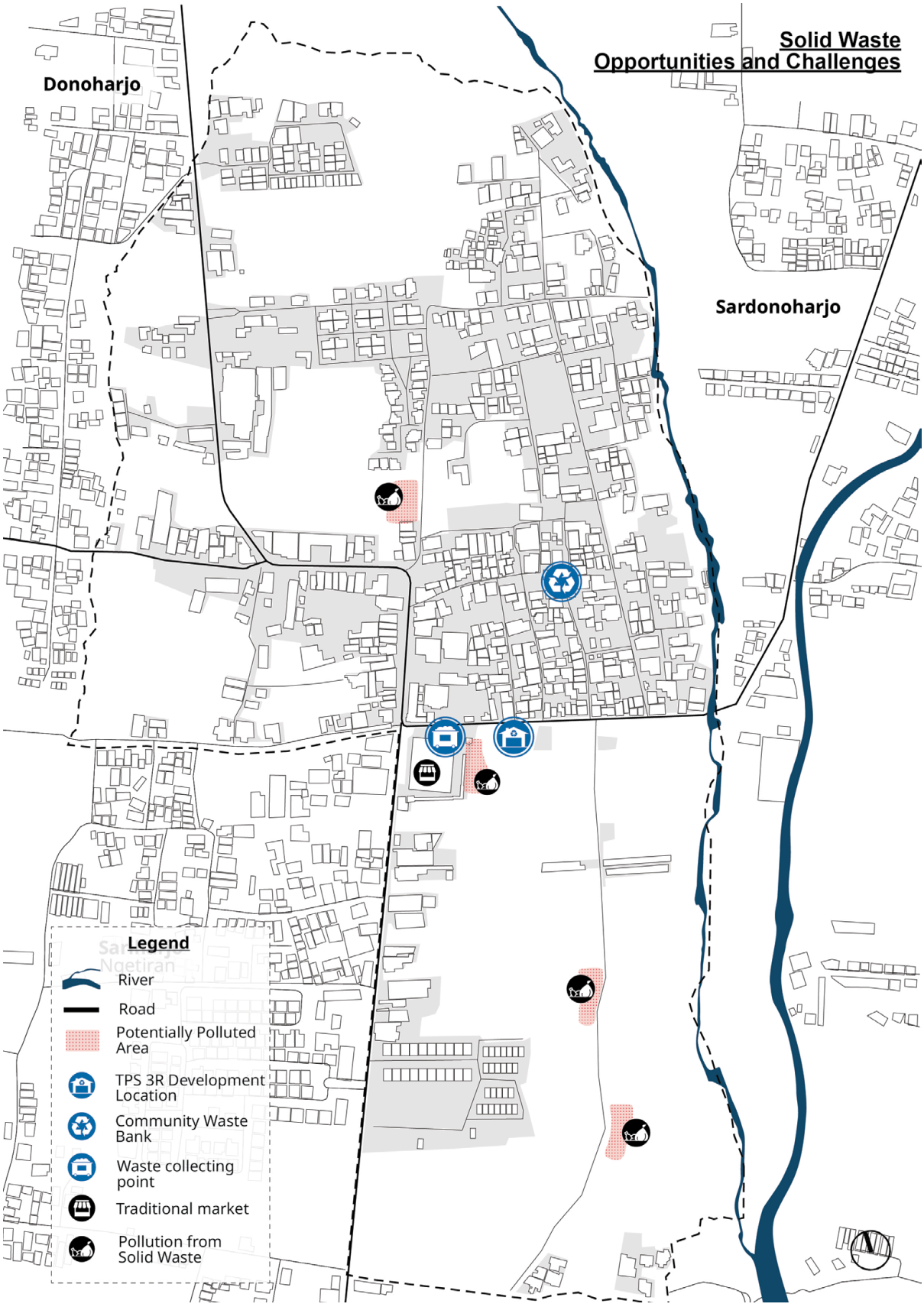
- **Development of solid waste processing site (TPS3R) at the sub-village level**

  The community proposed establishing a Material Recovery Facilities near the communal cattle farm in Rejodani 2. This village-owned site, estimated to be over 700 m2, meets the MRF readiness criteria. This establishment will enable Rejodani to manage its solid waste locally, with almost one ton dumped daily.

Figure 3.29 Solid waste in households and recycling practice

Source: PolyUrbanWaters Team, 2024

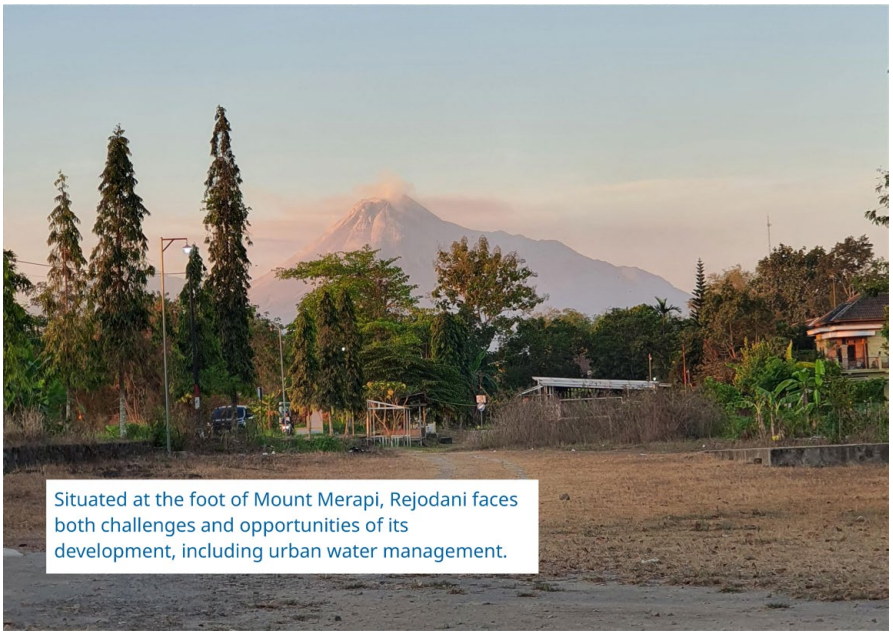
Figure 3.30 Solid Waste Opportunities and Challenges
Source: PolyUrbanWaters Team, 2024



3.9. Comprehensive Assessment for Rejodani's Development Strategies

A comprehensive analysis is conducted to better understand the current situation of Rejodani, which is seen through its current potential and challenges as well as what the external factor could impact to the areas. Analysis SWOT is expected to analysis Rejodani's current situation comprehensively, which then contributes to develop strategies and actions plan in the future. The purpose of conducting a SWOT analysis is to assess the internal strengths and weaknesses as well as external opportunities and threats faced by Rejodani that is currently undergoing urban transformation. Using the SWOT matrix, it helps to prioritize actions based on the insights gained from the analysis.

As can be seen in the matrix below, there are four quadrants consisting of four specific strategies which respond to the internal and external factors. The S-O (strength-opportunities) quadrant consists of strategies which utilize the strong assets, resources, capacity and initiatives to expand opportunity and utilize support from the local government. The W-O (weakness-opportunities) quadrant consists of strategies to utilize opportunities to improve the weaknesses of Rejodani Sub-villages. The S-T (strength-threat) quadrant consists of strategies which utilize the strong assets, resources, capacity and initiatives to mitigate and reduce threat on land use change and water issue. Lastly, the W-T (weakness-threat) quadrant consists of strategies which may improve the weaknesses of Rejodani Sub-villages and mitigate and reduce threat on land use change and water issue.



Situated at the foot of Mount Merapi, Rejodani faces both challenges and opportunities of its development, including urban water management.

Figure 3.31 SWOT Analysis Matrix

Source: PolyUrbanWaters Team, 2024

Strengths

- Utilize undeveloped Village Treasury Land (TKD) and convert vacant land into green spaces.
- Implement Nature-based Solutions (NbS) at household and community levels.
- Expand waste bank services and create green spaces.
- Improve septic tank construction and water quality awareness.
- Transition from shallow wells to piped water networks, with a focus on water quality testing.
- Preserve infiltration functions with water-permeable materials and infiltration wells.
- Enhance communal cattle farms with biodigester potential.
- Improve drainage systems and integrate infiltration wells.
- Develop inclusive public spaces as community centers.

Weaknesses

- Solid waste lack management
- Settlement densification increases the need for clean water and raises wastewater and solid waste production.
- Mismanagement of domestic wastewater and lack of community awareness on septic tank maintenance and waste reduction at the household level.
- Livestock and industrial wastewater flowing into rice fields.
- Poorly constructed infrastructure, resulting in inadequate drainage capacity.
- Irrigation canals running dry during the dry season.
- Suboptimal functioning of blue-green systems and inadequate infiltration wells.

Opportu

- Optimize spatial and zoning reg
  implement Central Sleman's Det
- Develop public spaces and greer
  land.
- Leverage the government's verti
  development.
- Increase stakeholders' awarenes
  partnerships for knowledge tran
- Expand the PDAM network to tra
  sanitation through centralized W
- Establish solid waste processing
  level.

Strategies to make use of **Opportunities** through c

- Optimize zoning regulations (RT
  vertical housing programs.
- Expand PDAM network and deve
  spaces.
- Increase stakeholder commitme
  environmental issues.
- Create solid waste processing fa
  community waste management.
- Improve water catchment and d
- Raise awareness of clean water s
- Ensure water quality standards a
- Improve stormwater infrastructu

Strategies to make use of **Opportunities** to minimi

- Implementation of building cove
  coefficient
- Ensure clean water needs fulfillm
- Transition from septic tank to ce
- Encourage community to practic
  composting at household level
- Ensure wastewater from comme
  standards
- Improvement of the function of
- Housing consultation and assist
  housing provision and improven

nities

ulations (RTRW and RDTR) and
ailed Spatial Plan.
n infrastructure by utilizing vacant

ical housing program for residential

ss of environmental issues and form
nsfer.
additional settlements and improve
WWTP.
sites (TPS3R) at the sub-village

Threats

- Rapid land use changes, social segregation due to gated housing, and commercial growth along main roads.
- Insufficient PDAM infrastructure and capacity to deliver safe water, with no secondary or tertiary piped networks.
- Irresponsible solid waste dumping by outsiders and high third-party waste collection fees in Rejodani Market.
- Decreasing water levels in shallow wells and reduced water catchment areas due to land conversion.
- Increased impervious surfaces and high risk of inundation in several areas.

f

our **Strengths**

RW and RDTR) and implement

elop green infrastructure and public

nt and form partnerships for

cilities (TPS3R) and enhance

rainage systems, and promote NbS.
security and upgrade PAMDUS.
and manage livestock wastewater.
ure and consider hybrid solutions.

Strategies to prevent **Threats** through our **Strengths**

- Ensure the implementation of spatial plan regulations
- Encourage the community to transition from hard surface uses to water-permeable materials
- Utilizing vacant land to create communal spaces
- Improve institutional capacity in clean water management
- Community education regarding solid waste management

f

ze **Weaknesses**

erage ratio and green base

ment
ntralized wastewater treatment
e solid waste separation and

rcial activities meet the safety

blue-green system
ance services from government for
ment

Strategies to minimize the potential dangers lying in sectors where **Weaknesses** meet **Threats**

- Strengthen building permits
- Enhance technical capacity in clean water management
- Increase community awareness of the importance of wastewater management
- Ensure stormwater infrastructures meet standards
- Provision of incentives and disincentives related to the provision of green open spaces

After participating in a series of FGD activities, the community took the initiative to replace the cemetery's concrete road with gravel, restoring its infiltration function.

Chapter 4

Towards water -sensitive community in the Peri-urban of Rejodani

4.1 Vision of Water-sensitive Community

The vision articulates the mid and long-term aspirations and goals for the development of Rejodani within the water-sensitive approach scenario. It provides statements and descriptions of the desired future state, guiding the development and decision-making processes by addressing the challenges and opportunities in Rejodani.

The co-producing shared vision consists of two parts. First, vision statements for each pillar called ***Desired Visions*** that were generated and stated by the community based on eight pillars PolyUrbanWaters. The eight community visions help to specify and detail the state they want to achieve in the future within the water-sensitive planning approach. Second, ***the Vision for Water-sensitive Sub-villages*** is consolidated to form a unifying vision that encompasses the eight pillars for the development of Rejodani.

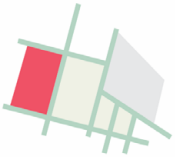
The community visioning also ensures that the water-sensitive planning contributes to the achievement of Sleman Regency's vision for Sleman Development in 2021-2026 which stated "Making Sleman a Smart, Prosperous, Competitive, Respectful of Diversity, and Community-Spirited Living Space" *(Terwujudnya Sleman Sebagai Rumah Bersama Yang Cerdas, Sejahtera, Berdaya Saing, Menghargai Perbedaan dan Memiliki Jiwa Gotong Royong)*. This also shows how the implementation of polycentric approaches to the management of urban waters consequently support the local government's vision.

4.1.1 Desired Visions on Eight PolyUrbanWaters Pillars

The Desired Visions is the statement of the Rejodani community on how they envision Rejodani in 2030 based on eight pillars of PolyUrbanWaters. This is a result of tailored activities to develop water-sensitive planning that fits with the size, resources, and local knowledge of the Rejodani community. A set of eight vision statements was formulated that aims to navigate the action based on community aspirations (see Figure 4.1).

Figure 4.1 Community 8 Vision Statement
Source: PolyUrbanWaters Team, 2023

Balance development between natural land and built-up area



Balanced land use development by preserving natural ecosystems, supporting sustainable agriculture, and ensuring environmentally conscious urban growth. It aims to prevent resource overuse, maintain agricultural productivity, and create resilient, habitable areas.

Maintain water catchment area and NbS application for water conservation

Maintaining balance conservation and development to mitigate risks of flooding and drought, possibly through Nature-based Solutions (NbS). It is vital for Rejodani as part of volcanic landform is crucial for water catchment in the hydrological cycle.

Healthy and environmentally friendly settlement

Access to healthy residential areas with environmentally friendly infrastructure and socially inclusive settlements for both existing and new residents.

Access to safe and affordable clean water for all residents both in quantity and quality

Adequate and safely managed water supply regarding the fast-growing and various activities in Rejodani that leads to improvement of health, hygiene, education, livelihoods, and environmental protection

Minimize waste generation from household and encourage waste management at village level

Increase public awareness to implement "reduce, reuse, and recycle" and "polluter pays" principles to minimize waste handling to outside areas. Accelerate the solid waste management infrastructure and system by the government.

Integrated and sustainable wastewater management across levels

Safe handling and treatment of wastewater that covers entire activities from domestic, agriculture and cattle farms, business entities, and public services through multi-scale management.

Integrated stormwater management supported by regulatory framework

Integrated and standardized stormwater management for resilient and sustainable systems to mitigate flood risk encompassing planning, design, construction, operations, and maintenance stages.

Blue-green infrastructure to conserve water resources and reduce environmental issues

Blue-green infrastructure to support community livelihood. Manage riparian zones and increase groundwater recharge. Provide green open space for multi-purpose communal space and green area

4.1.2 Water-sensitive Sub-Villages: Livable, Harmonious, and Sustainable Peri-urban Community

The eight desired visions were compelled into one vision for Water-Sensitive Sub-villages. The vision becomes a key aspirational framework that guides all actions and measures progress with a target time of 2030. As a result of visioning activity by the community, the vision for water-sensitive sub-villages of Rejodani is formulated as:

"Towards a Livable, Harmonious, and Sustainable Peri-urban Community"

There are three keywords in the vision, i.e. livable, harmonious, and sustainable. These conditions are envisioned in the future of Rejodani by implementing a water-sensitive approach.

Livable: Dynamic, evolving community, especially in peri-urban areas facing urban transformation challenges and opportunities. In a water-sensitive sub village, water-related basic-needs services (water supply, wastewater and waste management, stormwater management) are effectively characterized by a high level of livability because it has a high degree of community engagement and social inclusiveness, extensive green public and recreational spaces and a well-protected environment. It denotes a quality of living space that enhances community well-being and meets diverse needs amidst ongoing development.

Harmonious: Community is able to maintain the harmonious spirit among local residents and migrants (those who live in old settlements and those who live in new gated communities). They maintain the spirit of togetherness, equality, and mutual cooperation while undergoing a transformation from rural to urban.

Sustainable: Sub-villages hope that the development and transformation process will continue in the principle of balance between economic, social, and environmental interests.

This principle integrates with the Sariharjo Village's vision which was translated as "To accomplish Sariharjo's community who are more prosperous, cultured, have a true self identity and independence with a healthy and sustainable settlement space". It also aligns with Sariharjo slogan which was created during a workshop of baseline assessment i.e. "Water for our next generation".

Should all action plans be implemented, by 2030 Rejodani will be in a significantly improved situation and better prepared to face future transformation processes, especially in alignment with RPJP at regency and national level. The next five years represent a crucial transition period

for initiating changes and moving away from business-as-usual practices that do not follow sustainable principles. While it is understood that not all indicators of livability, harmony, and sustainability will all be fully achieved by 2030, substantial progress is expected to be achieved.

4.2 Strategies and Action Plans

The vision of a water-sensitive community is supported by three main strategies that were developed to achieve the vision. The strategy is developed by categorizing the eight pillar-based community visions into three synthesized strategies, based on common themes and shared goals. These strategies consist of a series of actions designed to achieve the formulated vision. The three main strategies are:

Strategy 1: Ensuring Affordable, Healthy, and Environmentally Friendly Settlement

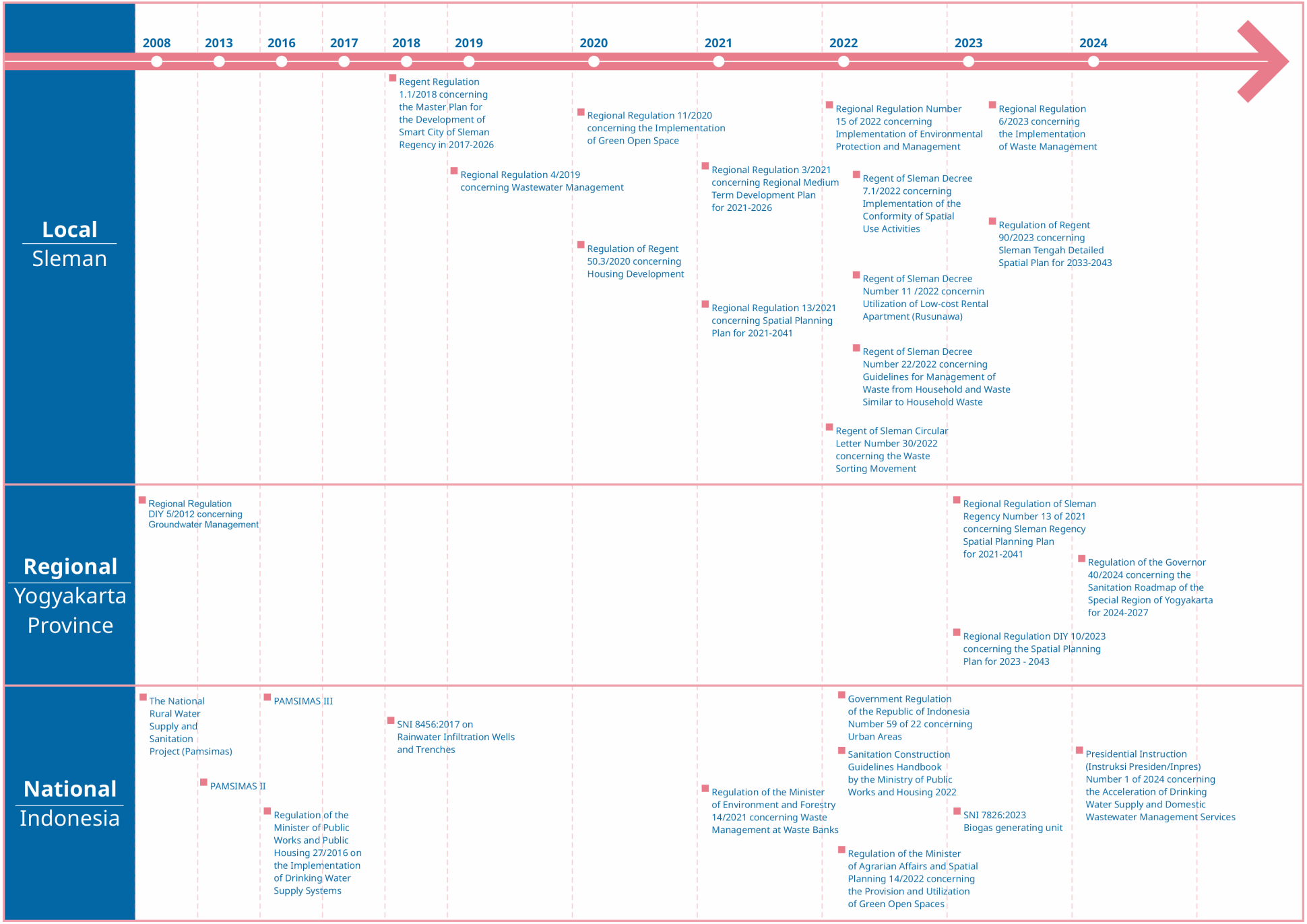
Strategy 2: Ensuring Affordable Water Safety

Strategy 3: Ensuring Water Conservation and Management

To ensure the accomplishment of the vision, the three strategies are then elaborated into a series of Action Plans which are a list of initiatives or activities within a specific time frame. The baseline year of action plan is 2024, with implementation starting in 2025 and the final goal set for 2030. The formulation of the list of actions also refers and aligns with the government planning and related policies. The local government has established several policies related to water management and supports the implementation of water-sensitive planning concepts. However, they have not yet been integrated and need to be comprehensively incorporated into urban development planning and water-related infrastructure development. These local policies also adhere to provincial and national policies, thereby supporting national development goals. For further details see Figure 4.2.

This action plan provides stakeholders with a clear roadmap to mobilize resources and implement commitments to achieve their vision. Local governments in cooperation with communities, private sector, and CSOs are the actors involved in the action plans. As the local government responsible for planning and regulating most public and private infrastructure and development, they play a crucial role in implementing water-sensitive development. However, the presence of the government in peri-urban is still limited. To address the gap, a community-based approach in providing services is employed as a strategy before transitioning to government-led services.

Figure 4.2. Reference to government's policy
Source: PolyUrbanWaters Team, 2024



Strategy I

Ensuring affordable, healthy, and environmentally friendly settlement

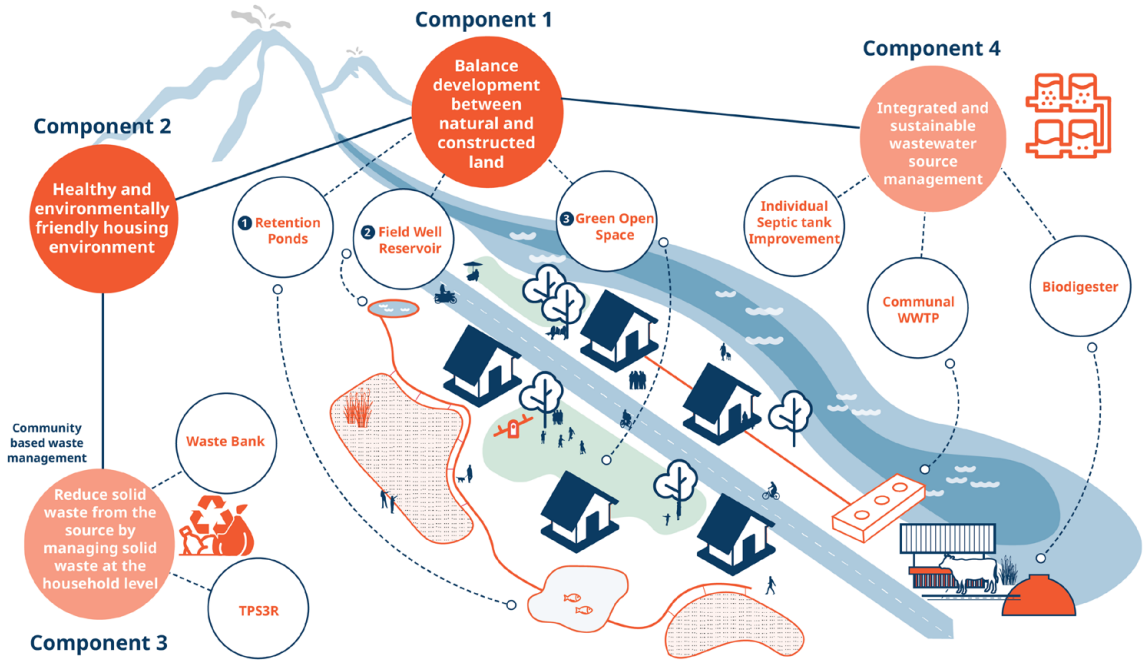


Figure 4.3.

Strategy 1: Components of Action Plan for Affordable, Healthy, and Environmentally Friendly Settlement

Source: PolyUrbanWaters Team, 2024

Background

- The rapid land use change from agricultural to built-up area
- The competitive land prices on the main road of the sub-villages (Palagan road)
- The environmental degradation due to the rapid development
- The inadequate infrastructure in settlement area
- To increase settlement livability

Objective

To ensure the Rejodani community has access to affordable housing supported by a healthy environment.

About the strategy

Ensuring healthy, affordable, and environmentally friendly settlements involves the strategic development of living spaces that prioritize the well-being of residents, remain economically accessible, and minimize environmental impact. Affordability considerations involve creating housing options that cater to diverse income levels, promoting inclusivity. Environmentally friendly aspects encompass sustainable construction practices and waste reduction. The overall objective is to create balanced, resilient communities conducive to health,

affordability, and environmental sustainability. The pillar-based visions for this strategy are:

- Balance development between natural land, agriculture, and built-up or settlement areas (from Land Use Development pillar),
- Healthy and environmentally friendly settlement (from Settlement Development pillar),
- Reduce waste generation from household and encourage waste management at village level (from Solid Waste Management pillar), and
- Integrated and sustainable wastewater management across levels (from Wastewater Management pillar)

Type of Action Plan

- Physical infrastructure development
- Capacity building
- Regulation implementation
- Advocation
- Nature Conservation
- Monitoring and evaluation

Potential Stakeholders that need to be involved

Government

Sleman Regency Government

- Department of Land and Spatial Planning
- Department of Environment
- Department of Agriculture
- Department of Public Works

Village Government

Non-Government

- CSOs
- Community
- Private Sector

The list of action plans and activities for Strategy 1, with a five-year implementation time frame, is presented in Table 4.1. The formulation process for the action plans in Strategy 1 was supported by engineering analysis, leading to quantitative targets detailed in Annex A.1.

