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Planning Of A Clean Water Supply System In The Coastal Area Of Boneatiro Barat

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ABSTRACT

The availability of clean water is a fundamental requirement that must be fulfilled in terms of quantity, quality, continuity, and sustainability, particularly in coastal areas where water resources are vulnerable to environmental changes and seawater intrusion. Boneatiro Barat Village, Kapontori District, Buton Regency, is a coastal area that already has a clean water supply system; however, its existing raw-water source is located outside the village administrative area. This condition creates dependence on water resources from neighboring areas and may potentially affect the sustainability of water services. This study aims to identify alternative water-source potential, analyze the clean-water demand of the community for the next 10 years, and plan an appropriate water supply and distribution system for the Boneatiro Barat area. The study employed a descriptive quantitative approach through field surveys, direct observation, interviews, documentation, and secondary data collection. Primary data included water-source conditions, spring discharge, elevation, and existing distribution-network conditions, while secondary data consisted of population data and existing water-distribution network information. Population projections were calculated using the geometric method, while water-demand analysis included domestic demand, non-domestic demand, water losses, maximum daily demand, and peak-hour demand. Furthermore, water-source availability was analyzed, followed by the planning of pipeline networks, reservoirs, and pumping systems based on the topographical conditions and service requirements. The results of this study are expected to provide a technical basis for developing a more independent, effective, and sustainable clean-water supply system for the community of Boneatiro Barat Village.

Keywords: clean water, coastal area, alternative water source, water demand, distribution network, Boneatiro Barat.

ABSTRAK

Ketersediaan air bersih merupakan salah satu kebutuhan dasar masyarakat yang harus dipenuhi secara kuantitas, kualitas, kontinuitas, dan keberlanjutan, terutama pada wilayah pesisir yang memiliki karakteristik sumber daya air yang rentan terhadap perubahan lingkungan dan intrusi air laut. Desa Boneatiro Barat, Kecamatan Kapontori, Kabupaten Buton, merupakan wilayah pesisir yang telah memiliki sistem penyediaan air bersih, tetapi sumber air baku eksisting berada di luar wilayah administrasi desa. Kondisi tersebut menyebabkan ketergantungan terhadap sumber air dari wilayah lain dan berpotensi mengganggu

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keberlanjutan pelayanan air bersih. Penelitian ini bertujuan untuk mengidentifikasi potensi sumber air alternatif, menganalisis kebutuhan air bersih masyarakat hingga 10 tahun mendatang, serta merencanakan sistem penyediaan dan distribusi air bersih yang sesuai dengan kondisi wilayah Boneatiro Barat. Penelitian menggunakan pendekatan deskriptif kuantitatif melalui survei lapangan, observasi, wawancara, dokumentasi, dan pengumpulan data sekunder. Data primer meliputi kondisi sumber air, debit mata air, elevasi, dan kondisi jaringan distribusi, sedangkan data sekunder meliputi jumlah penduduk dan data jaringan eksisting. Proyeksi jumlah penduduk dilakukan menggunakan metode geometrik, sedangkan analisis kebutuhan air mencakup kebutuhan domestik, non-domestik, kehilangan air, kebutuhan harian maksimum, dan kebutuhan jam puncak. Selanjutnya dilakukan analisis ketersediaan sumber air dan perencanaan jaringan perpipaan, reservoir, serta sistem pemompaan berdasarkan kondisi topografi dan kebutuhan pelayanan. Hasil penelitian diharapkan dapat menjadi dasar teknis dalam pengembangan sistem penyediaan air bersih yang lebih mandiri, efektif, dan berkelanjutan bagi masyarakat Desa Boneatiro Barat.

Kata Kunci: Air bersih, wilayah pesisir, sumber air alternatif, kebutuhan air, jaringan distribusi, Boneatiro Barat

INTRODUCTION

Access to safe and adequate water is a fundamental requirement for human health, domestic activities, and socioeconomic development. The availability of drinking water cannot be assessed only from the existence of a water source, but must also consider its quality, quantity, continuity, accessibility, and reliability. The World Health Organization emphasizes that safely managed drinking-water services should be available when needed and free from contamination, because inadequate water services remain closely associated with waterborne diseases and other public-health risks (World Health Organization [WHO], 2023). Therefore, water-supply planning needs to integrate the characteristics of the water source, population demand, infrastructure capacity, and long-term operational sustainability.

The challenge of providing reliable water services becomes more complex in rural and coastal areas. Coastal communities frequently depend on groundwater, springs, rainfall, or other locally available sources, while their water resources are vulnerable to environmental and hydrological changes. In particular, groundwater systems in coastal areas are susceptible to seawater intrusion caused by excessive groundwater abstraction, low hydraulic gradients, sea-level rise, and other anthropogenic pressures (Bharadwaj et al., 2022). Consequently, the development of a water-supply system in a coastal settlement should not merely focus on increasing extraction capacity, but should also consider source sustainability and the protection of freshwater resources.