Table 4.1. Action Plan of Strategy 1: Ensuring Affordable, Healthy, and Environmentally Friendly Settlement

Action Plans	Activities	Stakeholders
Implementation of Central Sleman's Detailed Spatial Plan (RDTR)	Conducting information dissemination on the implementation of Central Sleman's Detailed Spatial Plan (RDTR)	• Department of Land and Spatial Planning • Planning Agency • Civil Service Police Unit • Department of Investment and One Stop Integrated Services • Sub-district Government
	Conducting monitoring and evaluation on the implementation of Central Sleman's Detailed Spatial Plan (RDTR) by involving community participation	• Department of Land and Spatial Planning • Community
Provision of public green open space	Building a village scale park	• Private Sector • Department of Environment
	Implementing green open space regulations in new residential areas	• Department of Land and Spatial Planning • Department of Environment • Community • Housing Developer
	Providing jogging tracks along the riverside	• River Basin Organization of Opak River • Department of Public Works, Housing and Settlement • Department of Environment
Preservation of agricultural land in accordance with Central Sleman's Detailed Spatial Plan (RDTR)	Protecting and regulating land use to prevent conversion in Sustainable Food Agriculture Areas (LP2B)	• Department of Agriculture, Food and Fisheries • Department of Land and Spatial Planning
	Providing incentives to support the protection of LP2B areas	• Department of Agriculture, Food and Fisheries • Department of Investment and One Stop Integrated Services
	Regenerating agriculture and developing millenial farmers	• Department of Agriculture, Food and Fisheries
	Targeting the development of agricultural tourism	• Department of Tourism
	Rehabilitating degraded agricultural lands	• Department of Agriculture, Food and Fisheries
	Establishing institutions for agricultural management	• Department of Agriculture, Food and Fisheries
	Capacity building in the agricultural sector	• Department of Agriculture, Food and Fisheries
	Integrating science and technology in agricultural practices	• Department of Agriculture, Food and Fisheries
	Enhancing land intensification through improved agricultural infrastructures, innovation, and the development of agribusiness-based systems	• Department of Agriculture, Food and Fisheries
	Improving irrigation infrastructure	• Department of Agriculture, Food and Fisheries • Village Government

Action Plans	Activities	Stakeholders
Preservation of agricultural land in accordance with Central Sleman's Detailed Spatial Plan (RDTR)	Building agriculture water reservoir	• Village Government • Department of Agriculture, Food, and Fisheries • Department of Public Works, Housing and Settlement
	Building water tower storage	• Village Government • Department of Agriculture, Food, and Fisheries • Department of Public Works, Housing and Settlement
	Encouraging organic farming for sustainable farming by organizing trainings	• Community (Farmers) • Village Government • Department of Agriculture, Food and Fisheries
Implementation of Central Sleman's Detailed Spatial Plan (RDTR)	Conducting information dissemination on the implementation of Central Sleman's Detailed Spatial Plan (RDTR)	• Department of Land and Spatial Planning • Planning Agency • Civil Service Police Unit • Department of Investment and One Stop Integrated Services • Sub-district Government
	Conducting monitoring and evaluation on the implementation of Central Sleman's Detailed Spatial Plan (RDTR) by involving community participation	• Department of Land and Spatial Planning • Community
	Providing green open spaces in the residential areas	• Department of Environment • Private Sector
Disseminate government services on consulting and assistance for housing provision and improvement	Providing information services related to livable housing	• Department of Public Works, Housing and Settlement
	Consulting/assistance for house planning	• Department of Public Works, Housing and Settlement
	Consulting/assistance during construction	• Department of Public Works, Housing and Settlement
	Consulting/supervision during construction, house development and repair	• Department of Public Works, Housing and Settlement
	Consulting/assistance in the house management, maintenance, and development	• Department of Public Works, Housing and Settlement
Improvement of community capacity in solid waste management	Assisting communities with solid waste management and sorting	• Department of Environment • Department of Community and Village Empowerment
	Promoting composting practice at each household	• Community
Strengthen institutional capacity in waste management	Developing institutional networks and cooperation in solid waste management	• Department of Environment • Department of Community and Village Empowerment • Community

Action Plans	Activities	Stakeholders
Strengthen institutional capacity in waste management	Developing system for community-based solid waste management and sorting	• Department of Environment • Department of Community and Village Empowerment • Community
	Conducting monitoring and evaluation on solid waste management	• Department of Environment • Department of Community and Village Empowerment • Community
	Implementating solid waste treatment regulation specifically at hosuehold level	• Department of Environment
Operationalize of waste bank on each sub-village	Constructing a waste bank with the integration of a chicken coop for organic waste	• Department of Environmen • Community
	Conducting regular monitoring and evaluation of waste bank activities	• Department of Environment
Strengthen institutional capacity of the waste banks	Developing the institutions for waste bank administrators	• Department of Environment
Infrastructure provision for solid waste processing	Developing TPS3R (Solid Waste Treatment Site with 3R principles)	• Department of Environment • Village Government • Community
Information dissemination	Conducting information dissemination of environmentally friendly wastewater management	• Department of Environment
Development of wastewater infrastructure	Improving individual septic tanks	• Community
	Providing technical assistance for the community to improve their septic tank	• Department of Environment
	Improving urban wastewater service network at Sewon WWTP system	• Department of Environment • Private Sector
	Constructing a communal domestic wastewater treatment plant	• Department of Environment
	Building a wastewater treatment plant for Rejodani Market	• Village Government
	Developing a biodigester and wastewater treatment plant for cattle farms in Rejodani 2	• Department of Agriculture, Food and Fisheries
Implementation of wastewater treatment regulation	Assisting wastewater management for commercial activities, business, premises, and public services	• Department of Environment
	Monitoring and evaluation of commercial activities, business premises, and public services wastewater management	• Department of Environment
Monitoring and evaluation of wastewater quality	Testing effluent water from Rejodani Market	• Village Government

Strategy II

Ensuring Affordable Water Safety

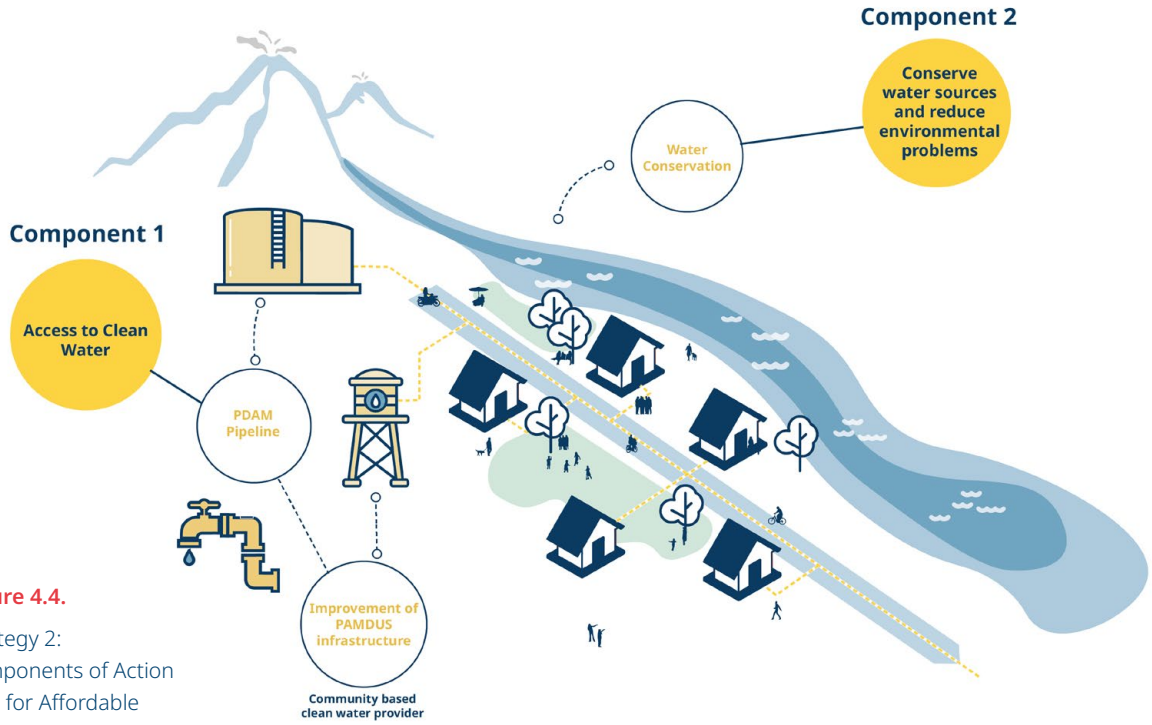


Figure 4.4.

Strategy 2: Components of Action Plan for Affordable Water Safety

Source: PolyUrbanWaters Team, 2024

Background

- Increasing number of populations
- Clean water need is increasing
- The use of shallow water which is not sustainable as main water source for Rejodani's residents
- Insufficient pipeline water service infrastructure
- Lack of safety managed clean water supply system
- Suboptimal functioning of blue and green infrastructure
- Unintegrated planning

Objective

To ensure the provision of reliable access to safe drinking water at reasonable cost for all community members, as well as promoting public health and well-being.

About the strategy

Ensuring affordable water safety involves implementing measures to provide reliable access to safe drinking water at a reasonable cost. Affordability considerations involve setting water prices that are reasonable for all income levels. Additionally, ensuring water safety entails monitoring water quantity and quality, addressing pollution sources, and implementing effective water treatment processes to meet health standards.

The goal is to guarantee that access to safe water is affordable and reliable, promoting public health and well-being. The pillar-based visions for this strategy are:

- Guaranteed access to safe and affordable clean water for all residents both in quantity and quality (from pillar Water Supply Management)
- Blue-green infrastructure to conserve water resources and reduce environmental issues (from pillar Blue and Green Infrastructure Management)

Potential Stakeholders that need to be involved

Type of Action Plan

- Physical infrastructure development
- Capacity building
- Regulation implementation
- Advocation
- Nature Conservation
- Monitoring and evaluation

Potential Stakeholders that need to be involved

Government

- **Sleman Regency Government**
  - Department of Land and Spatial Planning
  - PDAM (Local Water Company)
  - Department of Public Works
  - Department of Health
  - Department of Environment
  - Planning Agency
  - Department of Agriculture Pokja PKP (Housing and Settlement Area Working Group)
  - River Basin Organization of Opak River
- **Village Government**

Non-Government

- PAMDUS Organization
- Sub-village Organization

The list of action plans and activities for Strategy 2, with a five-year implementation time frame, is presented in Table 4.2. The formulation process for the action plans in Strategy 2 was supported by engineering analysis, leading to quantitative targets detailed in Annex A.2.

Table 4.2. Action Plan of Strategy 2: Ensuring Affordable Water Safety

Action Plans	Activities	Stakeholders
Expansion of PDAM Network	Raising community awareness to use safe water piping network (PDAM)	• Local Water Company (PDAM) • Department of Public Works, Housing and Settlement
	Building secondary and tertiary PDAM network	• Local Water Company (PDAM) • Department of Public Works, Housing and Settlement
	Proposing program assistance of PDAM connections for underprivileged communities	• Local Water Company (PDAM) • Department of Public Works, Housing and Settlement • Bank Sleman/BPBD DIY
Improvement of PAMDUS infrastructure and management	Establishing PAMDUS institution legally and formally	• PAMDUS Organization • Village Government
	Management training for PAMDUS institutional members	• PAMDUS Organization • Village Government
	Information dissemination for PAMDUS users	• Department of Health • Planning Agency • Department of Public Works, Housing and Settlement
	Installing water treatment	• PAMDUS Organization • Department of Public Works, Housing and Settlement
	Maintaining the cleanliness of the PAMDUS water reservoir	• PAMDUS Organization • Village Government
	Installing single pipeline from PAMDUS reservoir the reticulation system of the house connection	• PAMDUS Organization • Village Government
Monitoring Water Quality	Conducting regular test and monitor of PAMDUS's water quality	• Department of Health • Department of Environment
Create accesible communication platform	Optimizing existing platform for better communication and information	• Pokja PKP (Housing and Settlement Area Working Group)
Improvement river infrastructure	Maintaining river's embankment/retaining wall	• River Basin Organization of Opak River • Department of Public Works, Housing and Settlement
Clean River Program	Scheduling river cleaning by the community	• Community • Sub-village organization • Village Government
Provision of green facade and/or green fence	Implementing green walls at public buildings and residential area	• Community • Private Sector

Strategy III

Ensuring Water Conservation and Management

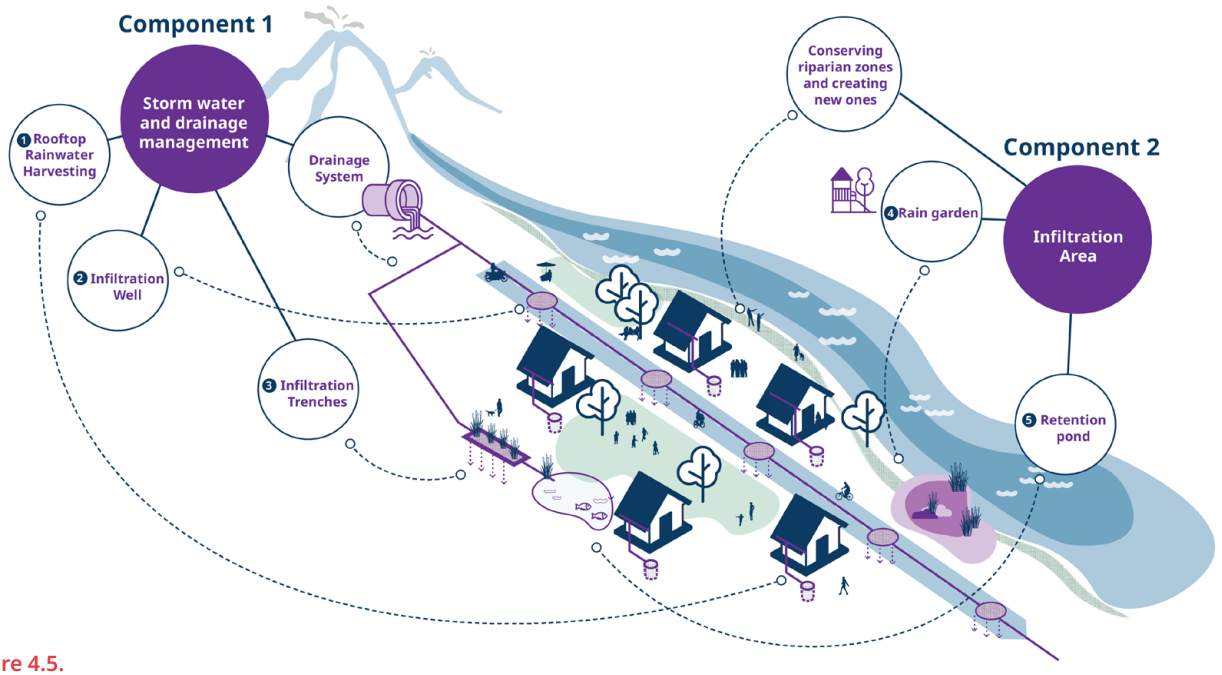


Figure 4.5.

Strategy 3: Components of Action Plan for Water Conservation and Management

Source: PolyUrbanWaters Team, 2024

1 Rooftop Rainwater Harvesting
Fresh Water
Storm Protection
Water Regulation

2 Infiltration Well
Groundwater Recharge
Flood Mitigation
Water Quality Improvement
Erosion Control
Biodiversity Support
Micro-climate Regulation
Sustainable Water Supply
Storm Water Management
Habitat Creation

3 Infiltration Trenches
Water Regulation
Storm Water Protection
Erosion Control
Aesthetic Value
Water Purification

4 Rain garden
Fresh Water
Aesthetic Value
Water Regulation
Soil Formation
Water Purification
Nutrient Cycling Treatment
Primary Formation

5 Retention pond
Storm Protection
Climate Regulation
Water Regulation
Social Relations
Water Purification
Wastewater Treatment
Recreation and Ecotourism
Habitat Provision
Air Quality
Aesthetic Values

Background

- Water infiltration areas are decreasing
- Groundwater and surface water levels are decreasing
- Irrigation runs dry during dry season
- Potential of flood during heavy rainy season
- Inadequate drainage channels
- Lack of integration between gray and blue-green infrastructure
- Dependency on gray infrastructure
- Constraints to preserve green areas

Objective

To ensure the implementation of practices towards water conservation and management which starts at the community level that contribute to environmental sustainability such as resilience to drought or scarcity, and the overall well-being of the communities.

About the strategy

Ensuring water conservation and management involves the implementation of strategies and practices to use and protect water resources responsibly. The goal is to balance water demand with available resources and safeguard water quality and quantity for both current and future generations. Effective water conservation and management contribute to

environmental sustainability, resilience to flood and drought risk, and the overall well-being of communities.

The pillar-based visions for this strategy are:

- Integrated stormwater management supported by regulatory framework (from pillar Stormwater Management)
- Maintain water catchment area and NbS application for water conservation (from pillar Water Catchment Management)

Type of Action Plan

- Physical infrastructure development
- Capacity building
- Regulation implementation
- Advocation
- Nature Conservation
- Monitoring and evaluation

Potential Stakeholders that need to be involved

Government

Sleman Regency Government
- Department of Public Works
- Department of Environment

Village Government

Non-Government
- Community
- Private sector

The list of action plans and activities for Strategy 3, with a five-year implementation time frame, is presented in Table 4.3. The formulation process for the action plans in Strategy 3 was supported by engineering analysis, leading to quantitative targets detailed in Annex A.3.

Table 4.3. Action Plan of Strategy 3: Ensuring Water Conservation and Management

Action Plans	Activities	Stakeholders
Implementation of sustainable drainage system	Raising community awareness about about eco-drainage system (Rainwater Harvesting System)	• Department of Public Works, Housing and Settlement • Village Government
	Implementing rainwater harvesting	• Community
	Integrating drainage with infiltration wells	• Department of Public Works, Housing and Settlement • Village Government
	Improving existing drainage system according to regulations	• Department of Public Works, Housing and Settlement • Village Government
	Building infiltration trench at residential area	• Community • Village Government
	Applying bioswale along village and regency roads	• Department of Public Works, Housing and Settlement • Village Government
Increase infilltration area	Implementing rain garden as infiltration	• Department of Environment • Village Government
	Using paddy field as a buffer zone to anticipate flood	• Community (farmers) • Department of Agriculture, Food and Fisheries
	Implementing biopores infiltration holes	• Community • Village Government • Department of Environment
Land and water protection from water pollutant	Applying biofilters into pollution hot spots	• Department of Environment • Village Government
	Applying phytoremediation to pollution hot spots	• Department of Environment • Village Government
	Conducting wastewater effluent tests from the home industry	• Department of Environment • Village Government
Preservation and restoration of green space	Improving riparian biodiversity with local tree planting (gayam tree (Inocarpus fagifer) and fruit tree)	• Department of Environment • Village Government
	Planting trees in each land plots sub-village areas (fruit tree)	• Department of Environment • Village Government
	Implementing the regulations of public green open space provision (Public green open space of at least 10% of the total green coverage ratio in each land plot)	• Department of Public Works, Housing and Settlement • Department of Environment • Private sector
Application of permeable materials	Implementing porous paving in roads, yards of residential area, and commercial areas	• Department of Public Works, Housing and Settlement • Village Government • Private Sector (Housing Developer)

Village-owned land that was initially vacant and later leased by a restaurant is now well-maintained, featuring thoughtfully designed landscaping that also functions as a water infiltration area, enhancing sustainable land use.

The ambiance in Rejodani remains green, with stormwater infrastructure on the main road integrating drainage systems and infiltration wells to effectively manage runoff and enhance groundwater recharge

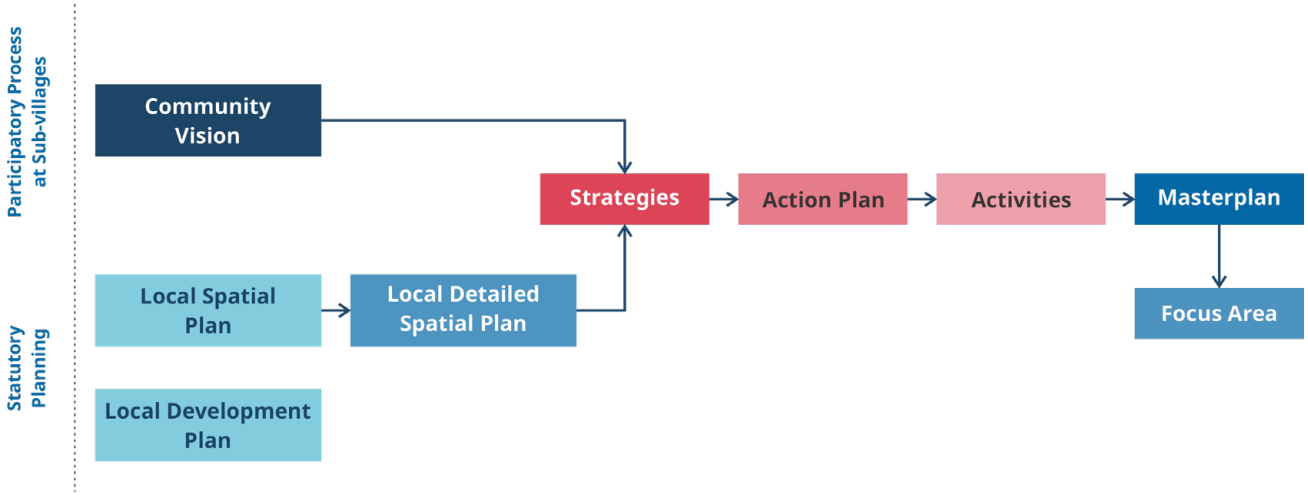
Chapter 5
Master Plan and Exemplary Focus Area

5.1. Masterplan Livable and Harmonious Peri-urban Community at Rejodani

Master planning is about making the connection between buildings, social settings, and their surrounding environments (Amirtahmasebi, et. al., 2016). This process incorporates design elements such as land use, infrastructure, and environmental considerations—in this case, including NbS implementations. Crucially, master plans play a pivotal role in guiding communities as they make decisions regarding land use development and preservation, as well as infrastructure planning.

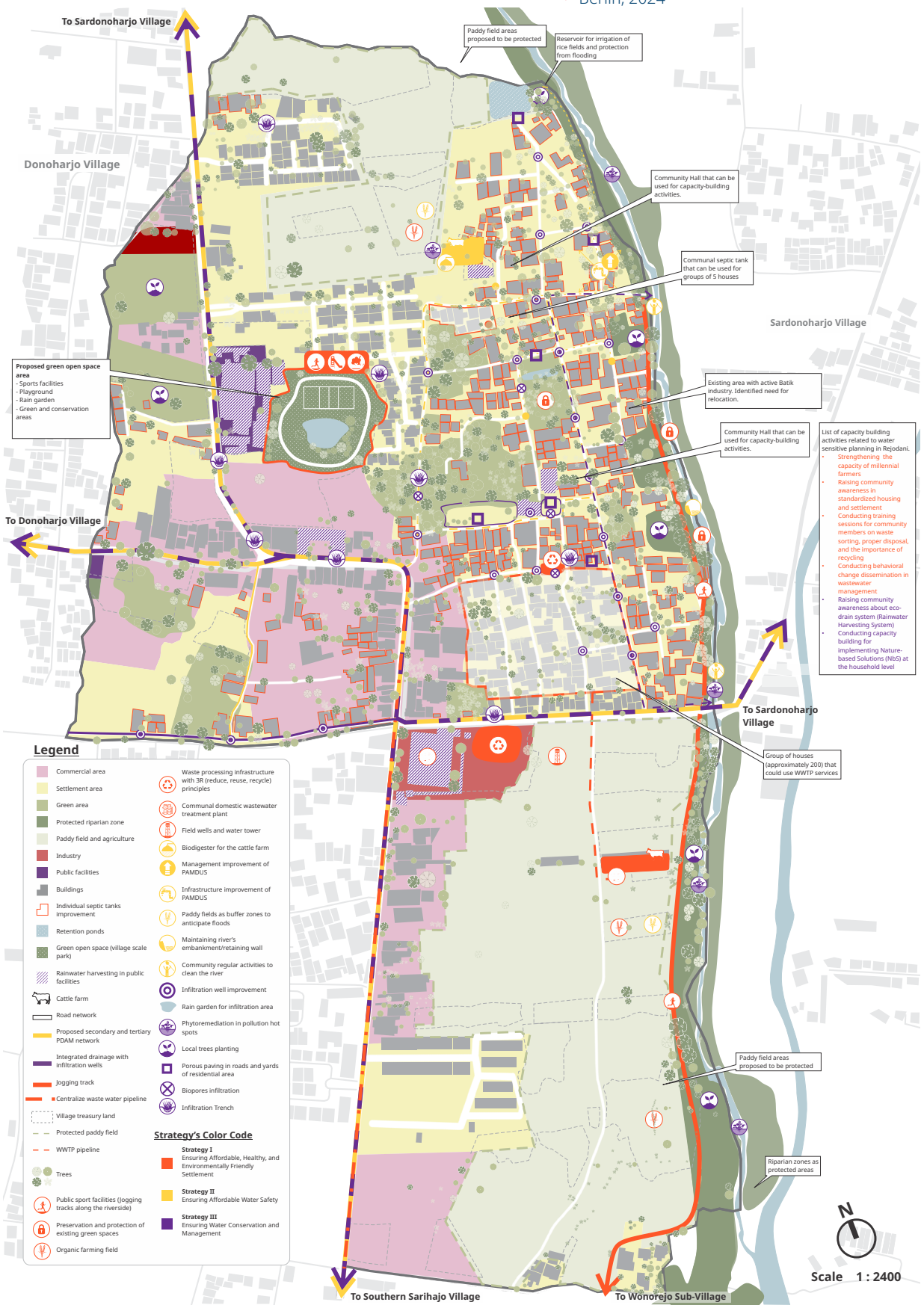
Figure 5.1 shows how participatory processes in developing community vision and statutory planning create masterplan and its correlation with strategies, action plans, and focus areas.

Figure 5.1 Comprehensive Plan Towards a Water-Sensitive Community in the Peri-Urban Area of Rejodani
Source: PolyUrbanWaters Team, 2024



The masterplan in this document is the realization of action plans, which includes the community's vision and government plans, in the spatial dimension. The spatial distribution of the action plans would help the community and other stakeholders to understand their commitments in a more real picture. Indeed, not all action plans can be put in the form of maps or spatial information because only physical projects or actions can be identified clearly in the locations. Figure 5.2 is the masterplan map which shows the spatial distribution of action plans.

Figure 5.2 Master Plan of Livable and Harmonious Peri-urban Community
Source: Kota Kita and Habitat Unit TU Berlin, 2024



The masterplan depicts the integration of proposed action plans with the identified existing assets in the pilot site. It displays the spatial distribution of action plans, coded in three different colors to represent each strategy. Spatial action plans, for example clean water pipeline expansion and waste bank construction, are displayed to show the exact location of the development or construction. Non-spatial action plans, such as training, information dissemination, and capacity building, are listed by the location where those actions will be conducted. For example, solid waste management training will be conducted in the community hall, therefore, the community hall is indicated on the map.

Masterplan of Blue and Green Infrastructure in Rejodani

The preservation and improvement of blue-green infrastructure is an integral part of water-sensitive urban development. The spatially planned blue-green infrastructure enhances the connectivity of urban habitats, benefits biodiversity, and acts as climate mitigation and flood control. The blue-green infrastructure master plan integrates the existing blue and green assets in Rejodani with new elements of BGI.

Area with high green connectivity is the vegetated riparian area of Boyong river in the east side of Rejodani. A village-scale park will serve as a core green space. The greening involves tree planting in several village vacant areas and building plots. It attempts to optimize the availability of identified vacant land that has potential for tree planting. The potentially private area includes residential, commercial, and public building plots. Tree planting on TKD vacant land is also reinforced to restore the land and prevent built-up development. Additionally, provision of vegetation in the roadside will reduce near-road air pollution, aid infiltration, and act as a noise barrier.

The blue infrastructure development focuses on enhancing the river ecosystem, sustainable urban drainage systems (SUDS), and reservoir development. Improvement of river ecosystems by preventing direct discharge of solid waste and wastewater that can harm the water bodies. In addition, Boyong River also serves as a reservoir for Merapi cold lava flow, with the improvement of the river embankment will optimize the function of the river body as a cold lava channel. Apart from providing ecosystem service, it will be functioning as shared space for the community in the form of a jogging track along the riverside. SUDS as blue-green drainage infrastructure will design the pilot site like a sponge which allows stormwater infiltration and purification. This consequently revitalizes the water bodies by reducing pollutants from the land.

Figure 5.3 Master Plan of Blue and Green Infrastructure in Rejodani
Source: Kota Kita and Habitat Unit TU Berlin, 2024

5.2. Focus Area

To illustrate the master plan's implementation, design illustrations are provided for four focus areas, each supported by a design model in a pilot area. These visuals offer a detailed view of how the masterplan's strategies will be applied on the ground. These four focus areas are:

1. Settlement area
2. Green open space
3. Road network
4. Agriculture area

Focus Area 1: Improving Settlement Area

Improving the settlement here refers particularly to two existing settlements which used to be rural village types, but are now transforming into more modern and dense settlements due to the increasing population in this area. The focus of the improvement would be adding more housing while keeping the maximum building density of 60%, more open spaces for water infiltration, more greeneries, better wastewater treatment, and healthy housing. The improvement of the existing settlements supports the actualization of Strategy 1 and Strategy 3 that consists of some action plans such as the implementation of housing and settlement standards, provision of water infrastructure, implementation of pavement with porous material, and decreasing surface runoff.

a. Providing water infrastructure network

The development of the water infrastructure network focuses on the infrastructure for water supply, wastewater, and stormwater. The expansion of the water pipeline network from PDAM will ensure access to safe water supply in Rejodani. The wastewater pipeline facilitates the wastewater treatment into the WWTP, which previously was discharged into the drainage channel untreated. Sustainable drainage system manages stormwater and preserves water resources. Infiltration wells, drainage channels, and the preservation or provision of green areas aim to reduce runoff and maintain or increase infiltration areas.

b. Enhancing the quality of blue and green infrastructure (Riverbank)

Located along the riverbank of the Boyong River, Rejodani has about 2 kilometers of riverbank on the east side. The existing condition of this riverbank is not properly designed and optimally used. The focus on the riverbank is to emphasize the importance of the connections and links between blue and green infrastructure. The initiation will enhance the existing riverbank to be an attractive jogging track and green network. Improving riparian biodiversity through local tree planting helps to protect and restore the river ecosystem. This focus area supports the actualization of Strategy 3 specifically in the action plan preserving and restoring green space.

c. Fostering action at household level

Action at household level is expected to lead to the improvement of the settlement in Rejodani. This will contribute to localized impact and behavioral change of the community. The action plan involves

implementing a green system by planting vegetation and trees at each household and installing green walls. Additionally, it aims to preserve infiltration areas by using green or permeable pavement, such as grass blocks, and incorporating biopore infiltration holes. The implementation of rain water harvesting is also encouraged to store stormwater and maintain water supply. Furthermore, the plan focuses on managing adequate sanitation by improving individual septic tanks.

Figure 5.4. Conceptual Illustration in Improving Settlement Area for Neighborhood Scale
Source: Kota Kita, 2024

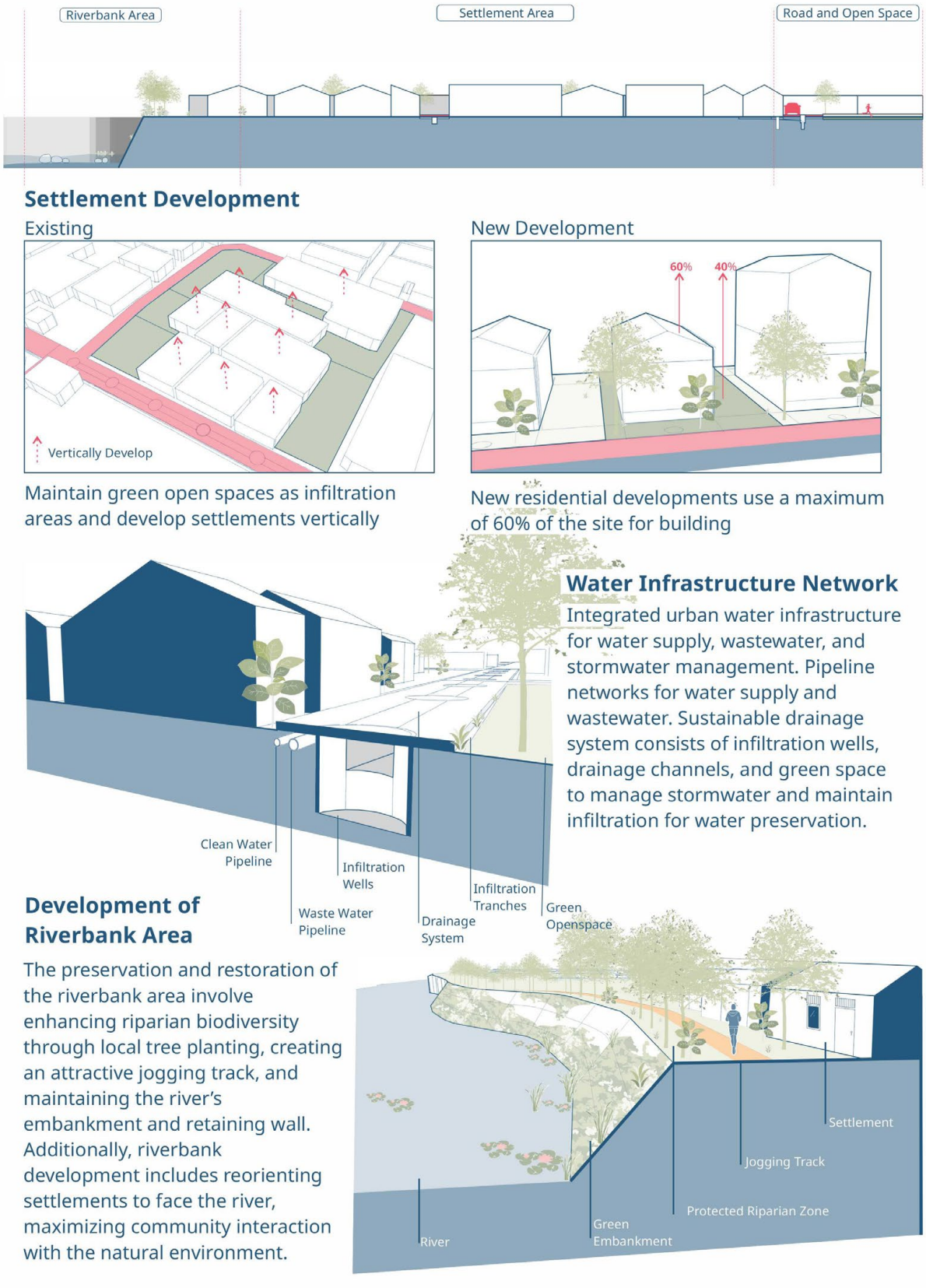


Figure 5.5. Conceptual Illustration in Improving Settlement Area for Household Scale
Source: Kota Kita, 2024

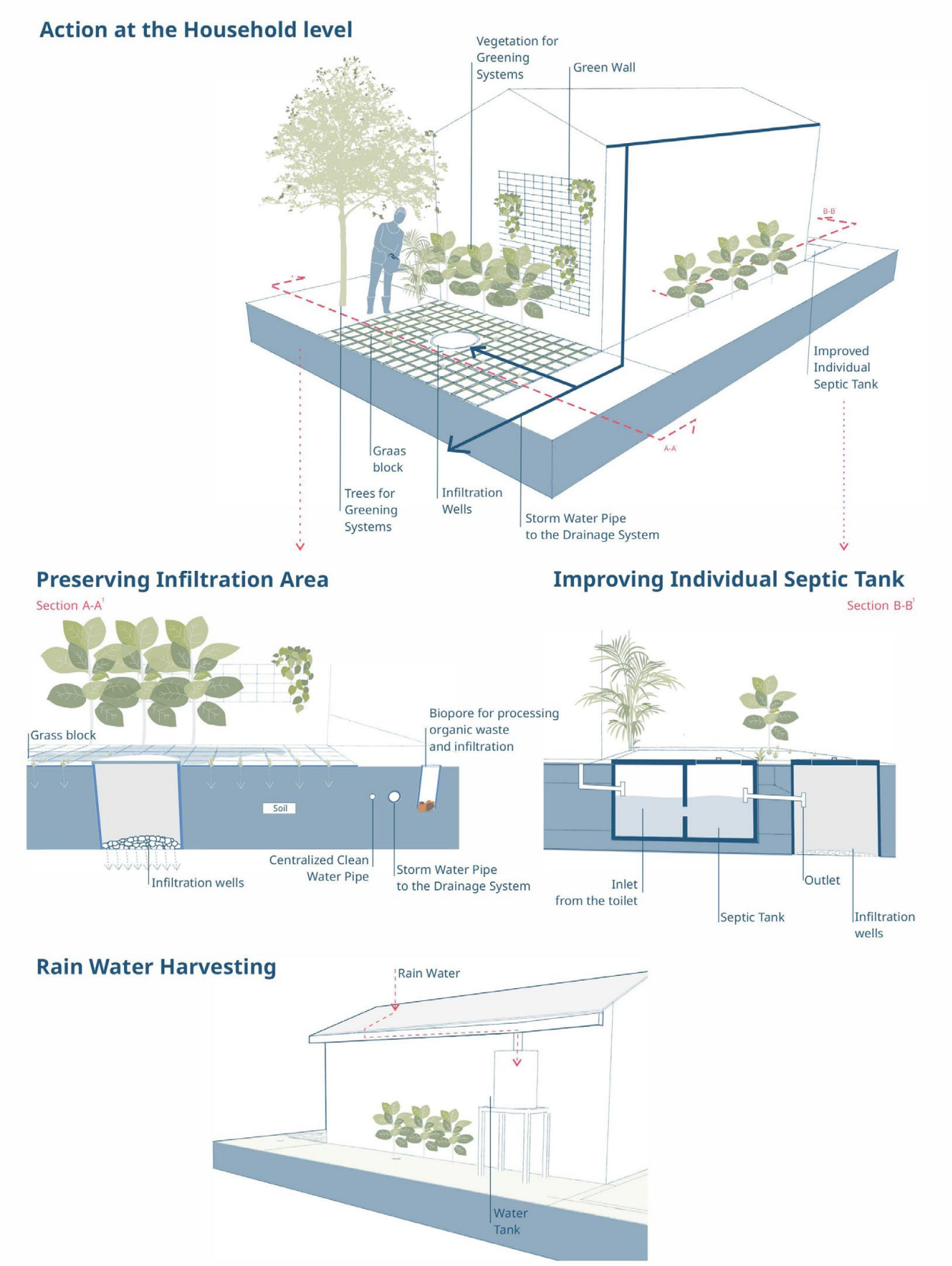


Figure 5.6 Conceptual Illustration in Providing Inclusive Green Open Space
Source: Kota Kita, 2024

Existing condition

Exemplary Illustration

Figure 5.7. Illustration of the community waste bank implementing 3R practices and the improvement of community-based water supply (Pamdus) with a water reservoir, filtration system, and safe piping to prevent water loss and contamination
Source: Habitat Unit TU Berlin, 2024

Existing condition

Exemplary Illustration

Focus Area 2: Providing Inclusive Green Open Space

This project stems from the lack of 'permanent' open and green space for the community to play, to mingle, and to do physical activities. The current public space is situated on private land that may be reclaimed at any time. Moreover, the design and management of this space are suboptimal, resulting in low utilization and satisfaction. The community desires a new public space that is not only secure but also accessible to everyone, owned by the village, and planned according to water-sensitive principles. The provision of green open space supports the actualization of Strategy 1. The development of the green open space is also supported by the government program in the Central Sleman's detailed spatial plan which mentions the provision of village-scale park. The designated area for village park has an area of 1.36 hectares, located in Rejodani 1.

The development will serve as a space for social and recreational activities, and also function as ecosystem services. The park serves as an ecosystem services for urban cooling, habitat biodiversity, and mitigating flooding. The park design supports stormwater management by applying a detention pond, infiltration trench, and porous pavement. The social and recreational function consists of a playground, jogging track, community space, and multifunctional field.

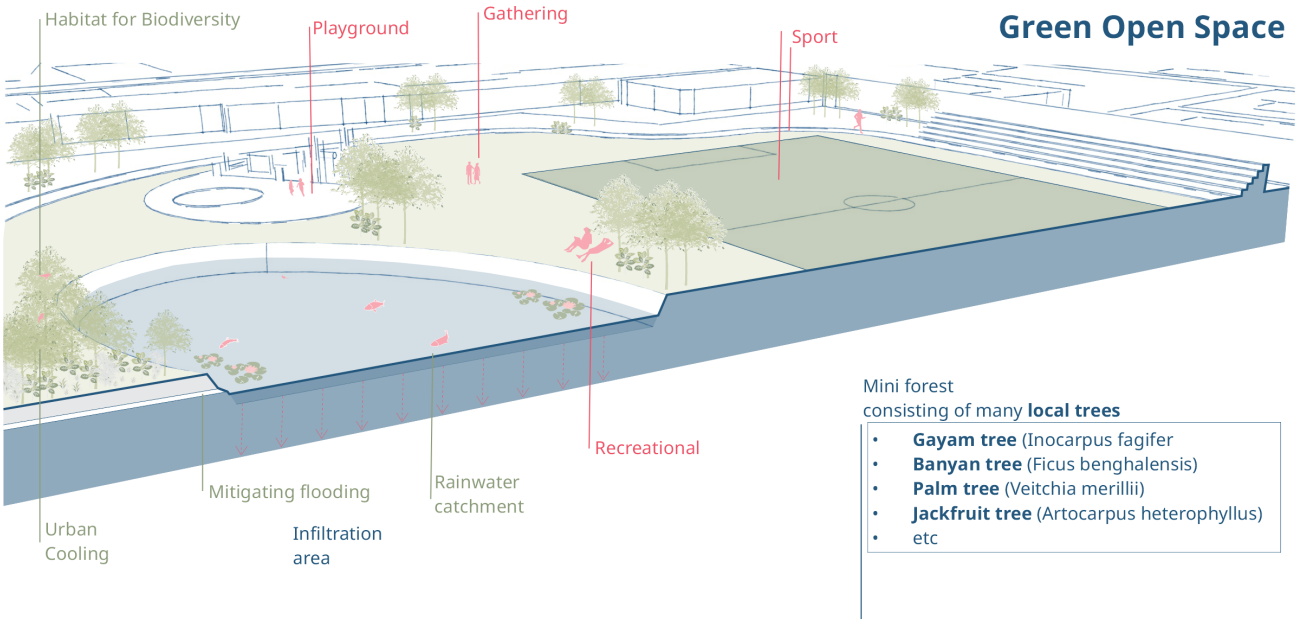
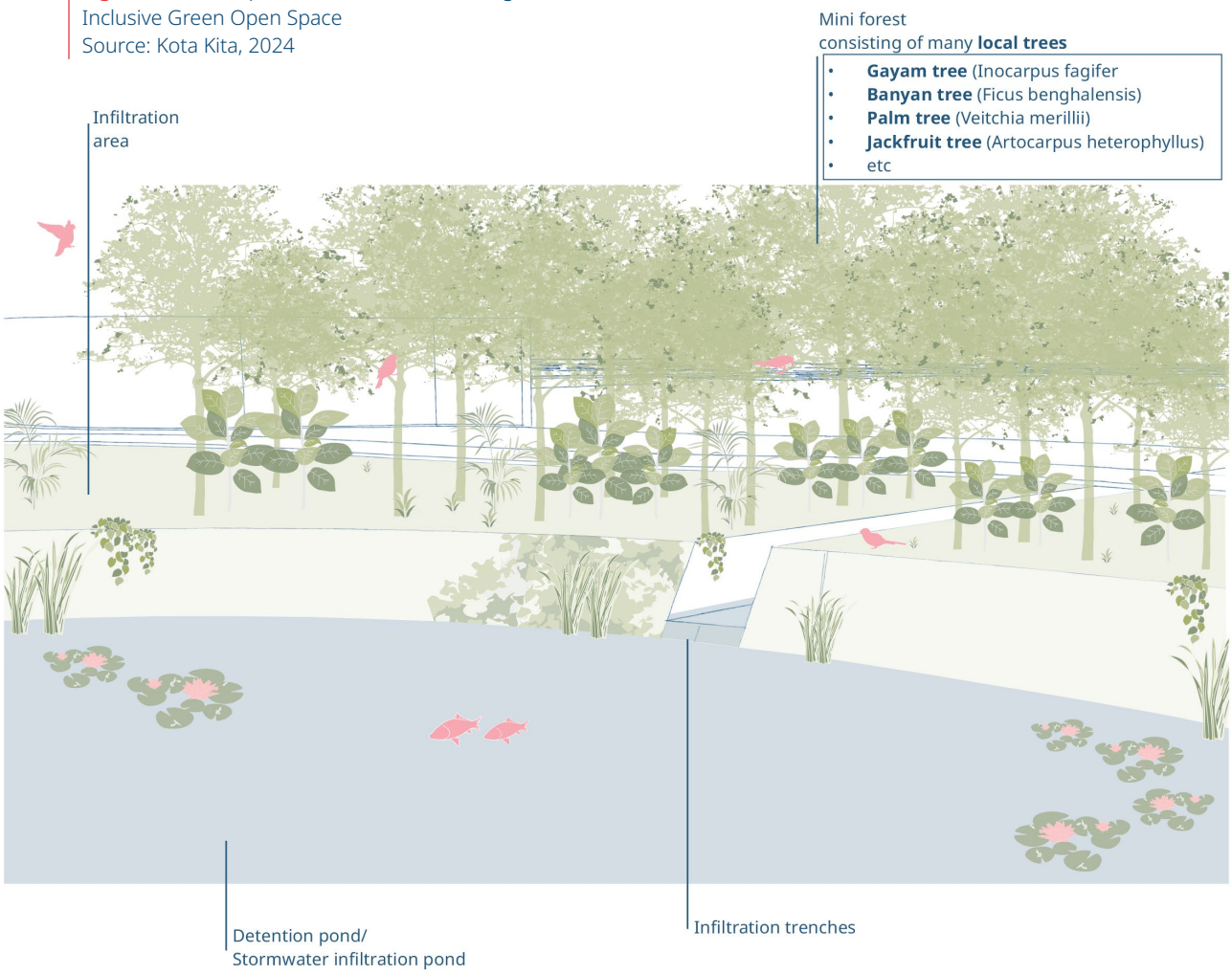


Figure 5.8. Conceptual Illustration in Providing Inclusive Green Open Space
Source: Kota Kita, 2024



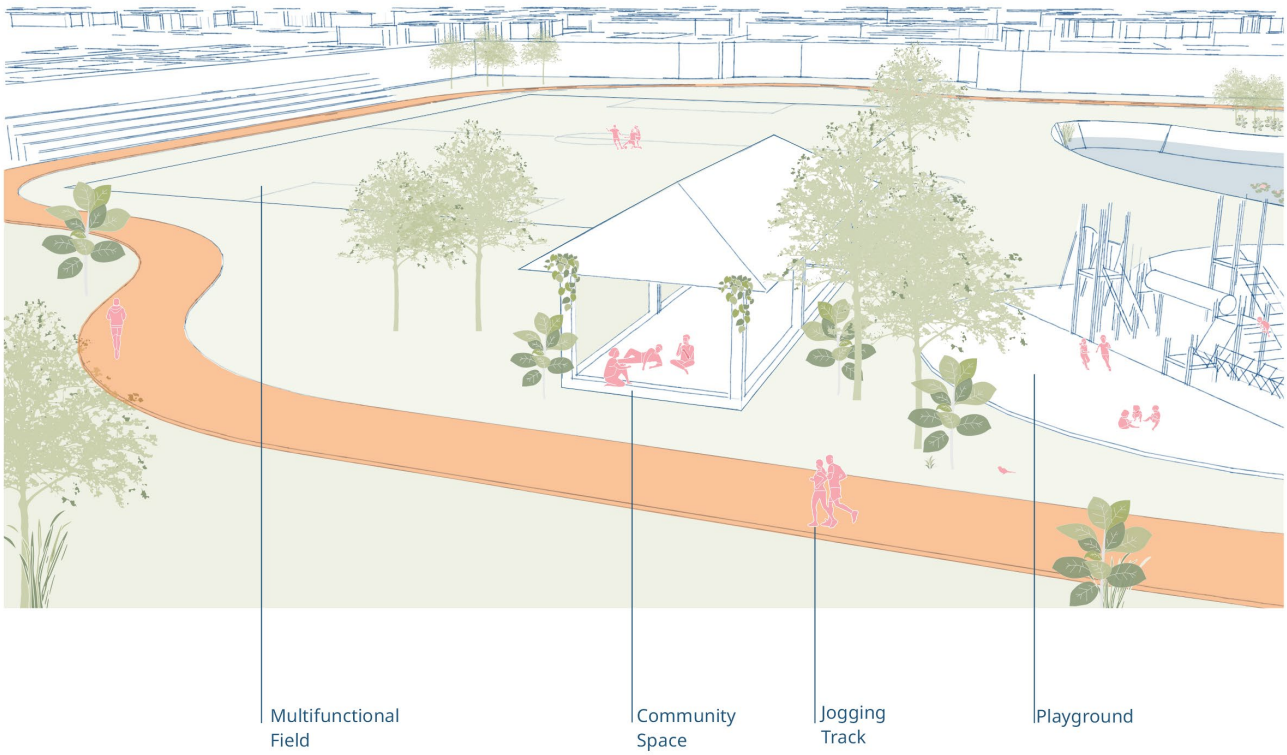


Figure 5.9. Illustration of the green open space highlighting its potential for development into a more functional, community-serving area
Source: Habitat Unit TU Berlin, 2024

Existing condition

Illustration

Figure 5.10. Illustration of the utilization of the riverbank as a jogging track to enhance community well-being
Source: Habitat Unit TU Berlin, 2024

Existing condition

Illustration

Focus Area 3: Promoting water-sensitive road networks

Urban growth drives the need for expanded and improved road networks to handle increased traffic, land use changes, and economic activities. This growth and road expansion can strain water management systems by increasing runoff from impervious surfaces, leading to flooding and pollution. The development alters natural water flows and can overwhelm drainage infrastructure. While the road network is a critical component of stormwater management, as economic activities and population grow, road networks tend to be widened to accommodate the needs of economic and human activities. As a result, the amount of hard surface increases, reducing drainage capacity to store water and resulting in increased runoff. This runoff often carries and deposits harmful pollutants such as trash, chemicals, materials, and dirt/sediment into the waterway or water bodies.

To address these challenges, water-sensitive road design becomes essential, as it incorporates features of green infrastructure to manage runoff, reduce pollution, and mitigate the impacts of urbanization. This design is expected to improve the quality of stormwater before it enters waterways or water bodies and helps enhance water infiltration. Additionally, in settlement planning, roads are one of the essential infrastructures that must be provided. Implementing water-sensitive road design will also enhance the quality of the settlements.

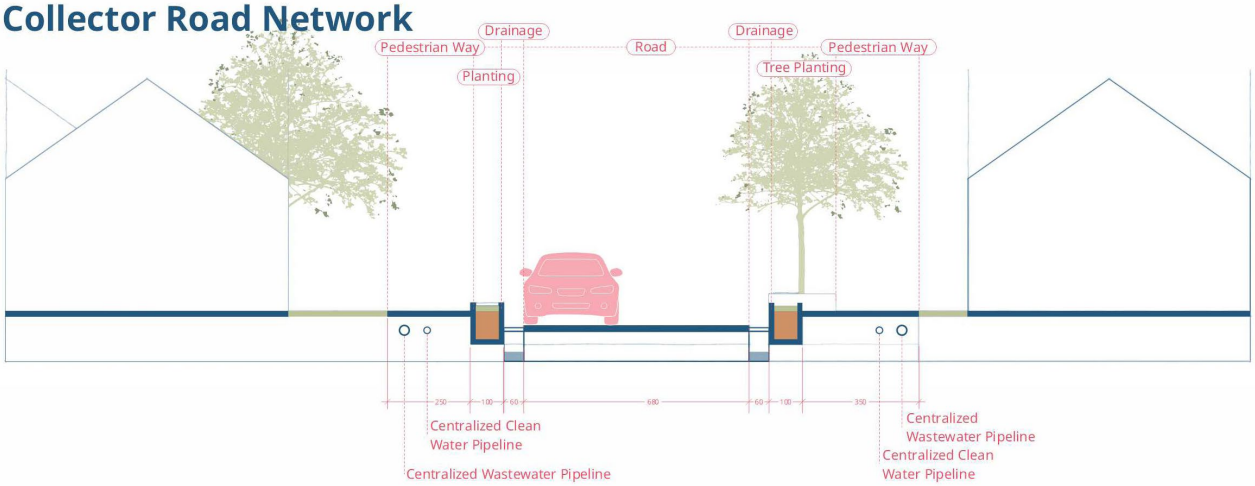
There are three road hierarchies in Rejodani: collector, local, and neighborhood road networks. Each road has its function and characteristics regarding its existing construction.

- Collector road: The Palagan road, with provincial road status, connects the inter-city economic centers and is used by many large vehicles.
- Local Road: with its status as regency road, it connects local activity centers and serves as a strategic district road.
- Neighborhood road: characterized by short-distance and low-speed travel, these roads are widely used to accommodate the community's daily activities as they are located within settlements.

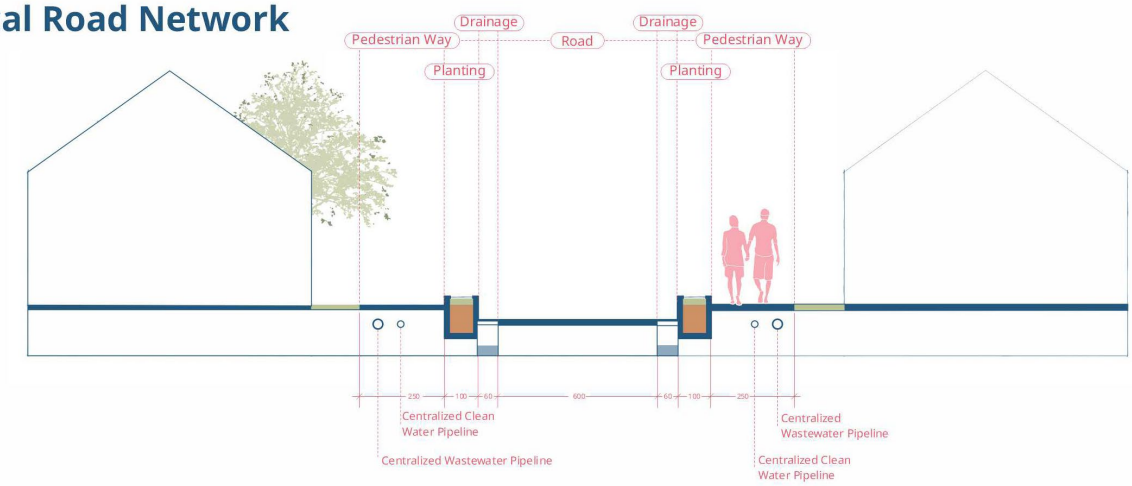
This project area is part of Strategy 3 and consists of several action plans, such as implementing pavement with porous material (especially in village/neighborhood roads), developing a sustainable drainage system, and reducing surface runoff. The components to support the implementation of water-sensitive roads include adding more trees and vegetation along the roadways, installing infiltration wells for sustainable urban drainage systems (SUDS), and creating pedestrian lanes for more walkable settlements.