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Water supply planning is also important from the perspective of public health. Water that is physically available does not necessarily meet the requirements for safe consumption. The WHO Guidelines for Drinking-water Quality recommend a risk-based approach extending from the catchment to the consumer, supported by health-based targets, water safety planning, and surveillance (WHO, 2022). This approach indicates that water-supply planning should incorporate not only hydraulic performance but also the protection and monitoring of water quality throughout the supply chain. The latest WHO guidance further emphasizes the need to explicitly consider small water supplies and strengthen risk management and sanitary inspection, which is particularly relevant to rural communities served by relatively small-scale systems (WHO, 2026).

In Indonesia, the sustainability of community-based water-supply systems is likewise influenced by technical, financial, institutional, and community factors. Research on decentralized water-supply systems in Indonesia demonstrates that financial capacity, community participation, and institutional arrangements are important determinants of system sustainability (Maryati et al., 2022). Similarly, analysis of rural water-supply programs in Indonesia indicates that community contributions and regular financial mechanisms can support the continued functionality of water-supply services (World Bank-related study as reported by the authors; see also the empirical findings in *Groundwater for Sustainable Development*) (2022). Thus, planning a water-supply system for a rural coastal village should consider not only the hydraulic design but also the long-term capacity of the community to operate and maintain the infrastructure.

Boneatiro Barat Village, located in Kapontori District, Buton Regency, Southeast Sulawesi, is a coastal settlement that requires an adequate and sustainable water-supply system. Based on the preliminary information used in this study, the village has an existing water-supply system, but its raw-water source is located outside the administrative boundaries of Boneatiro Barat. Such dependence may create operational and institutional risks because the continuity of water services depends partly on access to a source controlled or located outside the village. For a rural community, developing an alternative source within its own administrative area can therefore become an important strategy for improving water-supply independence and service reliability.

The preliminary field identification indicates that Boneatiro Barat has potential alternative water sources within its administrative area, particularly a cave spring and deep groundwater that may be accessed through a drilled well. Springs and groundwater can provide strategically important sources for rural water systems when their quantity and quality are adequate. However, because Boneatiro Barat is a coastal area, groundwater abstraction must be carefully evaluated to avoid excessive pumping and potential seawater intrusion. Previous research has identified seawater intrusion as a major threat to freshwater availability in coastal aquifers, particularly where

groundwater extraction exceeds sustainable conditions (Bharadwaj et al., 2022; Werner et al., 2022).

The planning of the Boneatiro Barat water-supply system therefore requires an assessment of both water availability and future demand. Population growth directly affects domestic water requirements and consequently determines the required capacity of the water source, reservoir, pumping system, and distribution network. A 10-year planning horizon is adopted in this study to estimate future water demand and to determine whether the identified alternative sources can adequately support the projected population. The planning process also needs to account for non-domestic demand and potential water losses so that the designed system does not only meet average demand but also remains capable of responding to higher demand conditions.

From the hydraulic perspective, the characteristics of the Boneatiro Barat service area require an appropriate distribution strategy. A pumping system can be considered where differences in elevation, source location, and service-area conditions make gravity flow insufficient to provide adequate pressure. The distribution network must consequently be designed by considering pipe diameter, discharge, flow velocity, pressure, head loss, reservoir capacity, and pump requirements. Hydraulic analysis is essential because changes in pipe diameter, elevation, and demand affect the distribution of flow and pressure throughout the network. The resulting design should provide adequate service while avoiding excessive pressure and unnecessary energy consumption.

The importance of a locally based water-supply system is also supported by evidence that decentralized systems can address limitations associated with centralized water infrastructure, particularly in communities where centralized services are difficult to extend or maintain (Maryati et al., 2022). For Boneatiro Barat, the utilization of a locally available cave spring and deep groundwater has the potential to reduce dependence on an external source, provided that the sources are technically feasible, hydraulically adequate, and environmentally sustainable. The proposed approach is therefore not simply an infrastructure development project, but a strategy for improving the resilience and independence of water services at the village level.

Based on these considerations, this study focuses on **planning a clean-water supply system for the coastal area of Boneatiro Barat Village** by evaluating alternative water sources, estimating future water demand over a 10-year planning period, and designing an appropriate water distribution system. The study specifically examines the discharge capacity of the alternative spring source, projected population and water demand, and the technical configuration of the water-supply network involving pumping, reservoirs, and distribution pipelines. The results are expected to provide a technical basis for developing a more reliable, independent, and sustainable water-supply system for the community of Boneatiro Barat.