Figure 5.12. Conceptual Illustration in Promoting water-sensitive road networks based on three road classification
Source: Kota Kita, 2024

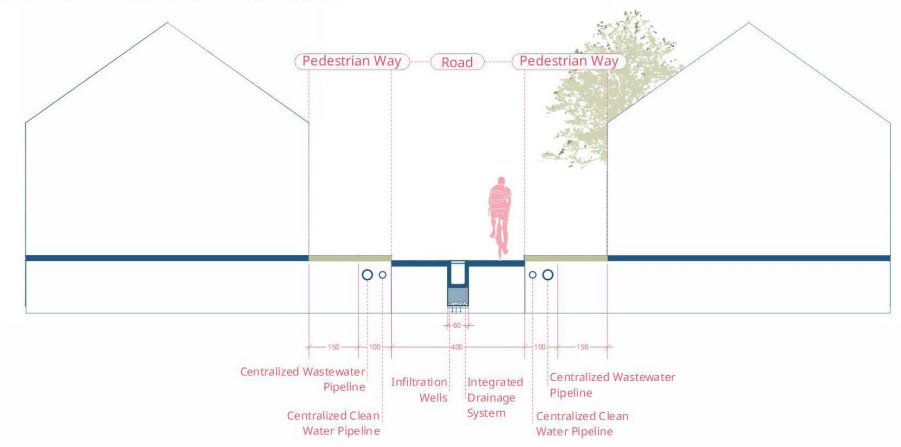
Collector Road Network

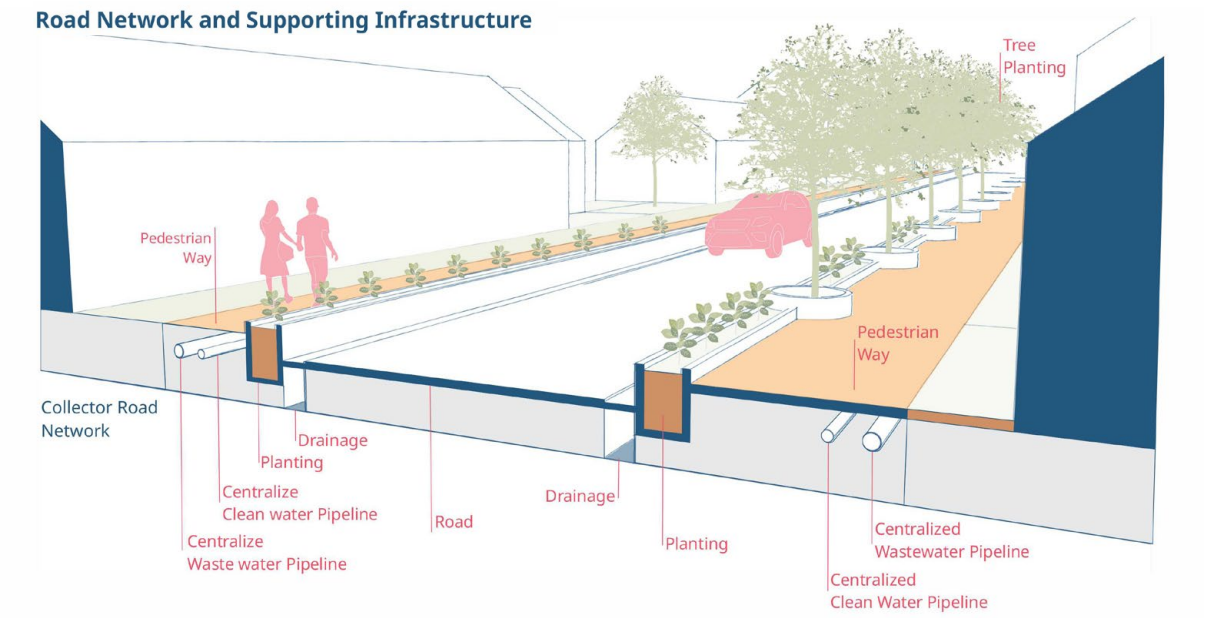


Local Road Network



Neighborhood Road Network





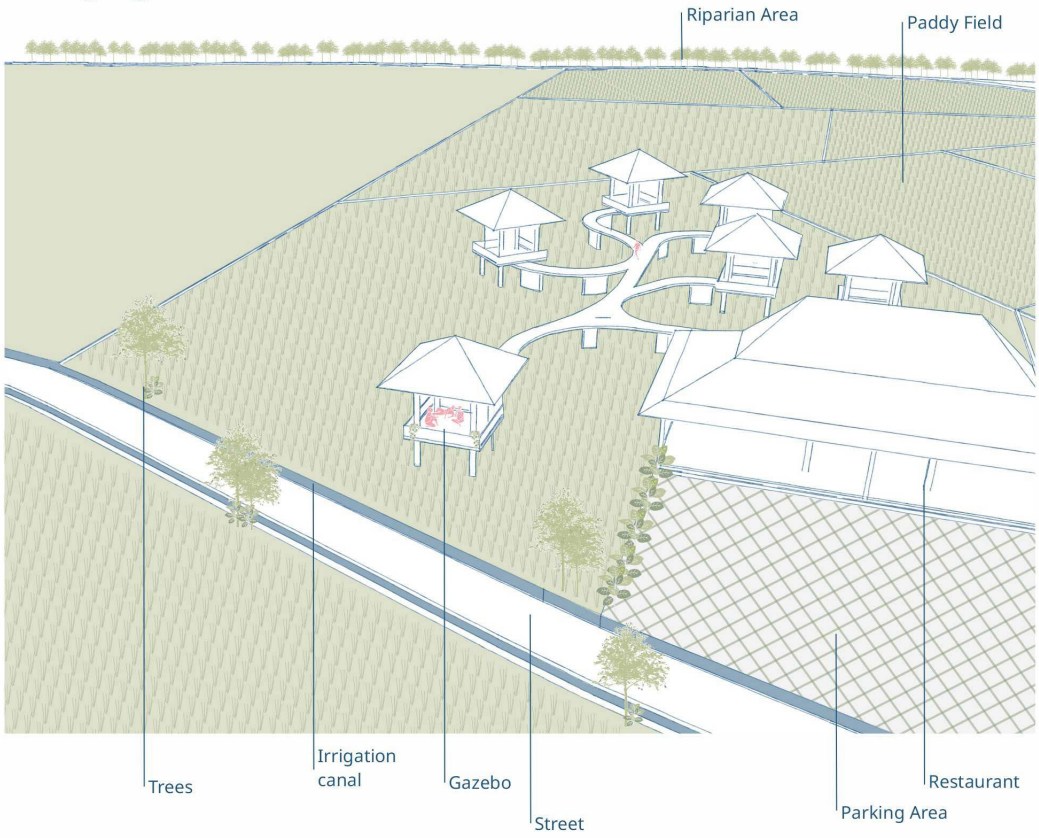
Focus Area 4: Preserving Agriculture Area

Rice fields in Village Treasury Land of Rejodani was selected as one of a focus area because they are viewed as an effective means to decelerate land conversion from agriculture areas to built-up areas. The accelerated land conversion in Sariharjo Village is shown from the decrease in rice fields, which declined from 276.59 hectares in 2010 to 250.95 hectares in 2015 (9.27% decrease), and further to 190.28 hectares in 2020 (21% decrease). In the Rejodani areas, current agricultural land covers 30.72 hectares. The target in vision building, as also outlined in the Sleman Zoning Regulation, is to preserve at least 27.75 hectares of agricultural land. With regard to the pace of land conversion at the village level, a similar situation is expected to happen at sub-villages level as well. Therefore, it is necessary to preserve rice fields in the Village Treasury Land to decelerate land conversion. Controlling land use change becomes important because land use conversion from non-built-up to built-up causes the declining of the land capacity in absorbing water and declining of infiltration capacity (Utaya, 2008).

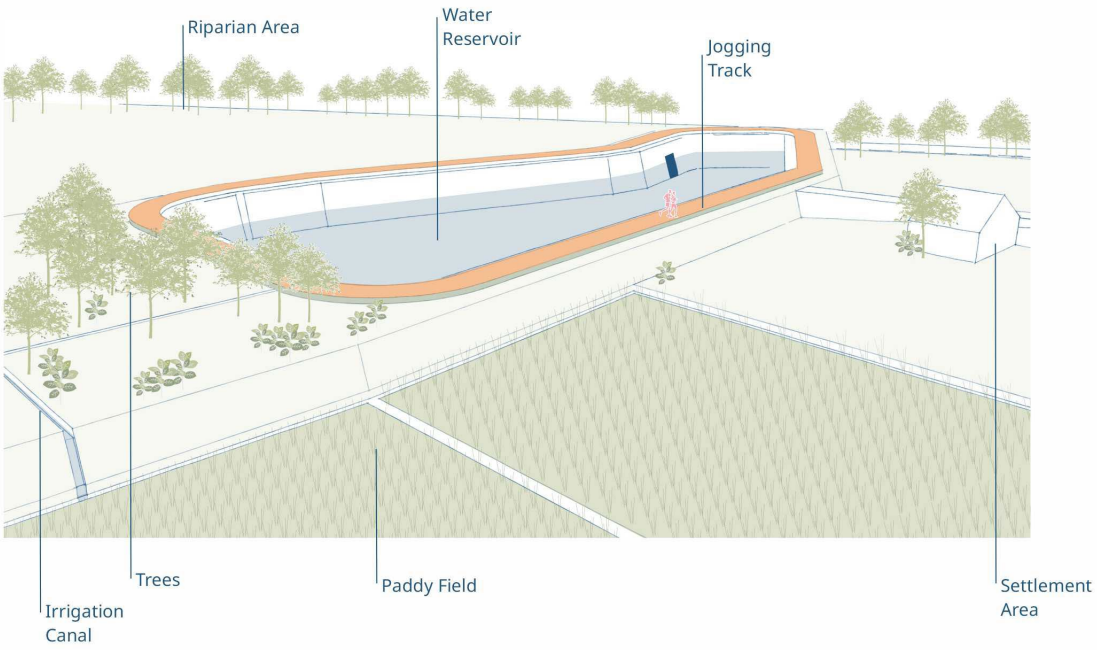
The incorporation of tourism or recreational functions in the rice field at Village Treasury Land is a proposed action plan in Strategy 1. The recreational element aims to provide an additional source of income for the farmers, while at the same time maintaining rice fields as food production. This shows that rice fields could double as recreational areas. Village Treasury Land has a stronger position than privately owned land to remain as agricultural land. Promoting agritourism in Village Treasury Land has a better chance to sustain rice fields with support from Village Government. The reservoir is part of the green and blue infrastructure which significantly contributes to more water-sensitive settlement. It could reduce runoff as well as serve as a water reservoir for irrigation resources. This reservoir is agreed to be built in the north part of the settlement, using village treasury land. The construction of reservoir in the northern part of Rejodani Sub-villages support the actualization of Strategy 2 specifically in provisioning water reservoirs for agriculture.

Figure 5.13. Conceptual Illustration in Preserving Agriculture Area
Source: Kota Kita, 2024

Preserving Agricultural Areas



Combining agricultural land with tourism without changing land use functions. Tourism facilities will be managed by farmer groups and from there they will get additional income.



Build water reservoirs to ensure water availability for agricultural land and channel it through irrigation canals. Water reservoirs also function as rainwater catchment and help control floods

To address waste issues, the community initiated a waste bank. Its activities include waste sorting, processing, and raising awareness among community. This image highlights one of the efforts to reduce plastic bag waste.

Chapter 6
Further Commitments

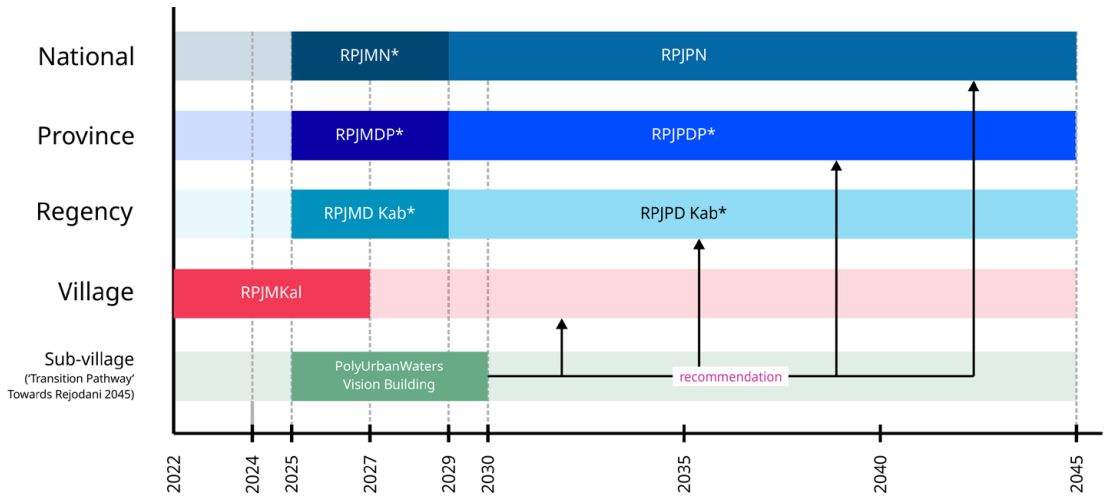
6.1. Transition Pathway

This transition pathway also means an important phase, from 2025 to 2030, in which the sub-villages of Rejodani I and II should be ready for a longer and better future, at least until 2045—a golden momentum for Indonesia to celebrate its 100 years of independence. This transition pathway, however, should be continued by all stakeholders' involvement and commitments to help people in Rejodani I and II. It is, therefore, very important to ensure the integration of this vision building document with other formal/legal development planning documents at the village and regency levels.

Figure 6.1 shows such integration, in which the vision building document prepared through this PolyUrbanWaters project is then linked or integrated into several 'statutory' planning documents. The first one is linked to the already ongoing Sariharjo Village Development Plan 2022-2027 (RPJMKal Sariharjo 2022-2027). Second, it linked to the Sleman Regency Medium-term Development Planning 2025-2029 (RPJMD Kabupaten Sleman 2025-2029) and Sleman Regency Long-term Development Planning 2025-2045 (RPJPD Kabupaten Sleman 2030-2045). Further, the link could be also extended to the RPJMD and RPJPD at the province and even national levels because they are also in the process of preparing those documents to be legally binding in 2025. On the other hand, actions at the local level should also be in-line with the development targets which are stated at the national level down to the regency and village level.

Figure 6.1 Position of Vision Building in Development Planning Cycle

Source: PolyUrbanWaters Team, 2024



Notes:

- RPJPN: National Long-Term Development Plan
- RPJMN: National Medium-Term Development Plan
- RPJPDP: Yogyakarta Province Long-Term Development Plan
- RPJMDP: Yogyakarta Province Medium-Term Development Plan
- RPJPD Kab: Sleman Regency Long-Term Development Plan
- RPJMD Kab: Sleman Regency Medium-Term Development Plan
- RPJMKal: Sariharjo Village Development Plan

*These documents will serve as the new development plans for each respective planning scale

The Vision Building as well as strategies in this document is actually also a list of commitments from both the sub-village communities as well as other stakeholders. This document could be therefore called a 'Commitment Documents' in which all stakeholders, through participatory process and consensus building, had agreed to develop strategies and a set of actions to realize their vision. It is therefore important to ensure that commitments would be further there, implemented, and monitored. This section provides Lists of Commitments of each stakeholder which can be used by each stakeholder to plan and implement their actions in the next seven years.

6.2. Stakeholder's Commitments

6.2.1. Commitments at Community Level

At the community, residents of Rejodani 1 and 2 already have an agreement to implement strategies consisting of several action plans that they think are very significant in realizing their vision. As can be seen in Table 6.1, there are at least 21 commitments that they are going to make from 2023 to 2030. In 2023, they implemented building six water retention ponds to reduce run-off in the area.

Table 6.1 Commitments at Community Level

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
Strategy 1: Ensuring Affordable, Healthy, and Environmentally Friendly Settlement					
1	Conducting monitoring and evaluation on the implementation of Central Sleman's Detailed Spatial Plan (RDTR) by involving community participation	1-2 times/year	Per regulations at the time	APBD K	2025-2030
2	Implementing green open space regulations in new residential areas	Year-round	Per regulations at the time	APBD K	2025-2030
3	Encouraging organic farming for sustainable farming by organizing trainings	1-2 times/year	85,000,000	APBD K, APBD Kal, Community	2027-2030
4	Promoting composting practice at each household	Year-round	1,305,100/unit	Community	2025-2030
5	Developing institutional networks and cooperation in solid waste management	1 unit	15,000,000.00	APBD K, APBD Kal, Community	2025-2030
6	Developing system for community-based solid waste management and sorting	1 time	Per regulations at the time	APBD K, APBD Kal, Community	2025-2030
7	Conducting monitoring and evaluation on solid waste management	1-2 times/year	Per regulations at the time	APBD K, APBD Kal, Community	2025-2030
8	Constructing a waste bank with the integration of a chicken coop for organic waste	1 unit	150,000,000	APBD K	2026
9	Developing TPS3R (Solid Waste Treatment Site with 3R principles)	1 unit	600,000,000	APBD K, APBD Kal, Community	2027-2028

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
10	Improving individual septic tank	2.3%/year	7,000,000/unit	APBD Kal	2025-2030
Strategy 2: Ensuring Affordable Water Safety					
11	Establishing PAMDUS institution legally and formally	1 unit	10,000,000	APBD Kal	2025-2026
12	Management training for PAMDUS institutional members	1-2 times/year	10,000,000/session	APBD Kal	2025-2030
13	Installing water treatment in the PAMDUS water storage	1 unit	150,000,000	APBD K	2028
14	Maintaining the cleanliness of the PAMDUS water reservoir	1 time/month	2,782,012/month	APBD Kal	2025-2030
15	Installing single pipeline from PAMDUS reservoir to reticulation system of the house connection	491 m	500,000,000	APBD Kal	2027-2028
16	Scheduling river cleaning by the community	1-2 times/year	Per regulations at the time	Community	2025-2030
17	Implementing green walls at public buildings and residential areas	Year-round	Per regulations at the time	Community, Private	2025-2030
Strategy 3: Ensuring Water Conservation and Management					
18	Implementing rainwater harvesting	Year-round	500,000/unit	Community	2025-2030
19	Building infiltration trench at residential area	Each house	5,000,000	Community	2027-2030
20	Using paddy field as a buffer zone to anticipate flood	Seasonal, during rainy season	Per regulations at the time	APBD K	2025-2030
21	Implementing biopores infiltration holes	Each house	125,000/unit	APBD K, APBD Kal, Community	2025-2030

***in-kind contribution*

6.2.2. Commitments at Village Level

At the village level, several commitments have also already been agreed upon by community leaders as well as the head of Sariharjo village. This commitment is part of their efforts in realizing their vision of "Ensuring Water for the Next Generation" - a slogan the communities declared in 2022. As seen in Table 6.2., there are at least 24 commitments by the village of Sariharjo in supporting Rejodani I and II to realize their vision.

Table 6.2 Commitments at Village Level

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
Strategy 1: Ensuring Affordable, Healthy, and Environmentally Friendly Settlement					
1	Improving irrigation infrastructure	321 m	485,352,000	APBD K	2028
2	Building agriculture water reservoir	1 unit	Per regulations at the time	APBD K	2025

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
3	Building water tower storage	1 unit	Per regulations at the time	APBD K, APBD Kal	2026
4	Encouraging organic farming for sustainable farming by organizing trainings	1-2 times/year	85,000,000	APBD K, APBD Kal, Community	2027-2030
5	Developing TPS3R (Solid Waste Treatment Site with 3R principles)	1 unit	600,000,000	APBD K, APBD Kal, Community	2027-2028
6	Building a wastewater treatment plant for Rejodani Market	1 unit	80,000,000	APBD K, APBD Kal	2025-2026
7	Testing effluent water from Rejodani Market	1-2 times/year	630,000/sample	Private Sector	2027-2030
Strategy 2: Ensuring Affordable Water Safety					
8	Establishing PAMDUS institution legally and formally	1 unit	10,000,000	APBD Kal	2025-2026
9	Management training for PAMDUS institutional members	1-2 times/year	10,000,000/session	APBD Kal	2025-2030
10	Maintaining the cleanliness of the PAMDUS water reservoir	1 time/month	2,782,012/month	APBD Kal	2025-2030
11	Installing single pipeline from PAMDUS reservoir to reticulation system of the house connection	491 m	500,000,000	APBD Kal	2027-2028
12	Scheduling river cleaning by the community	1-2 times/year	Per regulations at the time	Community	2025-2030
Strategy 3: Ensuring Water Conservation and Management					
13	Raising community awareness about sustainable drainage system	1-2 times/year	Per regulations at the time	APBD K	2025-2030
14	Integrating drainage with infiltration well	53 infiltration wells	530,000,000	APBD K	2025-2030
15	Improving existing drainage system according to regulations	332 meters	332,000,000	APBD K	2025-2030
16	Building infiltration trench at residential area	Each house	5,000,000	Community	2027-2030
17	Applying bioswale at regency road and village road	1,288 km	250,000,000	APBD K	2027-2030
18	Implementing rain garden for infiltration area	At each public green open space	Per regulations at the time	APBD K, APBD Kal	2025-2030
19	Implementing biopores infiltration holes	Each house	125,000/unit	APBD K, APBD Kal, Community	2025-2030
20	Applying biofilters into pollution hotspots	19 hotspots	Per regulations at the time	APBD K	2025-2030

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
21	Applying phytoremediation to pollution hotspots	19 hotspots	15,000,000	APBD K	2025-2030
22	Improving riparian biodiversity with local tree planting: gayam tree (Inocarpus fagifer) and fruit tree	100 trees in 2 km	60,000/sapling	APBD K, APBD Kal, Community	2025-2030
23	Planting trees in each land plots sub-village areas (fruit tree)	Minimum 1 tree each house	60,000/sapling	APBD K, APBD Kal, Community	2025-2030
24	Implementing water-permeable pavement in roads, yards of residential areas, and commercial areas	Year-round	140,000 m2	APBD Kal, Private Sector, Community	2025-2030

6.2.3. Commitments at Sub-district Level

Table 6.3 Commitments at Sub-district Level

No	Activities	Freq/Vol	Budget Estimation (IDR)	Funding Opportunities	Implementation Year
Strategy 1: Ensuring Affordable, Healthy, and Environmentally Friendly Settlement					
1	Conducting information dissemination on the implementation of Central Sleman's Detailed Spatial Plan (RDTR)	1-2 times/year	25,000,000	APBD K	2025

6.2.4. Commitments at Regency Level

At the regency level, several departments have already committed to actions specifically directed to Rejodani I and II. As documented from the third FGD conducted on October 19, 2023, several agencies under the Sleman regency had proposed several action plans to help Rejodani I and II realize their vision (see the Table 6.4.).

Table 6.4 Commitments at Regency Level

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
Strategy 1: Ensuring Affordable, Healthy, and Environmentally Friendly Settlement					
A	**Department of Land and Spatial Planning**				
1	Conducting information dissemination on the implementation of Central Sleman's Detailed Spatial Plan (RDTR)	1-2 times/year	25,000,000	APBD K	2025
2	Conducting monitoring and evaluation on the implementation of Central Sleman's Detailed Spatial Plan (RDTR) by involving community participation	1-2 times/year	Per regulations at the time	APBD K	2025-2030

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
3	Implementing green open space regulations in new residential areas	Year-round	Per regulations at the time	APBD K	2025-2030
4	Protecting and regulating land use to prevent conversion in Sustainable Food Agriculture Areas (LP2B)	Year-round	Per regulations at the time	APBD K	2025-2030
B	**Planning Agency**				
1	Conducting information dissemination on the implementation of Central Sleman's Detailed Spatial Plan (RDTR)	1-2 times/year	25,000,000	APBD K	2025
2	Information dissemination for PAMDUS users	1-2 times/year	Per regulations at the time	APBD Kal	2025-2030
C	**Department of Environment**				
1	Building a village scale park	1 unit (1.36 ha)	2,500,000,000	APBD K, Private Sector	2027
2	Implementing green open space regulations in new residential areas	Year-round	Per regulations at the time	APBD K	2025-2030
3	Providing jogging tracks along the riverside	2 km	2,000,000,000	APBD K, APBN	2028-2029
4	Providing green open spaces in the residential areas	Year-round	Per regulations at the time	APBD K, Private Sector	2025-2030
5	Assisting communities with solid waste management and sorting	1-2 times/year	15,413,000/session	APBD K	2025-2030
6	Developing institutional networks and cooperation in solid waste management	1 unit	15,000,000.00	APBD K, APBD Kal, Community	2025-2030
7	Developing system for community-based solid waste management and sorting	1 time	Per regulations at the time	APBD K, APBD Kal, Community	2025-2030
8	Conducting monitoring and evaluation on solid waste management	1-2 times/year	Per regulations at the time	APBD K, APBD Kal, Community	2025-2030
9	Implementing solid waste treatment regulation specifically at household level	Year-round	Per regulations at the time	APBD K	2025-2030
10	Constructing a waste bank with the integration of a chicken coop for organic waste	1 unit	150,000,000	APBD K, APBD Kal	2026

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
11	Conducting regular monitoring and evaluation of waste bank activities	1-2 times/year	Per regulations at the time	APBD K	2025-2030
12	Developing the institutions for waste bank administrators	1 unit	15,000,000	APBD K, Community	2025
13	Developing TPS3R (Solid Waste Treatment Site with 3R principles)	1 unit	600,000,000	APBD K, APBD Kal, Community	2027-2028
14	Conducting information dissemination of environmentally friendly wastewater management	1-2 times/year	Per regulations at the time	APBD K	2025-2030
15	Improving urban wastewater service network at Sewon WWTP system	4.14%/year	1,586,688	APBD K, Private Sector	2025-2030
16	Constructing a communal domestic wastewater treatment plant	1 unit	550,000,000	APBD K	2025-2030
17	Assisting wastewater management for commercial activities, business, premises, and public services	1-2 times/year	Per regulations at the time	APBD K	2025-2030
18	Monitoring and evaluation of commercial activities, business premises, and public services wastewater management	1-2 times/year	581.000/unit	APBD K	2025-2030
D	**Department of Public Works, Housing and Settlement**				
1	Providing jogging tracks along the riverside	2 km	2,000,000,000	APBD K, APBN	2028-2029
2	Building agriculture water reservoir	1 unit	Per regulations at the time	APBD K	2025
3	Providing information services related to livable housing	Year-round	Per regulations at the time	APBD K, Private Sector	2025-2030
4	Consulting/assistance for house planning	Year-round	Per regulations at the time	APBD K, APBN	2025-2030
5	Consulting/assistance during construction	Year-round	Per regulations at the time	APBD K	2025-2030
6	Consulting/supervision during construction, house development and repair	Year-round	Per regulations at the time	APBD K	2025-2030
7	Consulting/assistance in the house management, maintenance, and development	Year-round	Per regulations at the time	APBD K	2025-2030
E	**Department of Agriculture, Food and Fisheries**				
1	Protecting and regulating land use to prevent conversion in Sustainable Food Agriculture Areas (LP2B)	Year-round	Per regulations at the time	APBD K	2025-2030

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
2	Providing incentives to support the protection of LP2B areas	Year-round	Per regulations at the time	APBD K	2025-2030
3	Regenerating agriculture and developing millennial farmers	1 farmer group	Per regulations at the time	APBD P, APBD K	2025-2030
4	Rehabilitating degraded agricultural lands	Year-round	Per regulations at the time	APBD K	2025-2030
5	Establishing institutions for agricultural management	1 unit	15,000,000	APBD K	2025
6	Capacity building in the agricultural sector	1-2 times/year	Per regulations at the time	APBD K	2025-2030
7	Integrating science and technology in agricultural practices	Year-round	Per regulations at the time	APBD K	2025-2030
8	Enhancing land intensification through improved agricultural infrastructures, innovation, and the development of agribusiness-based systems	Minimum 27,75 hectares	Per regulations at the time	APBD K	2025-2030
9	Improving irrigation infrastructure	321 m	485,352,000	APBD K	2027
10	Building agriculture water reservoir	1 unit	Per regulations at the time	APBD K	2025-2026
11	Building water tower storage for agriculture	1 unit	Per regulations at the time	APBD K, APBD Kal	2027-2030
12	Encouraging organic farming for sustainable farming by organizing trainings	1-2 times/year	85,000,000	APBD K, APBD Kal, Community	2027-2030
13	Developing a biodigester and wastewater treatment plant for cattle farms in Rejodani 2	1 unit	30,030,099	APBD K	2025
F	**Department of Investment and One Stop Integrated Services**				
1	Conducting information dissemniation on the implementation of Central Sleman's Detailed Spatial Plan (RDTR)	1-2 times/year	25,000,000	APBD K	2025
2	Providing incentives to support the protection of LP2B areas	Year-round	Per regulations at the time	APBD K	2025-2030
G	**Department of Community and Village Empowerment**				
1	Assisting communities with solid waste management and sorting	1-2 times/year	15,413,000/session	APBD K	2025-2030

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
2	Developing institutional networks and cooperation in solid waste management	1 unit	15,000,000.00	APBD K, APBD Kal, Community	2025-2030
3	Developing system for community-based solid waste management and sorting	1 time	Per regulations at the time	APBD K, APBD Kal, Community	2025-2030
4	Conducting monitoring and evaluation on solid waste management	1-2 times/year	Per regulations at the time	APBD K, APBD Kal, Community	2025-2030
H	**River Basin Organization of Opak River (BBWSO)**				
1	Providing jogging tracks along the riverside	2 km	2,000,000,000	APBD K, APBN	2028-2029
I	**Civil Service Police Unit (Satpol PP)**				
1	Conducting information dissemniation on the implementation of Central Sleman's Detailed Spatial Plan (RDTR)	1-2 times/year	25,000,000	APBD K	2025
J	**Department of Tourism**				
1	Targeting the development of agricultural tourism	Maximum 1000 m2/lot	Per regulations at the time	APBD K, Private Sector	2025-2030
Strategy 2: Ensuring Affordable Water Safety					
A	**Environmental Department**				
1	Conducting regular test and monitor of PAMDUS's water quality	1-2 times/year	618,000/sample	APBD Kal, APBD K	2025-2030
B	**Department of Public Works, Housing and Settlement**				
1	Raising community awareness to use safe water piping network (PDAM)	1-2 times/year	Per regulations at the time	APBD K	2025-2030
2	Building secondary and tertiary PDAM network	219 connections	1,500,000/connection*	APBD K, APBD P	2025-2030
C	**Local Water Company (PDAM)**				
1	Raising community awareness to use safe water piping network (PDAM)	1-2 times/year	Per regulations at the time	APBD K	2025-2030
2	Building secondary and tertiary PDAM network	219 connections	1,500,000/connection*	APBD K, APBD P	2025-2030
3	Proposing program assistance of PDAM connections for underprivileged communities	1-2 times/year	Per regulations at the time	APBD K	2025-2030
D	**Department of Health**				
1	Information dissemination for PAMDUS users	1-2 times/year	Per regulations at the time	APBD Kal	2025-2030
2	Conducting regular test and monitor of PAMDUS's water quality	1-2 times/year	618,000/sample	APBD Kal, APBD K	2025-2030

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
E	**River Basin Organization of Opak River (BBWSO)**				
1	Maintaining river's embankment/retaining wall	2 km	Per regulations at the time	APBD K	2025-2030
F	**Pokja PKP (Housing and Settlement Area Working Group)**				
1	Optimizing existing platform for better communication and information	Year-round	Per regulations at the time	APBD K	2025-2030
G	**Bank Sleman/BPBD DIY**				
1	Proposing program assistance of PDAM connections for underprivileged communities	1-2 times/year	Per regulations at the time	APBD K	2025-2030
Strategy 3: Ensuring Water Conservation and Management					
A	**Environmental Department**				
1	Implementing rain garden for infiltration area	At each public green open space	Per regulations at the time	APBD K, APBD Kal	2025-2030
2	Implementing biopores infiltration holes	Each house	125,000/unit	APBD K, APBD Kal, Community	2025-2030
3	Applying biofilters into pollution hotspots	19 hotspots	Per regulations at the time	APBD K	2025-2030
4	Applying phytoremediation to pollution hotspots	19 hotspots	15,000,000	APBD K	2025-2030
5	Conducting wastewater effluent tests from the home industry	1-2 times/year	630,000/sample	Private Sector	2027-2030
6	Improving riparian biodiversity with local tree planting (gayam tree (Inocarpus fagifer) and fruit tree)	100 trees in 2 km	60,000/sapling	APBD K, APBD Kal, Community	2025-2030
7	Planting trees in each land plots sub-village areas (fruit tree)	Minimum 1 tree each house	60,000/sapling	APBD K, APBD Kal, Community	2025-2030
8	Implementing the regulation of minimum 25% green coverage ratio at the residential zone, where 10% of it should be dedicated as public green open space	Minimum 25% green coverage ratio, 10% dedicated as public space	Per regulations at the time	APBD K, APBN, Private Sector	2025-2030
B	**Department of Public Works, Housing and Settlement**				
1	Raising community awareness about sustainable drainage system	1-2 times/year	Per regulations at the time	APBD K	2025-2030
2	Integrating drainage with infiltration well	53 infiltration wells	530,000,000	APBD K	2025-2030

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
3	Improving existing drainage system according to regulations	332 meters	332,000,000	APBD K	2025-2030
4	Applying bioswale at regency road and village road	1,288 km	250,000,000	APBD K	2027-2030
5	Implementing rain garden for infiltration area	At each public green open space		APBD K, APBD Kal	2025-2030
6	Implementing water-permeable pavement in roads, yards of residential areas, and commercial areas	Year-round	140,000/m^2	APBD Kal, Private Sector, Community	2025-2030
7	Implementing the regulation of minimum 25% green coverage ratio at the residential zone, where 10% of it should be dedicated as public green open space	Minimum 25% green coverage ratio, 10% dedicated as public space	Per regulations at the time	APBD K, APBN, Private Sector	2025-2030
C	**Department of Agriculture, Food and Fisheries**				
1	Using paddy field as a buffer zone to anticipate flood	Seasonal, during rainy season	Per regulations at the time	APBD K	2025-2030
C	**Department of Agriculture, Food and Fisheries**				
1	Using paddy field as a buffer zone to anticipate flood	Seasonal, during rainy season	Per regulations at the time	APBD K	2025-2030

6.2.5. Commitments of Private Sectors

The private sectors in this area have also already agreed to some activities to make the settlement more water-sensitive. In a specific FGD conducted with private sectors operated in these two sub-villages, they are committed to improving their waste treatment or management. They are aware that their existing waste treatments do not guarantee a water sensitive environment or the sustainability of their business. Table 6.5. shows several private sectors already agreeing to some actions.

Table 6.5 Commitments of Private Sector

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
Strategy 1: Ensuring Affordable, Healthy, and Environmentally Friendly Settlement					
1	Building a village scale park	1 unit (1.36 ha)	2,500,000,000	APBD K, Private Sector	2027
2	Implementing green open space regulations in new residential areas	Year-round	Per regulations at the time	APBD K	2025-2030
3	Providing green open spaces in the residential areas	Year-round	Per regulations at the time	APBD K, Private Sector	2025-2030
4	Improving urban wastewater service network at Sewon WWTP system	4.14%/year	1,586,688	APBD K, Private Sector	2025-2030

No	Activities	Freq/Vol	Budget Estimation	Funding Opportunities	Implementation Year
Strategy 2: Ensuring Affordable Water Safety					
1	Implementing green walls at public buildings and residential areas	Year-round	Per regulations at the time	Community, Private Sector	2025-2030
2	Conducting wastewater effluent tests from the home industry	1-2 times/year	630,000/sample	Private Sector	2027-2030
3	Implementing the regulation of minimum 25% green coverage ratio at the residential zone, where 10% of it should be dedicated as public green open space	Minimum 25% green coverage ratio, 10% dedicated as public space	Per regulations at the time	APBD K, APBN, Private Sector	2025-2030
4	Implementing water-permeable pavement in roads, yards of residential areas, and commercial areas	Year-round	140,000 m2	APBD Kal, Private Sector, Community	2025-2030

6.3. Implications for Long-Term and Broader Contexts: Policy Brief

In addition to the list of actions for each institution as formulated in the Stakeholder's Commitment, the implications of this vision building has also been formulated on a wider spatial scale and longer time scale in the regency level. The implications applied are in the form of a series of policies that must be carried out by the Sleman Regency Government to ensure the implementation of water-sensitive development throughout the Sleman area. This policy formulation is presented in the form of a policy brief attached in Annex K.

An example of how residents use wells to draw water with electric pumps, storing it in tanks to ensure steady water pressure throughout their households.

Communal cattle farming in Rejodani reflects the rural character of the area, which is experiencing a gradual decline in livestock numbers due to urbanization, as seen from a socio-economic aspect.

Chapter 7
Conclusion and Lesson Learned

7.1. Conclusion

This document is the output of a long introduction process and commitment to water-sensitive development in the sub-villages of Rejodani I and Rejodani II, specifically with a polycentric water approach. This process began in 2021 by preparing a baseline report, 'Towards a Sustainable and Water-Sensitive Sariharjo, Sleman Regency, Indonesia', examined Sariharjo Village, a selected village as the case study. The report demonstrated the urgency of implementing water-sensitive development in Sariharjo Village, a peri-urban area with the urban and water related challenges and opportunities. At the village level, a community consensus was raised to build and create a water-friendly village, within the slogan 'Water for the Next Generation".

A next step of preparing a water sensitive community was started in 2023, a vision building process, with the selection of Rejodani I and Rejodani II sub-villages, two sub-villages in Sariharjo Village, as the pilot projects of vision building. A participatory process, by involving the community and related stakeholders, and channeling to the higher level actors at the regency level was conducted during the vision building process. This participatory process reflected the community's vision and built the water sensitivity at the highest level and as a shared commitment to achieve by the community to the regency level government, that was conducted through a series of Focus Group Discussions. Moreover, the vision building process is also supported by utilizing several methods including fieldwork and observation, secondary data collection, regulations review, which are conducted by the local team expert which consist of academicians and practitioners. The result summarizes the formulation of vision, strategy and actions plans that are visualized in the master plan and focus area. As the result, this document consists of different chapters as detailing the outputs of the process:

1. a vision or a desired condition of water-sensitive sub-villages in 2030;
2. three strategies to ensure the achievement of the vision that has been formulated;
    - Ensuring affordable, healthy, and environmentally friendly settlement;
    - Ensuring affordable water safety; and
    - Ensuring water conservation and management

3. the elaboration of the three strategies in the course of action plans, including implementation period, volume, actors/stakeholders, and possible funding sources.

In the end, the three strategies were translated into 26 series of action plans and 76 different activities/programs that will be implemented within six years, from 2024 to 2030. This series of actions is also known as the 'transition pathway', which is a crucial period to bring the two sub-villages to a much better condition in many years ahead, at least until 2045, when Indonesia achieves its long-term development vision, which is 'Golden Indonesia 2045'. This series of actions also includes the implementation of Nature-based Solutions (NbS) that promotes utilization of natural features and processes in a sustainable manner to address socio-environmental challenges.

Furthermore, these series of actions, as a transition pathway, come from different commitments of stakeholders at different levels, from the community to the regency level government. The importance of community participation from the two sub-villages, are the main commitment to achieve this water sensitive community, as they are the direct actors impacted to the future of their neighborhood within the support of other stakeholders in different levels (see table 6.1 for further commitment from the community). As stated in this document, other stakeholders—such as the Sariharjo Village government (see Table 6.2), the sub-district government (see Table 6.3), Sleman Regency government (see Table 6.4), and various private sectors (see Table 6.5)—have committed and will continue to support the development of water-sensitive peri-urban communities in Rejodani I and Rejodani II sub-villages. Simply, this document comprises selected menus to be implemented until 2030 aiming to achieve and actualize the livable, harmonious and sustainable sub-villages.

The integration of this document into development planning document is required to achieve the vision of water sensitive development, including Sariharjo Village Development Plan 2022-2027 (RPMJKal Sariharjo 2022-2027), Sleman Regency Medium-term Development Plan 2025-2030 (RPJMD Kabupaten Sleman 2025-2030), and Sleman Regency Long-term Development Plan (RPJPD Kabupaten Sleman 2025-2045). This integration is crucial to ensure the sustainability and implementation of various initiatives and innovations that emerge during the Vision Building process, as it becomes an integral part of the official development plan with legal validity.

In the future, it is expected that this document, particularly the processes and methods used, can be adapted by villages and even secondary cities in Southeast Asia that share similar characteristics and challenges. As climate pressures and environmental stresses intensify on cities, integrating a water-sensitive approach into urban planning and development governance becomes increasingly crucial.

7.2. Lesson Learned

The process of developing the vision building in Rejodani has formulated valuable insights and lessons learned, both in terms of process and substance. This learning should be documented and served as a guideline for other areas facing similar challenges of urban water management. The key learnings include:

1. The polycentric approach, which is used to assess urban development and water issues, is an effective approach used to achieve water sensitive development due to its comprehensive and interconnected assessment. Most importantly, this approach assesses the importance of stakeholders involvement and collaboration in different levels, as an asset to realize water-sensitive urban development.

2. As the basis of understanding the current development and water challenges in the area, it is required and important to conduct a Baseline Study which documents in a comprehensive report. An effective vision building must begin with preparing a comprehensive, rational, measurable baseline information, which contains the conditions, challenges, problems, and opportunities of the area studied. This baseline study provided the scientific basis for the vision formulation and to build strategy and focus areas of the vision building process.

3. The village and sub-village scale areas are the appropriate areas to build and implement water sensitive development, mainly when it comes to encouraging community participation to achieve water sensitive community. Moreover, the selected pilot area characterized as peri-urban areas, faced many urban water challenges as well as its potential and opportunities to build water sensitive development, and address future urban water challenges.

4. The vision building process used comprehensive methods, combining both primary and secondary data collection through field observations, transect walk, multi stakeholder interview, series of participatory FGDs, and desk-based data collection mainly to gather government related documents. This process of data collections aimed to better understand the phenomena, current conditions and strategically predicted the future of urban development and water conditions of the area.

5. The participation process used in vision building is very effective and must be designed in detail. This process allows the active involvement of sub-village residents to convey their aspirations and desires. In this context, a dynamic and open FGD model can be a medium for citizens to carry out the vision formulation process consisting of three stages, included: 1) the stage of formulating issues and problems; 2) the stage of introduction of alternative alternatives, including NbS; 3) and the stage selection of alternatives and commitments. This

participation process should be based on the collaboration principles, as this process involves different stakeholders, a transparent, equal and mutual understanding of partners should be built.

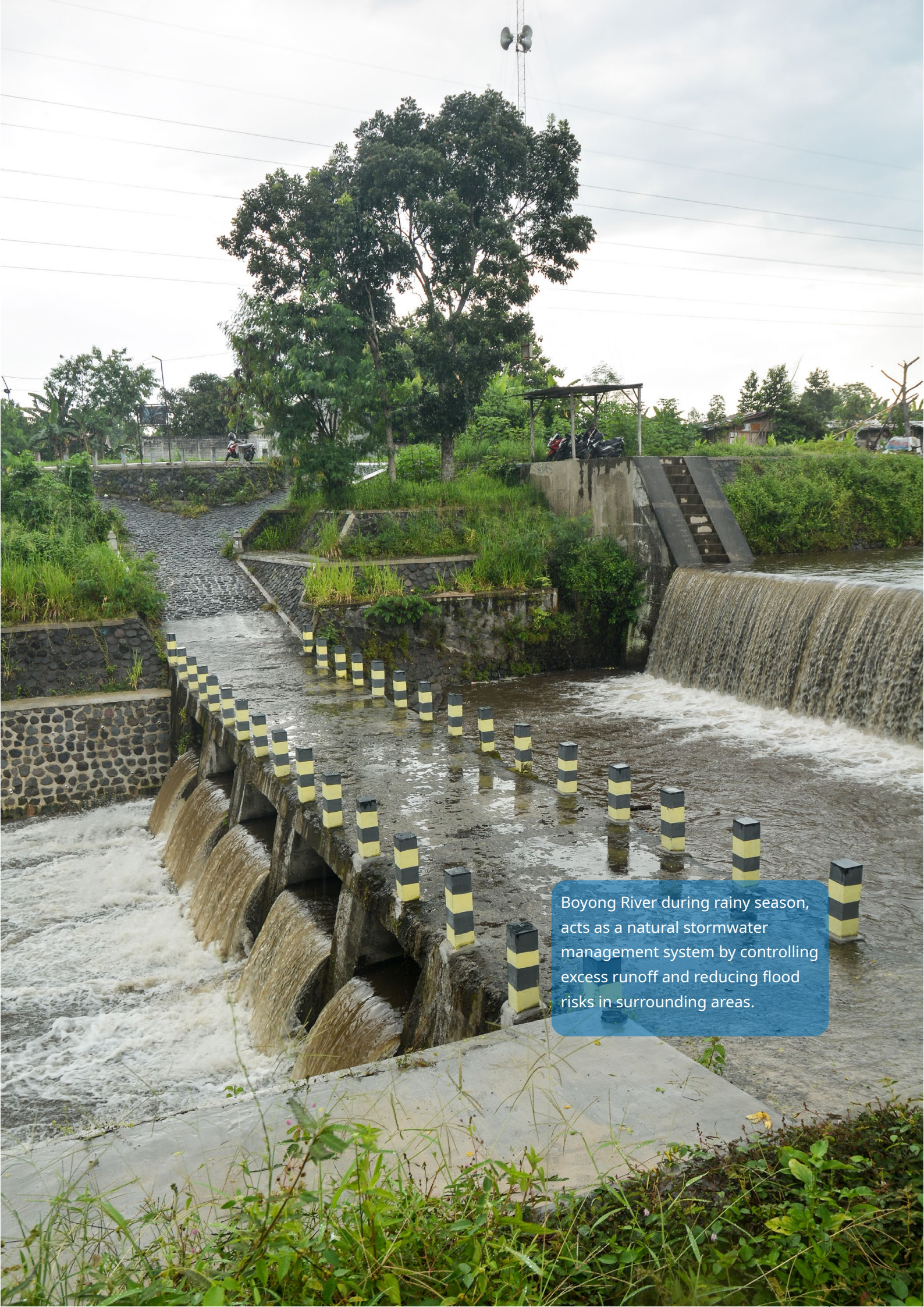
6. The knowledge transfer, mainly to implement solutions offered during the capacity building process helps facilitate transformation and encourage community to create changes. In Rejodani I and Rejodani II, the act was translated into the construction of infiltration wells near the sub-village's cemetery/mosque. The act was done almost at the same time or within a few weeks of the vision building process, even when it was not fully completed.

7. The need for effective communication at the local government level, village government level and with community leaders and members. In addition, several tools are also utilized to enable more effective participation in the process. This includes a list of NbS strategies with their descriptions which was explained to the participation of the FGD and let them select some of them that are appropriate to be implemented in their community. The importance of an effective and reliable facilitator. An effective and reliable facilitator team must assist the participatory vision formulation process. This is because the community does not always have the resources to facilitate this process.

8. The formulation of the vision and commitment must be realistic and measurable. This is so that many wishes of residents of villages and sub-villages can be formulated according to existing resources, especially financial resources. In this context, the participatory process should be then supported by engineering/expert analysis to rationalize and quantify the target and actions.

9. Government support remains very necessary. The vision building process at the sub-village level must still involve the government because there are many sources of funds and programs available in the government, both at the regency, sub-district, and village/kelurahan levels.

All the processes should be supported with good documentation. The entire process of collaborative participation must be well documented so that the tradition of verbal discussions carried out by villagers and sub-villagers can be recorded transparently and clearly. In addition, a more detailed guideline would be produced that could be used in other sub-villages, villages, and other areas in Sleman Regency.



Boyong River during rainy season, acts as a natural stormwater management system by controlling excess runoff and reducing flood risks in surrounding areas.

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ANNEX

A. Action Plan

A.1. Action Plan of Strategy 1: Ensuring Affordable, Healthy, and Environmentally Friendly Settlement

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
Percentage of non-built-up area consists of water bodies, protection areas, and agricultural land	56.14% of land in Rejodani is non-built-up area (39.27 ha)	Maintaining minimum 50.38% (35.21 ha) non-built-up area consist of: • Water bodies: 0.63 ha • Protected area: 1.63 ha • Agricultural land: 27.75 ha	Implementation of Central Sleman's Detailed Spatial Plan (RDTR)	1: Balance Development between natural land and built-up area	Conducting information dissemination on the implementation of Central Sleman's Detailed Spatial Plan (RDTR)	Rejodani 1, Rejodani 2	• Department of Land and Spatial Planning • Planning Agency • Civil Service Police Unit • Department of Investment and One Stop Integrated Services • Sub-district Government						
					Conducting monitoring and evaluation on the implementation of Central Sleman's Detailed Spatial Plan (RDTR) by involving community participation	Rejodani 1, Rejodani 2	• Department of Land and Spatial Planning • Community						
Percentage of green open space	The available green open space is located in private owned land that can be	Availability of permanent public green open space in accordance with Central Sleman's Detailed Spatial Plan	Provision of public green open space		Building a village scale park	Village scale park zone in Rejodani 1	• Private Sector • Department of Environment						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
	converted to built-up area anytime				Implementing green open space regulations in new residential areas	Rejodani 1, Rejodani 2	• Department of Land and Spatial Planning • Department of Environment • Community • Housing Developer						
					Providing jogging tracks along the riverside	Riverside in Rejodani 2	• River Basin Organization of Opak River • Department of Public Works, Housing and Settlement • Department of Environment						
Percentage of agricultural land area	Agricultural land cover an area of 30.72 ha (43.91%)	Preserve at least 27.75 ha of agricultural land (39.67%)	Preservation of agricultural land in accordance with Central Sleman's Detailed Spatial Plan (RDTR)	1: Balance Development between natural land and built-up area	Protecting and regulating land use to prevent conversion in Sustainable Food Agriculture Areas (LP2B)	Sustainable Food Agriculture Areas in Rejodani 1	• Department of Agriculture, Food and Fisheries • Department of Land and Spatial Planning						
					Providing incentives to support the protection of LP2B areas	Sustainable Food Agriculture Areas in Rejodani 1	• Department of Agriculture, Food and Fisheries • Department of Investment and One Stop Integrated Services						
					Regenerating agriculture and developing millennial farmers	Rejodani 1, Rejodani 2	• Department of Agriculture, Food and Fisheries						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
					Targeting the development of agricultural tourism at agricultural zone	Rejodani 2	• Department of Tourism						
					Rehabilitating degraded agricultural lands	Rejodani 1, Rejodani 2	• Department of Agriculture, Food and Fisheries						
					Establishing institutions for agricultural management	Rejodani 1, Rejodani 2	• Department of Agriculture, Food and Fisheries						
					Capacity building in the agricultural sector	Rejodani 1, Rejodani 2	• Department of Agriculture, Food and Fisheries						
					Integrating science and technology in agricultural practices	Rejodani 1, Rejodani 2	• Department of Agriculture, Food and Fisheries						
					Enhancing land intensification through improved agricultural infrastructures, innovation, and the development of agribusiness-based systems	Rejodani 1, Rejodani 2	• Department of Agriculture, Food and Fisheries						
					Improving irrigation infrastructure	Rejodani 1, Rejodani 2	• Department of Agriculture, Food and Fisheries • Village Government						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
					Building agriculture water reservoir	Rejodani 1	• Village Government • Department of Agriculture, Food, and Fisheries • Department of Public Works, Housing and Settlement						
					Building water tower storage for agriculture	Rejodani 2	• Village Government • Department of Agriculture, Food, and Fisheries • Department of Public Works, Housing and Settlement						
					Encouraging organic farming for sustainable farming by organizing trainings	Rejodani 1, Rejodani 2	• Community (Farmers) • Village Government • Department of Agriculture, Food and Fisheries						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
Percentage of built-up land area	43.86% of the land in Rejodani is a built-up area (30.68 Ha)	Maximum built-up area is 48.44% (33.89 Ha) of the Rejodani area: - Medium density housing: 24,08 Ha - Industrial area: 0.09 Ha - Tourism: 0.07 Ha - Trade and services: 8.14 Ha - Cattle farms: 0.25 Ha	Implementation of Central Sleman's Detailed Spatial Plan (RDTR)	2: Healthy and environmentally friendly settlement	Conducting information dissemination on the implementation of Central Sleman's Detailed Spatial Plan (RDTR)	Rejodani 1, Rejodani 2	• Department of Land and Spatial Planning • Planning Agency • Civil Service Police Unit • Department of Investment and One Stop Integrated Services • Sub-district Government						
					Conducting monitoring and evaluation on the implementation of Central Sleman's Detailed Spatial Plan (RDTR) by involving community participation	Rejodani 1, Rejodani 2	• Department of Land and Spatial Planning • Community						
					Providing green open spaces in the residential areas	Settlements in Rejodani 1 and Rejodani 2	• Department of Environment • Private Sector						
Affordability and availability of housing for the next generation	High housing and land cost limiting home ownership acess for middle-lower income family	Ensuring enabling environment for housing development including information delivery related to government services on	Disseminate government services on consulting and assistance for housing provision and improvement	2: Healthy and environmentally friendly settlement	Providing information services related to livable housing	Rejodani Sub-villages	• Department of Public Works, Housing and Settlement						
					Consulting/assistance for house planning	Rejodani Sub-villages	• Department of Public Works, Housing and Settlement						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
		consulting and assistance for housing provision and improvement			Consulting/assistance during construction	Rejodani Sub-villages	• Department of Public Works, Housing and Settlement						
					Consulting/supervision during construction, house development and repair	Rejodani Sub-villages	• Department of Public Works, Housing and Settlement						
					Consulting/assistance in the house management, maintenance, and development	Rejodani Sub-villages	• Department of Public Works, Housing and Settlement						
Households practicing solid waste management (reuse, waste separation, composting, etc.)	Community in Rejodani haven't implemented solid waste management at household level which further intensifies the strain on landfill	100% of households practicing comprehensive solid waste management	Improvement of community capacity in solid waste management	3: Reduced solid waste at the source by managing solid waste at the household level	Assisting communities with solid waste management and sorting	Rejodani 1, Rejodani 2	• Department of Environment • Department of Community and Village Empowerment						
					Promoting composting practice at each household	Rejodani 1, Rejodani 2	• Community						
			Strengthen institutional capacity in waste management		Developing institutional networks and cooperation in solid waste management	Rejodani 1, Rejodani 2	• Department of Environment • Department of Community and Village Empowerment • Community						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
					Developing system for community-based solid waste management and sorting	Rejodani 1, Rejodani 2	• Department of Environment • Department of Community and Village Empowerment • Community						
					Conducting monitoring and evaluation on solid waste management	Rejodani 1, Rejodani 2	• Department of Environment • Department of Community and Village Empowerment • Community						
					Implementing solid waste treatment regulation specifically	Rejodani 1, Rejodani 2	• Department of Environment						
Availability of active waste bank	Inactive waste bank	Establish and maintain at least one active waste bank in each sub-village within the community	Operationalize of waste bank on each sub-village	3: Reduce waste generation from household and encourage waste management at village level	Constructing a waste bank with the integration of a chicken coop for organic waste	Rejodani 2	• Department of Environment • Community						
					Conducting regular monitoring and evaluation of waste bank activities	Rejodani 2	• Department of Environment						
			Strengthen institutional capacity of the waste banks		Developing the institutions for waste bank administrators	Rejodani 2	• Department of Environment						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
Availability of Integrated Waste Processing Site	Absence of integrated Waste Processing Site	Integrated waste processing site on each sub-village	Infrastructure provision for solid waste processing		Developing TPS3R (Solid Waste Treatment Site with 3R principles)	Rejodani 2	• Department of Environment • Village Government • Community						
Availability and operation of wastewater treatment plant	There is no wastewater treatment from settlements, cattle farms, or commercial activities	Raising public awarness of safe wastewater treatment	Information dissemination	4: Integrated and sustainable wastewater source management	Conducting information dissemination of environmentally friendly wastewater management	Rejodani 1, Rejodani 2	• Department of Environment						
		50% individual septic tanks is desludged to meet improved wastewater treatment standards	Development of wastewater infrastructure		Improving individual septic tanks	Rejodani 1	• Community						
					Providing technical assistance for the community to improve their septic tank	Rejodani 1	• Department of Environment						
		20.69% household in Rejodani 2 connected to IPAL Sewon			Improving urban wastewater service network at Sewon WWTP system	Rejodani 2	• Department of Environment • Private Sector						
		17.24% household connected to communal WWTP			Constructing a communal domestic wastewater treatment plant	Rejodani 2	• Department of Environment						
		100% wastewater from Rejodani Market managed			Building a wastewater treatment plant for Rejodani Market	Rejodani Market	• Village Government						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
	There is no treatment plant for waste from cattle farms	100% wastewater from cattle farms managed			Developing a biodigester and wastewater treatment plant for cattle farms in Rejodani 2	Cattle farm in Rejodani 2	• Department of Agriculture, Food and Fisheries						
Discharge wastewater quality meets safety standard	No wastewater management except in some restaurants	The wastewater quality meets the safety standard	Implementation of wastewater treatment regulation	4: Integrated and sustainable wastewater source management	Assisting wastewater management for commercial activities, business, premises, and public services	Rejodani 1, Rejodani 2	• Department of Environment						
					Monitoring and evaluation of commercial activities, business premises, and public services wastewater management	Rejodani 1, Rejodani 2	• Department of Environment						
			Monitoring and evaluation of wastewater quality		Testing effluent water from Rejodani Market	Rejodani 1, Rejodani 2	• Village Government						

Description: Implementation year Y1= 2025; Y2= 2026; Y3= 2027; Y4= 2028; Y5= 2029; Y6= 2030

A.2. Action Plan of Strategy 2: Ensuring Affordable Water Safety

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
Households connected to PDAM networks	Only 9.73% households are connected to PDAM networks	30% households in Rejodani 1 and 32.57% households in Rejodani 2 connected to PDAM networks	Expansion of PDAM Network	1: Guaranteed access to safe and affordable clean water for all residents both in quantity and quality	Raising community awareness to use safe water piping network (PDAM)	Rejodani 1, Rejodani 2	• Local Water Company (PDAM) • Department of Public Works, Housing and Settlement						
					Increasing the number of households connecting to PDAM services	Rejodani 1, Rejodani 2	• Local Water Company (PDAM) • Department of Public Works, Housing and Settlement						
					Proposing program assistance of PDAM connections for underprivileged communities	Rejodani 1, Rejodani 2	• Local Water Company (PDAM) • Department of Public Works, Housing and Settlement • Bank Sleman/BPBD DIY						
Improvement of PAMDUS performance	PAMDUS services managed by individual	Formation of PAMDUS institution	Improvement of PAMDUS infrastructure and management	1: Guaranteed access to safe and affordable clean water for all residents both in quantity and quality	Establishing PAMDUS institution legally and formally	Rejodani Sub-villages	• PAMDUS Organization • Village Government						
					Management training for PAMDUS institutional members	Rejodani Sub-villages	• PAMDUS Organization • Village Government						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
					Information dissemination for PAMDUS users	Rejodani 1	• Department of Health • Planning Agency • Department of Public Works, Housing and Settlement						
	Water loss caused by pipeline leakege	Improved PAMDUS infrastructure and water treatment			Installing water treatment storage in the PAMDUS water storage	PAMDUS water storage	• PAMDUS Organization • Department of Public Works, Housing and Settlement						
					Maintaining the cleanliness of the PAMDUS water reservoir	PAMDUS water storage	• PAMDUS Organization • Village Government						
					Installing single pipeline from PAMDUS reservoir the reticulation system of the house connection	Rejodani 1	• PAMDUS Organization • Village Government						
Clean water quality meets safety standards	The water from PAMDUS has never been tested so the water quality is unknown	100% tested and treated PAMDUS water	Monitoring Water Quality	1: Guaranteed access to safe and affordable clean water for all residents both in quantity and quality	Conducting regular test and monitor of PAMDUS's water quality	Household connected to PAMDUS pipeline	• Department of Health • Department of Environment						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
Strengthen communication of existing platform for clean water management	Partial and one way coordination	Involvement of stakeholders from sub-village level to regency level	Create accesible communication platform	1: Guaranteed access to safe and affordable clean water for all residents both in quantity and quality	Optimizing existing platform for better communication and information	Rejodani Sub-villages	• Pokja PKP (Housing and Settlement Area Working Group)						
Blue infrastructure maintanance	Irregular maintenance schedule	100% well maintained river infrastructure	Improvement river infrastructure	2: Blue-green infrastructure to conserve water resources and reduce environmental issues	Maintaining river's embankment/retaining wall	River in Rejodani 1 and Rejodani 2	• River Basin Organization of Opak River • Department of Public Works, Housing and Settlement						
	Irregular schedule of clean river program	Regular schedule of clean river program	Clean River Program	2: Blue-green infrastructure to conserve water resources and reduce environmental issues	Scheduling river cleaning by the community	Riverside in Rejodani 1 and Rejodani 2	• Community • Sub-village organization • Village Government						
Implementation of vertical greenery	Lack of vertical greenery in residential areas	Implementing vertical greenery in residential areas	Provision of green facade and/or green fence	2: Blue-green infrastructure to conserve water resources and reduce environmental issues	Implementing green walls at public buildings and residential area	Rejodani 1, Rejodani 2	• Community • Private Sector						

Description: Implementation year Y1= 2025; Y2= 2026; Y3= 2027; Y4= 2028; Y5= 2029; Y6= 2030

A.3. Action Plan of Strategy 3: Ensuring Water Conservation and Management

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
Runoff volume	Runoff occurring 8 m^3/hour at Rejodani II	Zero runoff	Implementation of sustainable drainage system	1: Integrated stormwater management supported by regulatory framework	Raising community awareness about sustainable drainage system	Rejodani 1 and Rejodani 2	• Department of Public Works, Housing and Settlement • Village Government						
					Implementing rainwater harvesting	Rejodani 1 and Rejodani 2	• Community						
					Integrating drainage with infiltration well	Rejodani 1 and Rejodani 2	• Department of Public Works, Housing and Settlement • Village Government						
					Improving existing drainage system according to regulations	Rejodani 1 and Rejodani 2	• Department of Public Works, Housing and Settlement • Village Government						
					Building infiltration trench at residential area	Rejodani 1 and Rejodani 2	• Community • Village Government						
					Applying bioswale along village and regency roads	Rejodani 1 and Rejodani 2	• Department of Public Works, Housing and Settlement • Village Government						

Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
			Increase infilltration area	1: Integrated stormwater management supported by regulatory framework	Implementing rain garden for infiltration area		• Department of Environment • Village Government						
					Using paddy field as a buffer zone to anticipate flood	Rice fields in Rejodani 1 and Rejodani 2	• Community (farmers) • Department of Agriculture, Food and Fisheries						
					Implementing biopores infiltration holes	Rejodani 1 and Rejodani 2	• Community • Village Government • Department of Environment						
Application of bioremediation to reduce water pollution in 19 hotpots	Water pollution hot spots are not treated	Water pollution hot spots treated using bioremediation process	Land and water protection from water pollutant	2: Integrated and sustainable wastewater management across levels	Applying biofilters into pollution hot spots	Pollution hot spots in Rejodani 1 & Rejodani 2	• Department of Environment • Village Government						
					Applying phytoremediation to pollution hot spots	Pollution hot spots in Rejodani 1 & Rejodani 2	• Department of Environment • Village Government						
					Conducting wastewater effluent tests from the home industry	Rejodani 1 and Rejodani 2	• Business entities, Department of Environment						

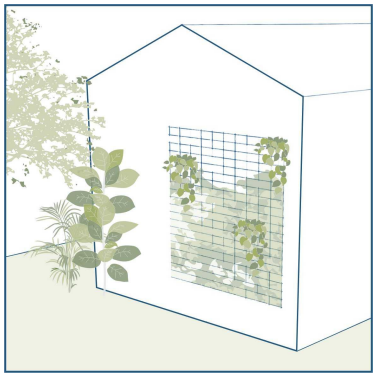
Indicators	Present	Target	Action Plans	Component	Activities	Location	Stakeholders	Year					
								1	2	3	4	5	6
Length of green belts along the river	1.02 km of green belt	Preserve 1.02 km of green belt	Preservation and restoration of green space	2: Maintain water catchment area and NbS application for water conservation	Improving riparian biodiversity with local tree planting (gayam tree (Inocarpus fagifer) and fruit tree)	Riparian zone	• Department of Environment • Village Government						
Implementation of green coverage ratio (Koefisien Dasar Hijau (KDH))	Not all land plots have enough green space	30% green coverage ratio for each plot			Planting trees in each land plots sub-village areas (fruit tree)	Rejodani 1 and Rejodani 2	• Department of Environment • Village Government						
					Implementing the Implementing the regulation of minimum 25% green coverage ratio at the residential zone, where 10% of it should be dedicated as public green open space	Settlements in Rejodani 1 and Rejodani 2	• Department of Public Works, Housing and Settlement • Department of Environment • Private sector						
Implementation of water-permeable materials	Many areas in settlements or commercial areas and road are still using hard material/pavement	Decreasing the use of hard material/pavement	Application of permeable materials	2: Maintain water catchment area and NbS application for water conservation	Implementing porous paving in roads, yards of residential area, and commercial areas	Rejodani 1 and Rejodani 2	• Department of Public Works, Housing and Settlement • Village Government						

Description: Implementation year Y1= 2025; Y2= 2026; Y3= 2027; Y4= 2028; Y5= 2029; Y6= 2030

B. List of Nature-based and Hybrid Solutions

NbS Type	Description

Green Wall



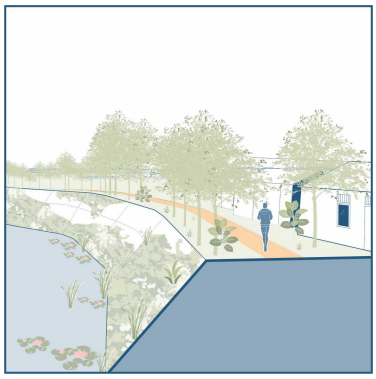
A vertical green infrastructure providing water infiltration space primarily serving as a visual barrier and noise buffer.

Function:

- Green wall's roots and microorganisms remove water pollutants
- Natural air-filters that creating a cleaner environment
- Naturally absorb and filter stormwater
- Have high rates of evapotranspiration which contributes to a normal water cycle
- To create a barrier from noisy, dirty and dangerous areas such as roads frequently used by motorized vehicles

Application at the pilot site: Public buildings and residential area

Riparian Green Zone



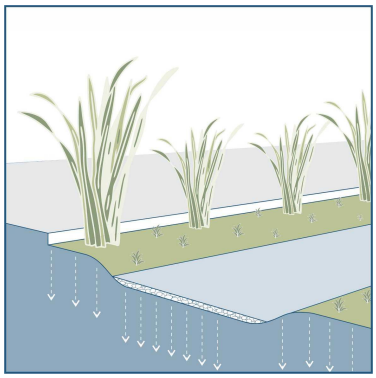
An area surrounding a river planted with diverse greenery, serving as both an infiltration zone and a pathway for runoff toward the river. Riparian zones are located along the streams and rivers.

Function:

- Rainwater catchment area
- Pathway for surface runoff to the next water channel (river)

Application at the pilot site: Green belts along the riverbank and jogging track

Infiltration Trenches



Excavated trenches filled with stones to create basins capable of retaining rainwater. This stored rainwater gradually seeps into the ground over a period of several days.
Infiltration trenches require limited space.

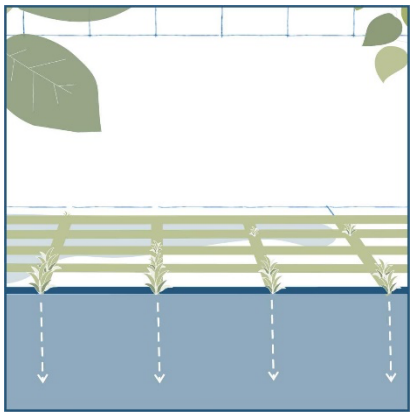
Function:

- To reduce the amount of urban runoff
- To reduce the load of pollutants discharged into the receiving water body.

Application at the pilot site: Along the secondary streets

NbS Type	Description

Green Paving System

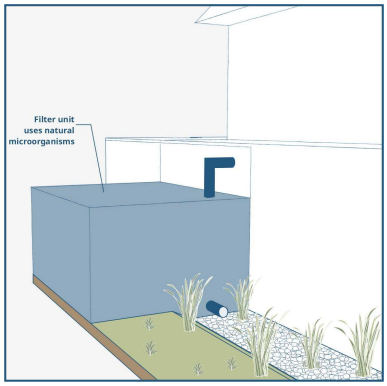


The construction material aims to augment infiltration areas, facilitating efficient water percolation into the soil, reducing inundation, and enhancing groundwater reserves.

Function: To manage and control surface water runoff after rainfall.

Application at the pilot site: Yards and roads porous paving at residential areas

Biofilter



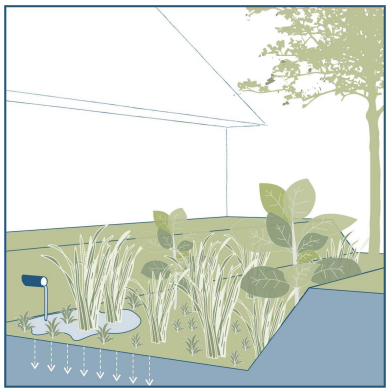
A wastewater treatment system utilizing natural microorganisms on a support medium to decompose pollutants, thereby restoring the water to a clean state.

Function:

- It can be installed communally, or as an extension of a septic tank.
- Purify water before it enters free water bodies.

Application at the pilot site: Water pollution hot spots

Constructed Wetlands (Phytoremediation)

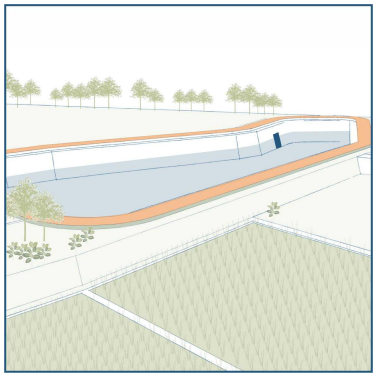
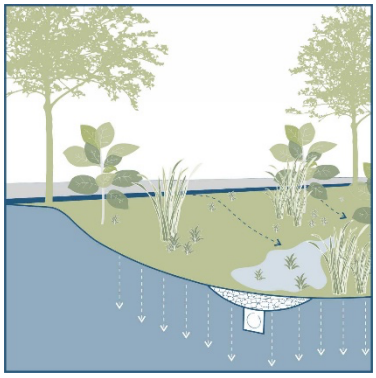


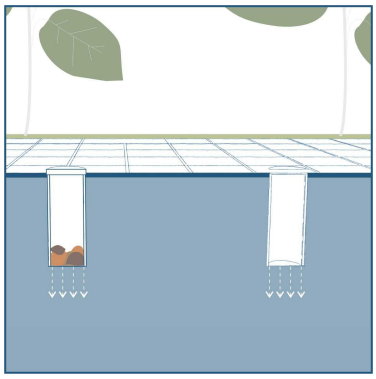
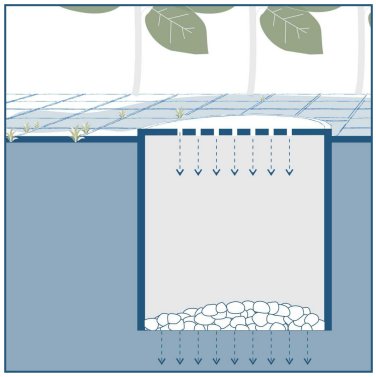
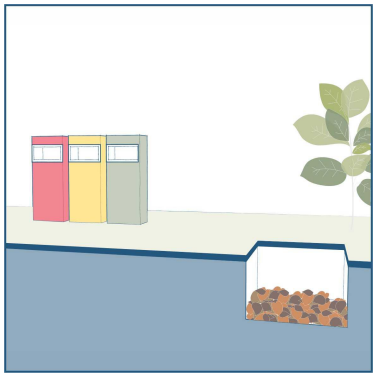
Constructed wetlands for phytoremediation uses the application of plant-based processes to improve hazardous contaminant conditions, aiming to obtain cleaner water.

Function:

- Use of plants and their parts for waste decontamination and pollution problems
- Water filtration and purification

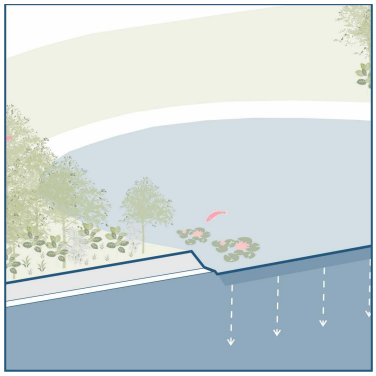
Application at the pilot site: Water pollution hot spots

NbS Type	Description
Tree Planting 	Installing or planting trees at vacant or derelict areas; renovating urban trees population; or creating green corridors / routes. Endemic character of the arboreal species implanted is taken into account since this is a guarantee of tree adaptation to soil and climate conditions. Function: • Provide shade to buildings • Reducing heat loading on building • Provide islands of respite from high temperatures in urban areas • Improve user's well-being as well as connection to nature Application at the pilot site: • Planting trees in several village vacant area and each building plot (residential, commercial, and public buildings) • Vacant area of TKD • Boyong riverbank
Wet Retention Pond / Reservoir 	Ponds or pools designed with additional storage capacity to attenuate surface runoff during rainfall events and use the water during the dry season. Function: • Remove urban pollutants • Improve the quality of surface runoff Application at the pilot site: Agriculture area (for irrigation)
Bioswale 	Shallow, flat bottomed, vegetated open channels designed to convey, treat and often attenuate surface water runoff. Function: • Reduce runoff volume • Improve water quality • Can enhance the natural landscape and provide aesthetic and biodiversity benefits Application at the pilot site: Along the street

NbS Type	Description
Biopore Infiltration Hole 	A hole with a diameter of 10-30 cm with a length of 30-100 cm which is covered with organic waste which functions to trap flowing water so that it can become a source of water reserves for underground water. Function: • Enhanced water infiltration • Improved soil structure • Nutrient retention • Flood mitigation • Groundwater recharge • Erosion control • Climate resilience • Water quality improvement Application at the pilot site: Residential and public buildings area
Infiltration Well 	Well or pit in the ground into which flows rainwater drainage. Function: • Groundwater recharge • Stormwater and flood management • Ecosystem support Application at the pilot site: Village's road and yard
Composting 	Method for treating solid waste in which organic material is broken down by microorganisms in the presence of oxygen. Organic material is delivered from the community and commercial. Function: • Store and manage organic waste • Applicable for environment as a fertilizer and soil amendment Application at the pilot site: Residential area (household and community level)

NbS Type	Description

Dry Retention Pond / Rain Garden



A strategically designed and landscaped depression or shallow basin that captures, absorbs, and filters stormwater runoff from roofs, driveways, sidewalks, and other impermeable surfaces.

Function:

- Capture and absorb rainwater
- Reduce runoff volume
- Water filtration
- Habitat creation
- Aesthetic enhancement

Application at the pilot site:
Vacant area of TKD, village park, public building yard

C. Focus Group Discussion Details

No	Activities	Date	Place	Target Group	Number of Participant
1	FGD Challenges and Opportunities Identification	June 9, 2023	Community Hall Rejodani 1	Community representatives and stakeholders in Rejodani 1 and Rejodani 2 sub-villages	31 people (M= 26; F= 5)
2	FGD Challenges and Opportunities Identification with Private Sector	August 22, 2023	EL PRIMO (Jl. Palagan Tentara Pelajar, Sariharjo, Ngaglik, Sleman)	Private sector or business actor in Rejodani 1 and Rejodani 2	14 people (M= 8; F= 6)
3	FGD Strategy and Solutions	July 20-21, 2023	Community Hall Rejodani 1	Community representatives and stakeholders in Rejodani 1 and Rejodani 2 sub-villages	25 people (M= 17; F= 8)
4	FGD Clarification, Prioritization, and Alignment	October 19, 2023	Sleman Planning Agency	Stakeholders that related to water-sensitive planning from multi-sectors and multi-level (sub-village to regency level)	37 people (M= 24; F= 8)

D. Demographic Profile

Table D.1. Population and Household in Rejodani I and Rejodani II

Year	Rejodani 1				Rejodani 2				Total Population	Density (people/ha)
	Male	Female	Total	Household	Male	Female	Total	Household		
2017	384	372	756	240	302	278	580	177	1,336	19,36
2018	386	374	760	242	305	281	586	181	1,346	19,51
2019	388	372	760	250	306	283	589	187	1,349	19,55
2020	381	375	756	253	302	281	583	189	1,339	19,41
2021	379	377	756	260	299	29	578	191	1,334	19,33
2022	374	367	741	261	288	274	562	190	1,303	18,88
2023	369	365	734	260	286	268	554	187	1,288	18,67

Source: Sariharjo Village Government Administration Report Year of 2017-2023

Table D.2. Major Occupations in Rejodani I and Rejodani II

Major Occupations	Rejodani I (people)	Rejodani II (people)	Rejodani I and Rejodani II (people)
a. Agriculture, Fisheries, Plantations, Livestock	11	40	51
b. Processing Industry (Factory, Handicraft, etc.)	2	24	26
c. Wholesale/retail trade and restaurants	4	8	12
d. Transportation, Warehousing, Communication	0	0	0
e. Services	6	15	21
f. Mining and Quarrying	0	5	5
g. Government Employees/Civil Servants	35	8	43
h. Army	5	0	5
i. Police officers	2	0	2
j. Doctor/Midwife/Health Professionals	6	0	6
k. Retired	25	12	37
l. Private Employees	30	65	95
m. Others (water, gas, electricity, construction, banking, etc.)	3	0	3

Source: RPJMKal Sariharjo 2022-2027

Table D.3. Labor force based on educational attainment

Education Degree	Rejodani I	Rejodani II	Rejodani I and Rejodani II
Doctoral graduate	13	1	14
Master graduate	8	2	10
Bachelor graduate	50	42	92
High School	110	76	186
Middle School	41	27	68
Elementary	10	6	16
Did not finish elementary school / did not go to school	0	4	4

Source: RPJMKal Sariharjo 2022-2027

E. Water Supply Management

Due to different activities, land use, and population density, the calculation for water supply was conducted separately at each sub-village instead of as one pilot area.

1. Water Demand (Domestic and Non-Domestic)

Population projection from 2024 to 2030 is required to calculate water demand. The population growth rate of Rejodani I is 1.3%, and Rejodani II's is 0.5%. Table E.1 shows the projected population at each sub-village.

Table E.1. Projected Population (people)

Sub-village	Year						
	2024	2025	2026	2027	2028	2029	2030
Rejodani I	765	775	785	795	805	815	826
Rejodani II	562	564	567	570	573	577	580

Source: PolyUrbanWaters Team, 2024

The average calculation of water demand (domestic and non-domestic) considered 25% water loss, following the Ministry of Public Works standard. Table E.2 shows the water demand calculation at each sub-village.

Table E.2. Total Water Demand (l/s)

Sub-village	Year						
	2024	2025	2026	2027	2028	2029	2030
Rejodani I	2.38	2.42	2.45	2.49	2.52	2.56	2.60
Rejodani II	1.21	1.24	1.28	1.31	1.34	1.38	1.41

Source: Civil Engineering Team Analysis

The average calculation of water demand (domestic and non-domestic) considered 25% water loss, following the Ministry of Public Works standard. Table E.3 shows the water demand calculation at each sub-village.

Table E.3. Household Connections by Water Source (household) in 2024

Water source	Number of households	Number of people
Rejodani I		
Pamdus + Shallow wells	69	207
PDAM	43	129
Shallow wells	143	429
Rejodani II		
Pamdus + Shallow wells	0	0
PDAM	0	0
Shallow wells	187	562

Source: Civil Engineering Team Analysis

2. Projection of Water Source Shifting to PDAM 2024-2030

The calculation used an assumption that PDAM usage will increase by 30% in 2030, while the number of shallow wells will continue to decrease by 2030. Given the current condition of PAMDUS, characterized by a declining flow rate and limited infrastructure in terms of both space and maintenance, the number of PAMDUS customers is projected to remain constant until 2030. Consequently, as the population in the Rejodani I area grows, the service coverage provided by PAMDUS is expected to decline progressively until 2030. In Rejodani II, it is assumed that there will be an additional 63 house connections of water supply at the Patra housing complex when fully occupied. There is also an additional population of 0.5% in 2030.

The transformation of the community from using shallow wells to PDAM services is highly dependent on financial and environmental factors. Financial considerations include the affordability of the initial connection fees and the monthly service charges. According to research conducted in 2023, approximately 23.86% of the community received Food Assistance, 22.75% were recipients of Family Welfare Cards, and 15.82% benefited from the Family Hope Program. These data illustrate the factors that impact household expenditure capacity.

The environmental factor is the good water quality of shallow wells. Further, PDAM can provide new connections when there are at least 7-10 new customers within one kilometer from reticulation pipe installation. The cost for a new PDAM installation is IDR 1,500,000. The cost per cubic meter of consumption depends on customer categorization.

Table E.4. Monthly fee simulation comparing the PDAM fee and electricity fee for shallow wells water pump

Consumption	PDAM monthly fee (IDR)	Shallow Wells (Electricity fee for water pump) (IDR)	Difference (IDR)
10 m^3	36,500	31,170.84	5,329.16
15 m^3	61,500	46,756.27	14,743.73

Source: Civil Engineering Team Analysis

According to the simulation, the monthly expenditure for water supply from shallow wells water will be cheaper than from PDAM.

Table E.5. Number Of Water Supply Services House Connection Per Sector (House Connection Unit (SR))

Sub-village	Year						
	2024	2025	2026	2027	2028	2029	2030
Rejodani I							
Pamdus	69	69	69	69	69	69	69
PDAM	43	49	56	62	69	76	83
Shallow wells	143	140	137	134	131	127	124
Rejodani II							
Pamdus	0	0	0	0	0	0	0
PDAM	0	10	21	31	42	52	63
Shallow wells	187	178	168	159	149	140	130

Source: Civil Engineering Team Analysis

Table E.6. Number Of Water Supply Services House Connection Per Sector (%)

Sub-Village	Year						
	2024	2025	2026	2027	2028	2029	2030
Rejodani I							
Pamdus	27.06	26.71	26.37	26.04	25.71	25.40	25.06
PDAM	16.86	19.05	21.24	23.43	25.62	27.81	30.00
Shallow wells	56.08	54.24	52.39	50.53	48.66	46.79	44.94
Rejodani II							
Pamdus	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PDAM	0.00	5.58	11.11	16.57	21.98	27.28	32.57
Shallow wells	100.00	94.42	88.89	83.43	78.02	72.72	67.43

Source: Civil Engineering Team Analysis

3. Domestic and Non-Domestic Water Demand

a. Domestic Water Demand

Table E.7. shows details and conversion to liters per second of domestic water demand from PAMDUS and PDAM based on population projection. The data was obtained by multiplying the number of households receiving water supply from these sources by the water demand according to Construction and Building Guidelines, Ministry of Public Works', which stated that the consumption is 15 m^3/household/month for a small-size city.

Table E.7. Domestic Water Demand (l/s)

Sub-village	Year						
	2024	2025	2026	2027	2028	2029	2030
Rejodani 1							
Pamdus	0.40	0.40	0.40	0.40	0.40	0.40	0.40
PDAM	0.25	0.28	0.32	0.36	0.40	0.44	0.48
Shallow wells	0.83	0.81	0.79	0.77	0.76	0.74	0.72
Total	1.48	1.49	1.51	1.53	1.55	1.57	1.59
Rejodani 2							
Pamdus	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PDAM	0.00	0.06	0.12	0.18	0.24	0.30	0.36
Shallow wells	1.08	1.03	0.97	0.92	0.86	0.81	0.75
Total	1.08	1.09	1.09	1.10	1.11	1.11	1.12

Source: Civil Engineering Team Analysis

b. Non-domestic Water Demand

Table E.8. shows the details and conversion to liters per second of non-domestic water demand from PDAM based on the type of activity. The calculation was based on the standards according to the Construction and Building Guidelines, Ministry of Public Works.

Table E.8. Non-domestic Water Demand for Strategic Areas (Tourism, Offices, and Industry) (l/s)

Sub-village	Unit	Standard	Forecast year						
			2024	2025	2026	2027	2028	2029	2030
Rejodani I									
Industry	5 unit	100 l/d	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Hospital type "D"	90 people	340 l/p/d	0.354	0.354	0.354	0.354	0.354	0.354	0.354
Orphanage	25 people	340 l/p/d	0.098	0.098	0.098	0.098	0.098	0.098	0.098
Islamic Boarding School	25 people	340 l/p/d	0.098	0.098	0.098	0.098	0.098	0.098	0.098
Total			0.56	0.56	0.56	0.56	0.56	0.56	0.56
Rejodani II									
Industry	3 unit	100 l/d	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Commercial Building	6	0.1 l/d	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Total			0.103	0.103	0.103	0.103	0.103	0.103	0.103

Source: Civil Engineering Team Analysis

4. PAMDUS piping network optimization

The household connection to the PAMDUS piping system will be modelled using the following EPANET application. The result is presented in Figure 1 and Table F.9. Based on the pipe network simulation results, it was found that the installation of parallel pipes from the source to the residents' homes, with each pipe installed individually by the water users, does not impact the pressure drop at the customers' homes. On average, residents served by PAMDUS receive water with a pressure ranging from 0.5 to 8 meters of water column (m). However, the individual installation of pipes complicates the maintenance of the pipe network because each section of the individual pipes is more prone to pipe leakage. Therefore, to improve PAMDUS's performance in the future, it is recommended that a single pipeline from the source be used for the reticulation system of the house connections. Using a single pipeline will make the maintenance of the pipe and minimize the leakage rate.

Figure E.1. EPANET Connection
Source: Civil Engineering Team Analysis

The current PAMDUS user fee is IDR 10,000 with 69 household connections and the manager is being paid an amount of IDR 450,000. The recommended treatments for improving the water quality are tray aerators, sand filters, storage chambers, and changing the household unit pipe. So, several options will be provided regarding the total price.

Table E.9. EPANET Information

Node ID	Water Demand	Pressure
	LPS	m
Junc 2	0.08	0.58
Junc 3	0.036	2.41
Junc 4	0.053	2.41
Junc 5	0.044	3.32
Junc 6	0.027	4.54
Junc 7	0.036	3.63
Junc 8	0.027	5.14
Junc 11	0.027	5.31
Junc 12	0.027	4.67
Junc 13	0.044	8.21
Resvr 1 (water source)	-0.46	0

Source: Civil Engineering Team Analysis

5. PAMDUS Improvement Scenario

Cost calculation for PAMDUS improvement was calculated in five scenarios.

1) Scenario 1: Existing Scenario

The first scenario represents existing conditions without infrastructure improvement, water quality enhancement, and piping system paid by users. This scenario includes employee salary for one person which is IDR 450,000/month.

2) Scenario 2: With Infrastructure Repair for Processing, Storage, and Piping Buildings (Existing Scenario with Piping System Cost)

In the second scenario, infrastructure improvement and water quality enhancement costs were calculated, and users must pay for the piping system cost. This scenario includes employee salary for one person which is IDR 450,000/month.

3) Scenario 3: With Infrastructure Repair for Processing, Storage, and Piping Buildings (Existing Scenario Without Piping System Cost)

In the third scenario, infrastructure improvement and water quality enhancement costs were calculated, and users do not pay for the piping system cost (related institutions pay for the piping system cost). This scenario includes employee salary for one person which is IDR 450,000/month.

4) Scenario 4: With Infrastructure Repair for Processing, Storage, and Piping Buildings (Ideal Scenario with Piping System Cost)

   The fourth scenario is the ideal scenario because it includes infrastructure improvements and water quality enhancement, but users must pay for the piping system cost. This scenario includes employee salary for one person which is IDR 2,315,976/month referring to minimum wage for Sleman Regency in 2024.

5) Scenario 5: With Infrastructure Repair for Processing, Storage, and Piping Buildings (Ideal Scenario Without Piping System Cost)

The fourth scenario is the ideal scenario because it includes infrastructure improvements and water quality enhancement, and users do not pay for the piping system cost (related institutions pay for the piping system cost). This scenario includes employee salary for one person which is IDR 2,315,976/month referring to minimum wage for Sleman Regency in 2024.

The cost calculation for PAMDUS improvements refers to the following prices with a depreciation cost for maintenance of 2-5% per year.

Table E.10. Cost Calculation Reference for PAMDUS Improvements

Flow rate for PAMDUS	34,560	l/d
	34.56	m^3/d
	1,036.8	m^3/month
Chlorine Chemical Requirements (Dosing in the storage tank)	1	mg/l
	1	g/m^3
	0.001	kg/m^3
	0.03456	kg/day
	1.0368	kg/month
Household	69	households

Source: Civil Engineering Team Analysis

Table F.11. PAMDUS Improvement Scenarios

Cost (IDR)	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Total cost	450,000	916,036	883,000	2,782,012	2,748,976
Total cost per meter cubic	434	884	852	2,683	2,651
Total cost per households	6,522	13,276	12,797	40,319	39,840

Source: Civil Engineering Team Analysis

F. Stormwater Management

1. Rainfall Analysis

After calculating the planned rainfall, the results are obtained as shown in Table F.1, with a return period of 10 years using the Gumbel method.

Table F.1. Design Rainfall Data

Region	Area (km^2)	I (Design Rainfall (mm/h))
Rejodani I	0,3235	169,8066
Rejodani II	0,3759	163,4699

Source: Civil Engineering Team Analysis

2. Roof runoff Volume

Runoff volume calculation based on land use data, adjusted for developed areas and roof runoff.

Table F.2. Runoff Rainfall Data

Region	Area (km^2)	Q (m^3/h)
Rejodani I		
Industrial Areas	0,0009	0,1452
Tourism	0,0007	0,1129
Trade and Services	0,0188	3,0327
Settlements (Medium)	0,1506	24,2942
Infrastructure and Public Facilities	0,0110	1,7745
Total		29,3596
Rejodani II		
Trade and Services	0,0626	9,7216
Settlements (Medium)	0,0901	13,9922
Infrastructure and Public Facilities	0,0017	0,2640
Total		23,9778

Source: Civil Engineering Team Analysis

3. Surface runoff Volume

Runoff volume calculation based on land use data, adjusted for developed areas and surface runoff.

Table F.3. Surface Rainfall Data

Region	Area (km^2)	Q (m^3/h)
Rejodani I		
Industrial Areas	0,0009	0,1223
Tourism	0,0007	0,0951
Cemetery	0,0028	0,2853
Trade and Services	0,0188	3,0327
Protected Areas	0,0055	0,7471
Settlements (Medium)	0,1506	24,2942
Infrastructure and Public Facilities	0,0110	1,7745
Open Spaces	0,0407	5,5289
Food Crops	0,0906	8,6153
Cattle Farms	0,0011	0,0654
Total		44,5608

Region	Area (km^2)	Q (m^3/h)
Rejodani II		
Trade and Services	0,0627	9,7216
Protected Areas	0,0109	1,4124
Settlements (Medium)	0,0903	13,9922
Infrastructure and Public Facilities	0,0017	0,2640
Open Spaces	0,0170	2,2232
Cattle Farms	0,0009	0,0000
Total		27,6934

Source: Civil Engineering Team Analysis

4. Evaluation of infiltration well numbers

From the topography characteristic of Rejodani I and II, the stormwater will flow from Rejodani I to Rejodani II or from north to south. Data on the water flow rate that needs to be introduced into the infiltration wells

Table F.4. Water Flow Rate Data

Area	Water Flow Rate	Unit
Rejodani I	73,92036957	m^3/jam
Rejodani II	51,67118611	m^3/jam

Source: Civil Engineering Team Analysis

Calculation refers to SNI 8456:2017

- Existing Infiltration Wells Data:
  1. Rejodani 1 = 30 infiltration wells
  2. Rejodani 2 = 16 infiltration wells
- Soil Type: Regosol with an assumed soil permeability value of 0.0635 m/hour
- Required Number of Infiltration Wells After Calculation:
  1. Rejodani I = 31 infiltration wells
  2. Rejodani II = 22 infiltration wells
- Runoff Due to Insufficient Infiltration Wells:
  1. Rejodani I = 2.39 m^3/hour
  2. Rejodani II = 10.77 m^3/hour
- Existing Drainage Data:
  1. Drainage I = Length 126 meters with width and depth of 50×50 cm (capacity: 1.59 m^3/hour)
  2. Drainage II = Length 206 meters with width and depth of 60×80 cm (capacity: 3.17 m^3/hour)

Thus, the total capacity of the existing drainage is 5.17 m^3/hour.

- Additional Infiltration Wells Needed:
  1. Runoff occurring = 8 m^3/hour at Rejodani II
  2. Required:
  - 5 infiltration wells with a depth (H) = 3 m, diameter = 0.6 m; or
  - 4 infiltration wells with a depth (H) = 3 m, diameter = 0.8 m.

Notes (Considerations for the placement of infiltration wells):

a. Location Considerations: Locations should not be centralized in one place but distributed across lower areas or areas prone to flooding. From the master plan, it appears that the infiltration wells are concentrated on the eastern side of Rejodani, which should also be considered.

b. Groundwater Depth: Consider the depth of the groundwater table to ensure that the infiltration wells can be used effectively.

5. Reservoir Plan

- Area to be Irrigated: 27,74 hectares (as a land use)
- With 9,06 Ha food corps in Rejodani I and 18,68 Ha food corps in Rejodani II.
- Runoff Coefficient: 0.25 (as per the runoff coefficient list).
- Design Rainfall: Using a 2-year return period. This is recommended for small cities, with a return period (T) of approximately 2-5 years.

Therefore, a reservoir capable of holding approximately 8.385 m^3 of water is required to irrigate the fields. However, it should be reconsidered whether the entire area will be irrigated using the water from the retention pond.

The recommended dimensions for the retention pond are 3 meter of depth and 2.795 square meter. From detailed spatial plan for the central Sleman Area (2023-2043). Thus, it is estimated that an area of approximately 27,74 hectares will be irrigated by this reservoir.

6. Runoff reduction plan

Reducing surface runoff can help manage water resources and prevent flooding. The application of Low Impact Development (LID) is an effective approach for managing stormwater runoff in tropical countries with high rainfall. LID strategies aim to mimic natural hydrological processes to manage rainfall at the source. Considering moderate land availability in Rejodani, the application of bioretention cells or bioswales is recommended to decrease runoff.

The effectiveness of bioswales in reducing runoff should be modeled using tools like the Storm Water Management Model (SWMM) to assess overall performance, including volume reduction, peak flow attenuation, and pollutant removal efficiency. While the modeling process is beyond the scope of this study, it represents a potential follow-up research area.

Currently, there is no bioswale standardization in Indonesia. However, the following typical design standards, based on guidelines released by Singapore, which has a similar tropical climate, can be referenced as recommendations in Table F.5.

Table F.5. Key parameters for bioswale design

Design parameters	Values
Bioretention area to catchment area ratio	2–4%
Minimum depth of topsoils	300 mm (for plants) 100 mm (for turf)
Maximum detention depth	300 mm
Slope of swale (i.e., side slope) for bioswale	1:10 to 1:4
Longitudinal slope for bioswale	1%–4%
Soil pH	5.5–7.5 (measured at 1:5 to water) 5.5–8.5 (measured at 1:2.5 to water)
Soil organic content	3%–10% (w/w)

Source: (Singapore's National Water Agency, 2018)

G. Wastewater Management

1. Wastewater Generation (domestic and non-domestic)

Wastewater demand obtained from 80% of water demand for domestic and non-domestic sectors. This percentage is in accordance with existing standards.

Table G.1. Wastewater generation from domestic and non-domestic (l/s)

Region	Year						
	2024	2025	2026	2027	2028	2029	2030
Rejodani I	1,90	1,93	1,96	1,99	2,02	2,05	2,08
Rejodani II	0,97	1,00	1,02	1,05	1,07	1,10	1,13

Source: Civil Engineering Team Analysis

2. Priority of domestic wastewater treatment services coverage per sector (Business as Usual scenario)

Prior to this, it is important to understand the existing domestic wastewater generation.

Table G.2. Wastewater generation from domestic (l/s)

Region	Year						
	2024	2025	2026	2027	2028	2029	2030
Rejodani I	1,18	1,20	1,21	1,23	1,24	1,26	1,27
Rejodani II	0,87	0,87	0,88	0,88	0,88	0,89	0,90

Source: Civil Engineering Team Analysis

- Rejodani I: The wastewater treatment projection is based on the percentage of users with either improved or soak-pit septic tanks. It is expected that improved septic tanks will continue to increase to 1,3% every year from the 1.3% population increase, along with an additional 1% of the existing population who switch from soak-pit septic tanks to improved septic tanks until 2030 to achieve a safe environment. In Rejodani I, there is no communal wastewater treatment plant planning due to the limited available land.
- Rejodani II: The wastewater treatment projection is based on the number of septic tanks and user percentages. Soak-pit septic tanks are expected to continue decreasing to 30% by 2030. Meanwhile, the other three technologies—improved septic tanks, WWTP Sewon, and communal WWTP—are expected to attract users up to 70% of the total soak-pit septic tanks. This assumes that by 2030, the number of users for IPAL Sewon will be 40 households that located around the Sewon WWTP sewerage network system. In order to eliminate the use of soak-pit septic tank, It is planned that there will be improved septic tanks are projected to serve 62 households by 2030, assuming that the new Patra housing complex will have its own improved septic tanks and the remaining households will used Communal WWTP. Both the Sewon WWTP and the communal residential WWTP are planned to begin operations in 2026. This is due to considerations for the registration process, installation of reticulation pipes, and connection to the Sewon WWTP, which will take approximately 2 years. For the communal WWTP, it is estimated that the process of surveying the willingness to connect, construction, and commissioning will also take about 2 years. Therefore, not everyone will be immediately connected to the existing IPAL systems and communal residential WWTP.

Table G.3. Domestic Wastewater Treatment Projection (Household Units)

Region	Year						
	2024	2025	2026	2027	2028	2029	2030
Rejodani I							
Improved Septictank	64	71	78	85	92	99	107
Soak-pit Septictank	191	188	184	180	176	172	168
Total	255	258	262	265	268	272	275
Rejodani II							
Improved Septictank	0	10	20	30	41	51	62
Soak-pit Septictank	187	178	154	131	107	83	58
Sewon WWTP	0	0	8	16	24	32	40
Communal WWTP	0	0	7	13	20	27	33
Total	187	188	189	190	191	192	193

Source: Civil Engineering Team Analysis

Table G.4. Domestic Wastewater Treatment Projection (%)

Region	Year						
	2024	2025	2026	2027	2028	2029	2030
Rejodani I							
Improved Septic Tank	25,10	27,40	29,70	32,00	34,30	36,60	38,90
Soak-pit Septic Tank	74,90	72,60	70,30	68,00	65,70	63,40	61,10
Rejodani II							
Improved Septic Tank	0,00	5,34	10,69	16,03	21,38	26,72	32,07
Soak-pit Septic Tank	100,00	94,66	81,72	68,79	55,86	42,93	30,00
Sewon WWTP	0	0	4,14	8,28	12,41	16,55	20,69
Communal WWTP	0	0	3,45	6,90	10,34	13,79	17,24

(Source: Civil Engineering Team Analysis, Improved Septic Tank (SNI 2398:2017))

- The septic tank can use a combined system (2 compartments). The dimensions that can be used are length (L) = 1.6 m; width (W) = 0.8 m; and height (H) = 1.6 m. The estimated price for the improved septic tank is IDR 6-7 Million for one household.

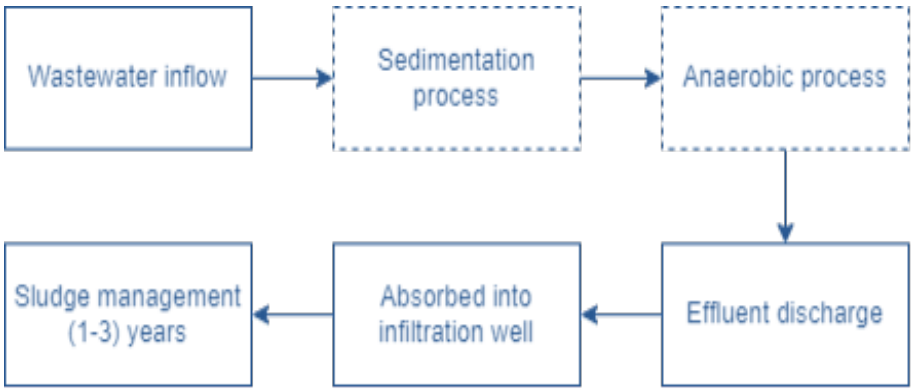


Figure G.1. Improved septic tank diagram
Source: Civil Engineering Team Analysis

3. The Communal wastewater treatment plant

WWTP (Wastewater Treatment Plant) uses an ABR (Anaerobic Baffled Reactor) technology equipped with a control tank, sedimentation chamber, an effluent pond and an indicator pond. As referenced in the 'Sanitation Construction Guidelines Pocket Book' by the Ministry of Public Works and Housing (PUPR).

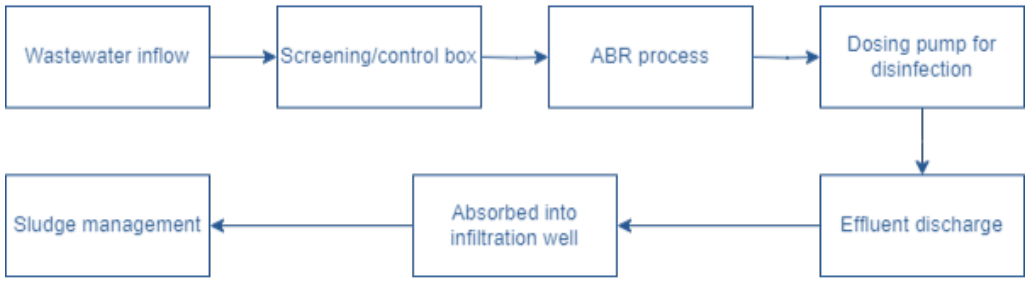


Figure G.2. Communal WWTP diagram
Source: Civil Engineering Team Analysis

Chlorination is applied at the end of the treatment process (in the effluent tank) to reduce the number of pathogenic bacteria discharged into the water body. The location of the WWTP will be in Rejodani II, adjacent to the biodigester for cattle farm waste. The estimated price for 1 residential wastewater treatment plant for 50 household connections is IDR 500.000.000 to IDR 550.000.000 million. A dosing pump for disinfection is used to add disinfectant to the wastewater disposal pipes. The price for a dosing pump is approximately IDR 20 million. Schematic diagram from residential wastewater treatment plant can been seen in Figure G.3.

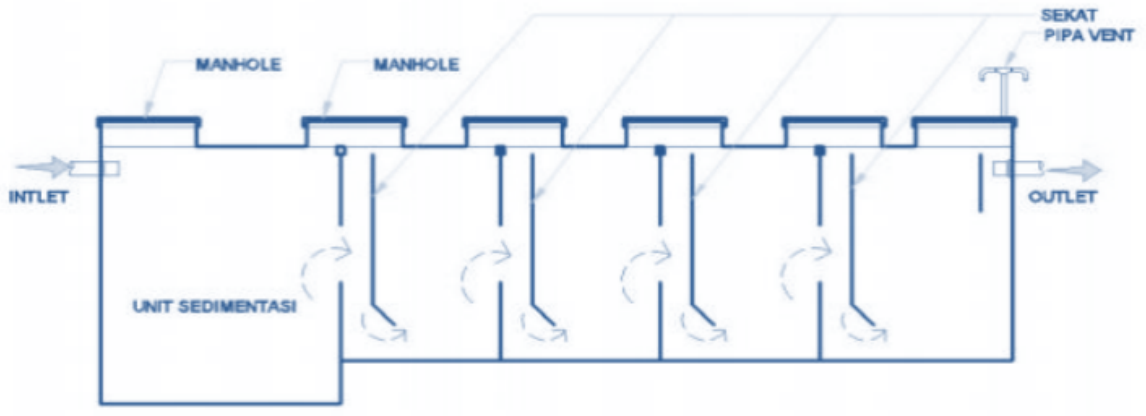


Figure G.3. ABR Treatment
(Source: 'Sanitation Construction Guidelines Pocket Book' by the Ministry of Public Works and Housing (PUPR))

4. Market Wastewater Treatment.

In managing 100% of the PDAM service area coverage, the following points need to be considered. This will help determine the capacity of the Market WWTP (Wastewater Treatment Plant) to be constructed. From the data obtained, it appears that the amount of waste from meat and fish cutting is not significant and will produce a small amount of wastewater. Therefore, the wastewater from meat and fish cutting will be mixed with the wastewater from toilets. Wastewater production assumes that 80% of clean water needs for the market. According to the 'Construction and Building Guidelines, Ministry of Public Works,' clean water needs for the market is 0,1 l/s.

Table G.5. Market Wastewater Generation

	Forecast year						
	2024	2025	2026	2027	2028	2029	2030
Market (l/s)	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Market (m^3/10 hour)/(m^3/day)	2,88	2,88	2,88	2,88	2,88	2,88	2,88

Source: Civil Engineering Team Analysis

5. WWTP unit type recommendation

An improved septic tank can use a combined system (2 compartments) with an additional grease trap to filter fats and oils from the wastewater from meat and fish cutting. The dimensions that can be used are length (L) = 2.5 m; width (W) = 1.3 m; and height (H) = 1.8 m. The design of the market WWTP is shown in Figure G.5 and G.6. The estimated price for the market WWTP is IDR 80 Million.

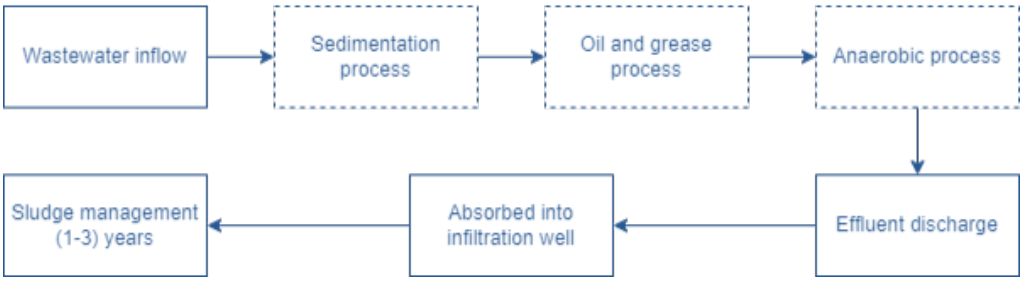


Figure G.4. Market WWTP diagram
Source: Civil Engineering Team Analysis

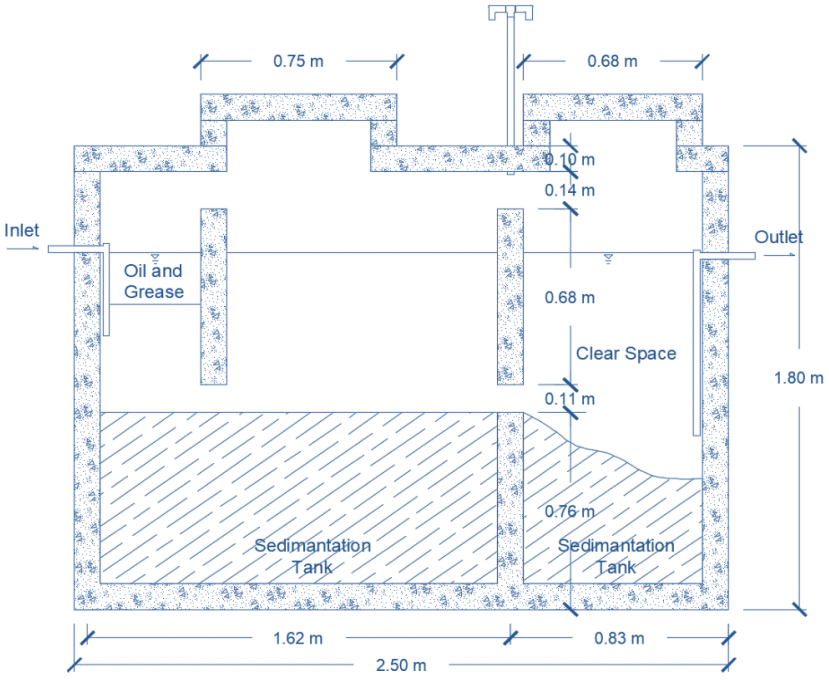


Figure G.5. Cross Section A-A' for Market WWTP

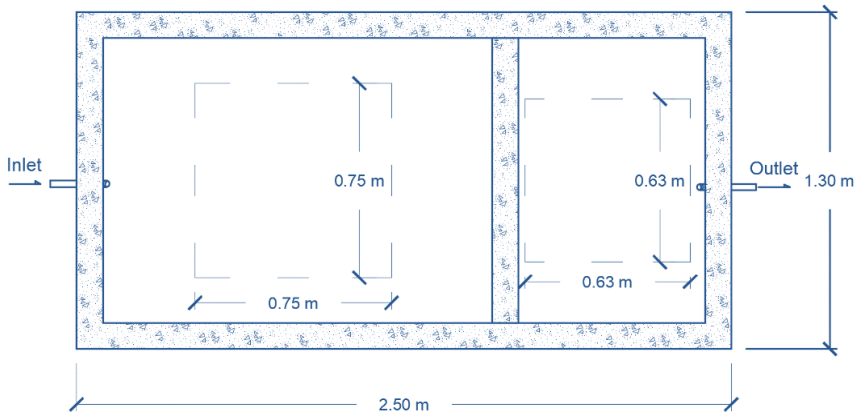


Figure G.6. Top View A-A' for Market WWTP

6. Farm Wastewater Treatment

- Analysis of the availability of feed and water resources for cattle farm

The trend in cattle farm production is assumed to be stagnant and tending to decline, considering that the RDTR (Spatial Planning) for the Rejodani II area designated for food crops will remain sustainable up to 2043. But for the Rejodani I area designated for settlements that will not remain sustainable. So, cattle farm in Rejodani I cannot be sustained.

- Recommendation on wether the farm should be maintained or not. It can be maintained in a concentrated area (Rejodani II), supported by the presence of a biodigester.
- Sludge generated from Rejodani II cattle farm

According to SNI 7826:2023, the sludge is calculated using the ratio of manure = 1:1. The sludge calculation uses the highest number of cuttle farm from year to year. The assumption is that the weight of one cow is 200 kg (average weight) with a manure production of 28.6 g/kg/day, while for goats, it is assumed to be 50 kg (average weight) per goat with a manure production of 18.1 g/kg/day.

Table G.6. Sludge Details for The Biodigester

Type of Livestock	Amount	Waste per day (kg)	Water Needed for Sludge per day (liter)
Cow	40	229	229
Goat	20	18	18

Source: Civil Engineering Team Analysis

- Biodigester design for cattle farm sludge treatment

Concrete dome-type biodigester in accordance with SNI 7826:2023 will have several criterias to design it.

Table G.7. The Design of Biodigester

Parameter	Unit	Size
I. Digestor Tank		
Volume of digestor tank	m^3	25
Volume of gasses room	m^3	6,25
II. Bak Raw Material Mixing Tank		
Minimum size of a cylindrical shape with a mixer (H×D)	cm	60×60
III. Manhole Size		
Type 1 *Manhole* (L×W)	cm	60×60
IV. Organic Sludge Output Storage Tank	Same with digester tank	

(Source: SNI 7826:2023)

- Bill of quantity for biodigester installation

This calculation will be carried out according to the UNIT PRICE OF WORK (HSP) for Construction in the Field of Public Works and Housing (Bidang Cipta Karya dan Perumahan). The breakdown for the calculation is in Table G.8.

Table G.8. BoQ for Biodigester

No.	Site Work	Note	Amount	Unit	Unit Cost	Total Cost
Materials used in Construction						
1	Land Cleaning	Worker	33,95	m2	IDR 11,616	IDR 394,361
		Foreman				
2	Land Removing	Worker	52,61	m3	IDR 87,195	IDR 4,587,232
		Foreman				
3	Formwork Installation	Worker	85,36	m2	IDR 106,549	IDR 9,094,610
		Foreman				
		Plywood				
		Nail				
3	Reinforcement	Worker	48,65	kg	IDR 134,460	IDR 6,541,528
		Foreman				
		Rebar (D = 8mm)				
		Tie wire				
4	Casting	Worker	5,97	m3	IDR 970,686	IDR 5,799,792
		Foreman				
		Portland cement				
		Concrete sand				
		Agregate				
		Water				
		Concrete mixer				
Additional Materials						
5	PVC Pipe 10"		1	unit	IDR 92,575	IDR 92,575
6	PVC Pipe Tape		1	unit	IDR 25,000	IDR 25,000
7	PVC Pipe Glue		1	unit	IDR 20,000	IDR 20,000
8	PVC T-Fitting		1	unit	IDR 5,000	IDR5,000
9	Gas Pipe		1	set	IDR 200,000	IDR 200,000
10	Stove		1	unit	IDR 600,000	IDR 600,000
11	Manometer		1	unit	IDR 300,000	IDR 300,000
12	Lamp		6	unit	IDR 395,000	IDR 2,370,000
Total						IDR 30,030,099

Source: Civil Engineering Team Analysis

H. Terms of Activities and Land Use (ITBX)

No	Activities	BA	PS	RTH-4	RTH-7	BJ	P-1	KPI	W	R-3	SPU-2	SPU-3	K-1	K-3
001	Annual Crop Farming	X	I	B	X	X	I	I	I	I	I	I	I	I
002	Annual Crop Farming (Excluding Narcotic and Illegal Medicinal Plants)	X	I	B	X	X	I	I	I	I	I	I	I	I
003	Annual Crop Farming (Narcotics and Medicinal Plants)	X	X	X	X	X	X	X	X	X	X	X	X	X
004	Houseplant Farming and Plant Breeding	X	I	B	X	X	I	I	I	I	I	I	I	I
005	Cattle and Buffalo Farming and Horse Farming and Similar Livestock Farming	X	B	B	X	X	B	X	B	X	X	X	X	B
006	Sheep and Goat Farming	X	B	B	X	X	B	X	B	B	X	X	X	B
007	Poultry Farming	X	B	B	X	X	B	X	B	B	X	X	X	X
008	Other Livestock Farming	X	B	X	X	X	B	B	B	B	X	X	X	B
009	Agricultural and Post-Harvest Support Services	X	X	X	X	X	B	I	I	B	X	X	X	B
010	Procurement and Distribution of Natural and Artificial Gas (Bio Gas Procurement)	X	B	X	X	X	B	B	X	B	X	X	B	B
011	Water Treatment	T	B	X	X	B	I	B	I	I	B	B	I	I
012	Water Treatment Supporting Activities	T	T	B	X	X	I	B	I	I	B	B	B	B
013	Collection, Treatment, and Disposal of Wastewater, Waste, and Non-Hazardous Waste	X	B	B	X	X	B	B	B	B	B	B	B	B
014	Collection, Treatment, and Disposal of Wastewater and Hazardous Waste	X	X	X	X	X	X	B	X	B	B	B	B	B

No	Activities	BA	PS	RTH-4	RTH-7	BJ	P-1	KPI	W	R-3	SPU-2	SPU-3	K-1	K-3
015	Organic Waste Compost Production	X	B	B	X	X	B	B	B	B	B	B	B	B
016	Remediation Activities and Other Waste and Waste Management	T	T	X	X	X	B	B	X	B	B	B	B	B
017	Residential Building Construction	X	X	X	X	X	B	T	X	B	B	X	I	I
018	Road Civil Building Construction	B	B	B	X	B	B	I	I	B	I	I	I	I
019	Construction of Irrigation and Drainage Networks	B	B	B	B	B	B	I	I	B	I	I	I	I
020	Civil Building Clean Water Treatment Construction	B	B	B	X	B	B	I	I	B	I	I	I	I
021	Civil Building Infrastructure and Facilities of Solid, Liquid, and Gas Waste Treatment Systems Construction	B	B	B	X	B	B	I	I	B	I	I	I	I
022	Groundwater Well Creation/Drilling	X	B	B	X	X	B	I	I	B	I	I	I	I
023	Construction of Irrigation, Communication and Other Waste	B	B	X	X	X	B	I	I	B	I	I	I	I
024	Water Resources Infrastructure Building Construction	B	B	B	X	X	B	I	I	B	I	I	I	I
025	Specialized Retail Trade of Food Commodities from Agricultural Products at Stores	X	X	X	X	X	X	T	B	B	X	X	I	I
026	Storage of Hazardous and Toxic Waste	X	X	X	X	X	X	I	X	B	X	X	B	B
027	On Street Parking Activities	X	X	X	X	B	X	X	X	B	X	X	B	B

No	Activities	BA	PS	RTH-4	RTH-7	BJ	P-1	KPI	W	R-3	SPU-2	SPU-3	K-1	K-3
028	On Street Parking Activities	X	B	B	X	X	X	I	I	I	I	I	I	I
029	Star Hotels	X	X	X	X	X	X	X	B	B	X	X	B	B
030	Hostel (Low-cost Hotel)	X	X	X	X	X	X	X	B	B	X	X	B	B
031	Vila	X	X	X	X	X	X	X	B	B	X	X	B	B
032	Hotel Apartments	X	X	X	X	X	X	X	B	B	X	X	B	B
033	Restaurant	B	B	X	X	X	B	B	B	B	X	X	B	B
034	Dinner-House Restaurant	B	B	X	X	X	B	B	B	B	X	X	B	B
035	Food Stalls	X	B	B	X	X	B	B	B	B	X	X	B	B
036	Mobile Food Provision/Non-Fixed Location	X	X	B	X	X	B	B	B	B	X	X	B	B
037	Restaurants and Other Mobile Food Provision	X	X	B	X	X	B	B	B	B	X	X	B	B
038	Café	B	B	X	X	X	X	B	B	B	X	X	I	I
039	Beverage Shops	X	X	B	X	X	B	B	B	B	X	X	I	I
040	Mobile Beverage Provision/Non-Fixed Location	X	X	B	X	X	X	B	B	B	X	X	B	B
041	Self-owned or Leased Real Estate	X	X	X	X	X	X	X	X	T	X	X	I	I
042	Venue Rental for MICE Activities and Special Events	X	X	B	X	X	X	X	X	B	B	B	I	I
043	Tourism Area	X	X	X	X	X	B	X	I	X	X	X	B	B
044	Industrial Zone	X	X	X	X	X	X	I	X	X	X	X	X	X
045	Field Facilities	X	X	B	X	X	X	B	B	B	I	I	B	B
046	Recreational Park	X	B	B	X	X	X	X	I	I	B	B	B	B
047	Recreational Parks/Tourism Parks	X	B	X	X	X	B	X	I	B	B	B	B	B
048	Residential Houses	X	B	X	X	X	B	T	T	I	B	B	I	I

Notes

I : Permitted
T : Permitted with Restrictions
B : Conditionally Permitted
X : Not Permitted

BA : Water Bodies *(Badan Air)*
PS : Protected Area (Perlindungan Setempat)
RTH-4 : Village Park *(Taman Kelurahan)*
RTH-7 : Cemetery *(Pemakaman)*
BJ : Roads *(Badan Jalan)*
P-1 : Agricultural Zone *(Tanaman Pangan)*
KPI : Industrial Zone *(Kawasan Peruntukan Industri)*
W : Tourism Zone *(Pariwisata)*
R-3 : Medium Density Residential Area *(Rumah Kepadatan Sedang)*
SPU-2 : District Scale Public Service Facilities *(Sarana Pelayanan Umum Skala Kecamatan)*
SPU-3 : Neighborhood Scale Public Service Facilities *(Sarana Pelayanan Umum Skala Kelurahan)*
K-1 : City Scale Trade and Services *(Perdagangan dan Jasa Skala Kota)*
K-3 : Neighborhood Scale Trade and Services *(Perdagangan dan Jasa Skala SWP)*

I. Abbreviations and Acronyms

Bahasa Indonesia	English	Explanation
APBD (Anggaran Pendapatan Belanja Daerah)	Regional Revenue and Expenditure Budget	Regional government budgeting plan for one year as stipulated by regional regulations. APBD can be used as a means of communication from the regional/local government to its people regarding allocation priorities carried out by the regional government after coordinating with the legislative body.
APBDes (Anggaran Pendapatan dan Belanja Desa)	Village Revenue and Expenditure Budget	Village budgeting plan which contains plans for village financial income and expenditure in one year.
Bappeda (Badan Perencanaan Pembangunan Daerah)	Local Planning Agency	Regional government's department/agency that has the task of carrying out the preparation of regional development planning, implementation of regional development planning, control, monitoring and evaluation of the implementation of regional development planning and research and development tasks.
BBWS (Balai Besar Wilayah Sungai)	River Basin Organization	Technical implementing unit of the Directorate General of Water Resources, Ministry of Public Works and Public Housing, which is tasked with managing water resources in the River Basin
DD (Dana Desa)	Village Funds	Funds sourced from the State Revenue and Expenditure Budget allocated for villages, transferred through the regency/city Regional Revenue and Expenditure Budget and used to finance the implementation of government, implementation of development, community development and community empowerment.
Dinkes (Dinas Kesehatan)	Department of Health	Regional government's department that carry out government affairs in the health sector.
Dinperindag (Dinas Perindustrian dan Perdagangan)	Department of Industry and Trade Service	Regional government's department that carry out government affairs and assistance tasks in the industrial and trade sectors.
Dispertaru	Department of Land and Spatial Planning	Regional government's department that carry out government affairs in land and spatial planning.
DLH (Dinas Lingkungan Hidup)	Department of Environment	Regional government's department that carry out government affairs in the fields of environment, cleanliness and parks. In addition, the scope of this department includes solid waste, wastewater management, parks and green open spaces, and environmental conservation.
DP3 (Dinas Pertanian, Pangan dan Perikanan)	Department of Agriculture, Food and Fisheries	Regional government's department that carry out government affairs in the fields of agriculture, food, and fisheries.

Bahasa Indonesia	English	Explanation
DPUPKP (Dinas Pekerjaan Umum, Perumahan dan Kawasan Permukiman)	Department of Public Works and Housing	Regional government's department that carry out government affairs in the fields of public works, housing, and residential areas.
IPAL (Instalasi Pengolahan Air Limbah	Wastewater Treatment Plan (WWTP)	A structure designed to remove biological and chemical wastes from water to allow the water to be harmless and usable for other activities.
KPY (Kawasan Perkotaan Yogyakarta)	Yogyakarta Urbanized Area	National Activity Center in the Special Region of Yogyakarta Province that functions as strategic economic areas located in Yogyakarta City and several sub-districts in Sleman Regency and Bantul Regency.
PAMDUS (Paguyuban Air Minum Dusun)	Community Clean Water Provision (Sub-Village)	Community-based water provision in sub-village level
PAMSIMAS (Penyediaan Air Minum dan Sanitasi Berbasis Masyarakat)	Community-Based Drinking Water and Sanitation Provision Program	National flagship program to increase rural population access to adequate drinking water and sanitation facilities through a community-based approach.
PDAM (Perusahaan Daerah Air Minum)	Local Water Company	A Regional-Owned Enterprise which is engaged in water services, with all or most of the capital owned by the Region.
Perbup (Peraturan Bupati)	Regent Regulation	Regulations set by the local head of government (regent/mayor) are implementing local regulations (Perda).
Perda (Peraturan Daerah)	Regional/Local Regulation	Laws and regulations established by the DPRD with the joint approval of the Regional Head (governor or mayor/regent).
Pokja PKP (Kelompok kerja Perumahan dan Kawasan Permukiman)	Housing and Settlement Area Working Group	Implementing elements of the Housing and Settlement Area Development Steering Team and formed to assist the Steering Team's duties which consist of representatives from each department's at the local government level which has programs/activities in the Housing and Settlement Area sector.
Inpres (Instruksi Presiden)	Presidential Instruction	Presidential Instructions are regulatory in nature and apply internally. Therefore, they are only used by the president to instruct institutions under his authority to do something.
RDTR (Rencana Detail Tata Ruang)	Detailed Spatial Plan	Detailed plans for the spatial planning of regencies/cities, supplemented by district/city zoning regulations
RPJMD (Rencana Pembangunan Jangka Menengah Daerah)	Local Medium-Term Development Plan	The Local Medium-Term Development Plan is a planning document for a five years period

Bahasa Indonesia	English	Explanation
RPJMKal/ RPJM Kalurahan (Rencana Pembangunan Jangka Menengah Kalurahan)	Village Medium-term Development Plan	The equivalent of RPJMD at the village level.
RPJPD (Rencana Pembangunan Jangka Panjang Daerah)	Local Long-Term Development Plan	The Local Long-term Development Plan is a planning document for a twenty-year period.
RT (Rukun Tetangga)	Community Association	The division of villages in Indonesia under Rukun Warga. RT is the lowest administrative division of Indonesia.
RTRW (Rencana Tata Ruang Wilayah)	Spatial Plan	Spatial plan is the result of a spatial planning process. This planning document consists of National Spatial Plan, Province Spatial Plan, and Regency/City Spatial Planning.
Rusunawa (Rumah Susun Sederhana Sewa)	Low-cost Rental Apartment	Multi-storey buildings built by the government in a residential area and rented to low-income families.
RW (Rukun Warga)	Neighborhood Association	The division of regions in Indonesia under the Village or Kelurahan (or under: Dusun or sub-village). Rukun Warga is not included in the division of administration, and the formation of local communities is through consultation in the framework of community service set by the village or villages.
SE (Surat Edaran)	Circular Letter	Official documents containing notifications, explanations and/or instructions on how to carry out certain matters that are considered important and urgent
SK Bupati (Surat Keputusan Bupati)	Regent's Decree	Official documents in the form of a Decree which is of a stipulation nature and signed by the Regent
TKD (Tanah Kas Desa)	Village Treasury Land	Land owned by the village government and managed for village business activities so that it becomes a source of village income
TPA (Tempat Pembuangan Akhir)	Landfill	Location where waste reaches the final stage of its management from when it first appears at the source, collection, transfer/transportation, processing and disposal
TPS3R (Tempat Pengolahan Sampah - Reduce Reuse Recycle)	3R Waste Management	The main concept of waste processing in TPS 3R is to reduce the quantity and/or to improve the characteristics of the waste, which will be further processed in the landfill (TPA). The system of TPS 3R is the same as MRF (materials recovery facility) that processes recyclable materials then sells them to manufacturers as raw materials for new products.

J. Terminology and Definitions

Terminology	Definition
Action plan	A detailed strategy outlining the steps, resources, and timelines needed to achieve a particular goal or objective (UNEP, 2019).
Activity	A specific task, event, or operation that is undertaken or performed (WHO, 2023).
Blue-Green Infrastructure	A sustainable approach to urban planning and design that incorporates natural elements, such as water bodies, green spaces, and vegetation, to provide environmental, social, and economic benefits (European Commission, 2020).
Ecosystem service	The benefits that people obtain from ecosystems, including provisioning services (like food and water), regulating services (like climate regulation and flood control), cultural services (like recreation and aesthetic values), and supporting services (like nutrient cycling and pollination) (Intergovernmental Platform on Biodiversity and Ecosystem Services, 2022)
Greywater	Wastewater from sinks, showers, laundry machines, and other non-toilet fixtures that is not contaminated with human waste (Environmental Protection Agency, 2023)
Hybrid solutions	A combination of different technologies or approaches to address a specific challenge, often involving a blend of traditional and innovative methods. In the European context, hybrid solutions are frequently used in areas such as energy, transportation, and climate change mitigation (European Commission, 2023)
Land use development	The process of planning, managing, and controlling how land is used, including decisions about zoning, infrastructure development, and land conservation (American Planning Association, 2024).
Master Plan	A comprehensive document that outlines the long-term vision, goals, and strategies for the development and growth of a specific area, such as a city, region, or country. Master plans are often used to guide urban development, infrastructure planning, and environmental protection (European Commission, 2016)
Nature-based solutions (NbS)	Cost-effective solutions inspired by nature that leverage natural processes and ecosystems to address societal challenges, providing environmental, social, and economic benefits while building resilience (URBAN GreenUP, 2023) .
Peri-Urban Area	A region located on the fringe of a city or urban agglomeration, characterized by a mix of urban and rural land uses (UN-Habitat, 2016)
Polycentric approach	A polycentric approach is a development strategy that promotes the integration of various aspects or pillars of urban planning and development, such as economic, social, environmental, and cultural factors. This approach aims to create more balanced and sustainable urban environments by considering the interconnectedness of these different dimensions.

Terminology	Definition
PolyUrbanWaters	A project or initiative that focuses on sustainable water management in urban and peri-urban areas, often incorporating nature-based solutions (PolyUrbanWaters Project, 2023)
Regency	In Indonesia, a regency is a second-level administrative division below a province.
Regency government	The government body that administers a regency in Indonesia.
Settlement development	The process of creating or expanding human settlements, including urban, suburban, and rural areas (UN-Habitat, 2020)
Stormwater	Stormwater is rainwater that flows over impervious surfaces, such as roads, roofs, and pavements, and enters drainage systems (European Commission, 2015)
Solid waste	Waste materials that are solid or semi-solid, such as garbage, rubbish, and construction debris (WHO, 2023)
Statutory planning	Planning that is based on laws and regulations, often involving zoning, land use controls, and development permits (American Planning Association, 2024)
Strategy	A plan of action designed to achieve a particular goal or objective (Harvard Business Review, 2023)
Sub-district	A subdivision of a regency, referred to as *Kecamatan* in Indonesian. A kecamatan is typically made up of several villages and is administered by a camat (head of kecamatan).
Sub-district government	The government body that administers a sub-district.
Sub-village	A subdivision of a village, referred to as *Dusun / Dukuh / Padukuhan* in Indonesia.
Sub-village community	The group of people living in a sub-village, often characterized by shared cultural, social, or economic ties.
Sustainable drainage systems (SUDS)	A set of measures that mimic natural processes to manage stormwater runoff sustainably, reducing its impact on water quality and quantity while providing additional benefits like improved biodiversity and amenity value (European Commission, 2015)
Strengths, Weaknesses, Opportunities, and Threats (SWOT)	A strategic planning tool used to identify an organization's internal strengths and weaknesses, as well as external opportunities and threats (Harvard Business Review, 2023).
Transition pathway	A planned sequence of actions or steps designed to move from one state to another, often used in the context of sustainability or climate change (IPCC, 2023)
Village	Lowest level of administrative division within a district. It is a self-governing entity with its own elected village head (Kepala Desa) and village council (Perangkat Desa). Villages are responsible for managing local affairs,

Terminology	Definition
	including social services, education, health, and infrastructure.
Village government	The government body that administers a village.
Vision building	The process of developing a shared, aspirational image of a desired future state (UNDP, 2023)
Waste bank	A facility or program that collects recyclable materials from the public for recycling or reuse (World Bank, 2023)
Water catchment	An area that collects and drains precipitation (IPCC, 2012)
Water-sensitive community	A community that has implemented strategies and practices to manage water resources sustainably and resiliently, often incorporating nature-based solutions (UNEP, 2023)
Water-sensitive urban development	A development approach that prioritizes the sustainable and resilient management of water resources in urban areas, often incorporating green infrastructure and water-sensitive design (ASCE, 2023)
Water-sensitive planning	A planning process that considers water resources as an integral part of urban development, incorporating strategies to manage stormwater runoff, reduce water consumption, and improve water quality (IWA, 2023)
Water-sensitive village	A village that has implemented strategies and practices to manage water resources sustainably and resiliently, often incorporating nature-based solutions and community-based approaches (UN-Habitat, 2023)
Water supply	The provision of water to a community or region for domestic, industrial, and agricultural purposes (WHO, 2023)

K. Policy Brief

POLICY BRIEF
Towards Water-Sensitive Development of Sleman Regency

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in collaboration with the Bremen Overseas Research and Development Association (BORDA),
Technical University Berlin (TU Berlin), University of Applied Science Koeln (TH Koln) Jerman,
with the support of the German Federal Ministry of Education and Research (BMBF).

Introduction

This Policy Brief was prepared based on the experience and summary of the activities of the PolyUrbanWaters (PUW) team in implementing the Polycentric Approach in Urban Water Management in Sleman Regency since 2019. The PUW local team consisting of the Universitas Gadjah Mada Department of Architecture and Planning, Universitas Gadjah Mada Department of Environmental Geography, Kota Kita, and AKSANSI collaborates with the Bremen Overseas Research and Development Association (BORDA), Technical University Berlin (TU Berlin), University of Applied Science Koeln (TH Koln), and is fully supported by the German Federal Ministry of Education and Research (BMBF).

The entire process of this activity also collaborated and was carried out with the full support of the Sleman Regency Regional Government, especially the Sleman Regency Regional Development Planning Agency (BAPPEDA) and related agencies. This document contains policy recommendations based on a long process of introducing and implementing the approach *Polycentric Urban Water Management* (Polycentric Approach in Urban Water Management) in Sleman Regency, especially in Sariharjo and Padukuhan Rejodani I and Rejodani II. It is hoped that this Policy Brief can immediately be transferred into policies, programs and activities, at various levels, both at the regency, village, and community levels to realize Water-Sensitive Sleman Regency.

The methodology used in this Policy Brief

This policy brief was prepared based on studies, strategy development, vision, mission and action plans that have been implemented in Sariharjo Village as a whole, and specifically in Rejodani I and Rejodani II sub-villages which represent the development conditions of Sleman Regency, especially in the northern part. This recommendation can be a model for peri-urban areas that are experiencing rapid growth and have similar characteristics in Sleman Regency, Yogyakarta Urban Area, as well as fast-growing areas in other secondary cities in Indonesia.

The findings and recommendations are based on the PolyUrbanWaters approach, which combines eight dimensions of water-sensitive urban development. These dimensions include; 1) management of land use changes and their dynamics; 2) management of the development of settlement patterns; 3) waste management; 4) wastewater management; 5) clean water management; 6) stormwater management; 7) water catchment areas management; and 8) green and blue infrastructure management. These eight dimensions are interrelated and important to understand in facing current and future water management challenges in the development dynamics of Sleman Regency.

The Urgency of a Water-Sensitive Development Approach in Sleman Regency

1. The findings of this activity show the urgency for the government, along with society and the private sector, to overcome the increasingly pressing water management problems in Sleman Regency;

2. Increasing flooding, groundwater pollution and decreasing groundwater levels are the main problems faced by most areas of Sleman, while quality management of clean water and wastewater services as well as waste management are not yet fully guaranteed;
3. Development that prioritizes economic growth needs to be accompanied by a water-sensitive urban development concept to ensure the sustainability of Sleman Regency, especially in peri-urban areas which are experiencing development pressure without adequate urban planning and infrastructure development;
4. Even though it is located in the upstream area, including the slopes of Mount Merapi, which is an area with abundant water resources, the process of transformation into an urban area in Sleman Regency is taking place quickly. The success of Sleman Regency in building a water-sensitive regency will be a key factor in the sustainability of the Yogyakarta region;
5. Along with the rapid population growth of Sleman Regency, accompanied by the expansion of areas with urban characteristics, economic and social changes in Sleman Regency are becoming increasingly rapid. This scenario further increases the risk to water security in the region, unless development is managed carefully;
6. Vulnerability to water problems in Sleman Regency may worsen in the future due to the impacts of climate change, such as increased frequency and intensity of floods and longer dry seasons, which may become normal. Therefore, preventive and adaptive measures need to be implemented to deal with this threat.

Peri-urban Problems and Challenges: The Need for New Directions and Breakthroughs

1. In the peri-urban area of Sleman Regency, including the Sariharjo Village, the eight dimensions of water-sensitive development have so far not been managed well.
2. Each development impact prognosis indicates a high risk to regional sustainability, as long as current urban development practices are implemented using the method *Business As Usual* (BAU) continues or even accelerates. This will cause:
    a) uncontrolled urban development *(urban sprawl)*, characterized by one of the significant loss of green areas such as rice fields and other green spaces, will result in changes in the character of the sub-urban areas of Sleman Regency;
    b) decline in the quality of the residential environment;
    c) serious risks to public health and the environment;
    d) lack of sufficient and safe clean water supply,
    e) frequent flooding; And
    f) loss of social coherence.

The Need for a New Vision: Water-sensitive Development to Ensure Sustainability

1. A consistent and effective strategy is needed to overcome the challenges of water management and urban development in the peri-urban area of Sleman Regency;
2. The strategy must adopt the concept "Water-Sensitive Urban Development" by prioritizing water issues as a cross-sector issue in sustainable development;
3. The strategy aims to ensure: 1) affordable, healthy and environmentally friendly settlement; 2) provision of good quality and affordable clean water, safe waste water management, safe waste management and management flood; 3) a green-blue network and green (public) open spaces that are well developed and managed, and guarantee accessibility and affordability for all residents; 4) fair and inclusive distribution for various community groups and other types of users; and 5) inclusive governance;
4. This strategy must take into account the dynamics of development in peri-urban areas, such as the transformation of settlement structures, providing guidance for new development, and providing water services that are appropriate to the needs and carrying capacity of peri-urban areas;

5. The strategy must encourage sustainable development and infrastructure management with the understanding that "nature" and its ecosystem services provide an important role for water security, livability and resilience of Sleman Regency;
6. Implementation of this strategy must be based on a multi-stakeholder participatory process involving public entities, communities, the private sector, and academia, using a polycentric approach to water governance in elaborating good practices on how to develop strategies and action plans that can be effectively accommodated at the sub-village level and community.

Water sensitive Development Policy

1. Development must follow water-sensitive principles, which have become mainstream in development planning in Sleman Regency;
2. A clear and explicit policy regarding water-sensitive development is needed through Regional Regulations (Perda) or Regent Regulations (Perbup) of Sleman Regency;
3. Mainstreaming water-sensitive development in all development planning documents and spatial planning documents is the basis for preparing development plans;
4. There is a need for detailed and technical Water sensitive Sleman Action Guidelines to support the Water sensitive Sleman Regional Regulation;
5. The importance of guidelines for spatial planning and development that incorporate gray and blue-green infrastructure throughout residential areas;
6. Encouragement of village governments to draft Water-sensitive Village Regulations/Kalurahan Regulations (Perdes/Perkal), especially in areas facing serious water challenges;
7. The government must increase institutional capacity and expertise to ensure effective provision of water services, especially in peri-urban areas. Capacity building is primarily aimed at community-based organizations for water-sensitive water and land management.

Action Plan for Sleman

The water-sensitive development strategy is detailed into action plans as follows:

a. Green Space Planning:
    1. Control maximum building density to 60% in all settlements by complying with building boundary lines according to the Detailed Spatial Planning Plan (RDTR).
    2. Development of public green open space at least 20% of the total land, with at least 20% in the form of public green open space to provide a minimum of 30% green open space in Sleman Regency.
    3. Protection of river banks and incentives for the development of green spaces provided by the community and the private sector.
    4. Conservation of protected green areas, including agricultural land/rice fields by enforcing laws regarding the suitability of land use with spatial planning and by encouraging organic farming systems, high economic farming, and increasing the capacity of farmers and farmer groups.
b. Integrated stormwater management approach:
    Construction of infiltration wells, integration of drainage channels with infiltration wells, construction of infiltration channels, implementation of water-sensitive paving models, construction of reservoirs, and preservation of river banks.
c. Reducing Gaps by Improving Modern and Sustainable Infrastructure Services:
    1. Environmentally sensitive design for new residential complexes (including *gated communities)*
    2. Extensive improvement of rural areas by carrying out systematic water infrastructure development, improving public spaces, as well as improving the performance of waste and waste management originating from agriculture and MSMEs.
d. Accelerating the Expansion of the Clean Water Pipeline Network:

Expanding the clean water pipe network to all segments of society, private entities and public spaces, as well as increasing public awareness about the importance of clean water.

e. Wastewater Management:
   Improving centralized and decentralized services in terms of effective fecal sludge management including routine maintenance, improving septic systems, and strict law enforcement. Commercial and service wastewater management is also important. It is important to pay attention to the location of these entities to be close to adequate clean water facilities.
f. Waste management:
   Implementation program 3R *(Reduce, Reuse, Recycle)* waste by sorting waste from its source, namely from the household level, increasing the effectiveness and efficiency of waste banks, increasing the number of TPS3R units, completing the construction of two waste site in Sleman Regency and ensuring sustainable management, as well as issuing a regent's regulation regarding "no bags plastic" at a minimarket in the Sleman area.
g. Stakeholders Capacity Building:
   Developing stakeholders capacity within the Sleman Regency government, village government, Padukuhan, and the private sector regarding the development of water-sensitive sub-villages.

Water-oriented Development for Sleman: The Key to Success

1. Political commitment and consistency of regional leaders, in this case the Regent and Deputy Regent, including a commitment to increase the capacity and professionalism of services providing basic water-related infrastructure, especially in peri-urban areas;
2. Multi-party collaboration in the field of Water-Sensitive development with the aim of increasing professionalism and efficiency of services;
3. Inclusive development process by involving all elements of society and the private sector, as well the parties others include universities, mass media, and *influencers*;
4. Legal support, clear regulations, regulatory enforcement, as well as awareness and participation of the community and stakeholders other related.

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POLYURBAN WATERS