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METHOD

This study employed a **descriptive-quantitative approach** to plan a clean water supply system for Boneatiro Barat Village, Kapontori District, Buton Regency, Southeast Sulawesi. The approach was selected because the study involved field measurements, population data, water-source discharge, elevation, and hydraulic calculations to determine the capacity and configuration of the proposed water-supply system. The planning process considered the quantity, quality, continuity, and accessibility of raw-water sources, which are important considerations in the development of a drinking-water supply system (Government of the Republic of Indonesia, 2015).

The study was conducted in Boneatiro Barat Village, a coastal area consisting of Boneatiro Barat and Ladirani hamlets. The research was carried out for approximately three months, from the end of March to the beginning of June 2026. The research object consisted of the existing and potential water-supply system, including the available water sources, water-distribution network, reservoir location, pumping system, and service area. The population used as the initial basis for water-demand planning was **590 inhabitants**, while the planning horizon was established at **10 years**.

Data collection consisted of **primary and secondary data**. Primary data were obtained through direct field observation, interviews, documentation, and measurements of the existing water-supply conditions. The primary data included the location and condition of the water sources, spring discharge, elevation, existing distribution facilities, and the characteristics of the existing pipeline network. Field measurements were supported by GPS, measuring tape, camera, current-meter equipment, and Google Earth. Secondary data were obtained from the Boneatiro Barat Village Office and relevant institutions and included historical population data, existing water-distribution information, maps, and other supporting technical documents.

The data collection process began with a **literature review and preliminary field survey**. The literature review was conducted to establish the theoretical and technical basis for population projection, water-demand analysis, raw-water source evaluation, hydraulic analysis, pipeline planning, reservoir planning, and pumping-system design. The field survey was subsequently conducted to identify the actual conditions of the study area and to obtain the technical data required for system planning. This approach is consistent with the principle that water-supply planning should integrate technical infrastructure with the availability and sustainability of water resources (Government of the Republic of Indonesia, 2015).

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Population projection was performed using the **geometric method**. This method estimates future population based on the proportional growth rate calculated from historical population data. The projected population was calculated using:

$$P_n=P_0(1+r)n$$

where P_n is the projected population in year n, P_0 is the initial population, r is the annual population growth rate, and n is the projection period. The projected population was subsequently used as the basis for estimating future water requirements over the 10-year planning period.

Water-demand analysis included **domestic demand, non-domestic demand, and distribution losses**. Domestic water demand was calculated based on the projected population and the applicable unit water requirement. Non-domestic demand included water requirements for public and social facilities within the service area. Water losses were also incorporated into the calculation to obtain the total system requirement. The general calculation was expressed as:

$$Q_{total}=Q_d+Q_{nd}+Q_l$$

where Qtotal is total water demand, Q_d is domestic demand, Q_{nd} is non-domestic demand, and Q_l is water loss. The planning also considered maximum daily and peak-hour demand to determine the required capacity of the source, reservoir, pump, and distribution network. The use of a planning period and service-demand criteria follows the technical framework commonly applied in Indonesian water-supply planning.

The available water sources were evaluated based on **quantity, quality, continuity, and accessibility**. Two potential sources were considered, namely the cave spring and deep groundwater through a bore well. The spring discharge was determined through field measurement, while the feasibility of the deep groundwater source was considered in relation to its potential yield and the technical requirements of a bore-well system. Because Boneatiro Barat is located in a coastal environment, groundwater development also requires consideration of possible seawater intrusion. Water-quality assessment should therefore include relevant physical, chemical, and microbiological parameters in accordance with the applicable Indonesian drinking-water health requirements (Ministry of Health of the Republic of Indonesia, 2023).

Hydraulic analysis was performed to determine the appropriate **pipe diameter, flow velocity, discharge, pressure, and head loss** within the proposed distribution network. The continuity equation was used to establish the relationship between discharge, cross-sectional area, and flow velocity:

$$Q=AV$$

where Q is discharge, A is the cross-sectional area of the pipe, and V is flow velocity. Major head loss was evaluated using the Hazen–Williams equation, while minor losses caused by fittings,

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valves, bends, and other accessories were also considered. The total head requirement for the pumping system was determined from the elevation difference between the source and service area together with the calculated hydraulic losses.

The proposed system was designed using a **source–pump–reservoir–distribution network configuration**. The reservoir was considered as a storage and balancing component between water production and consumption, while the pumping system was used to provide sufficient hydraulic head where gravity flow could not adequately serve the target area. The final design therefore considered source capacity, projected water demand, reservoir requirements, pipe dimensions, pump head, flow velocity, and pressure at critical points in the distribution network.

The analysis was conducted sequentially, beginning with **field-data collection, population projection, water-demand calculation, raw-water-source evaluation, hydraulic analysis, and infrastructure planning**. The final stage consisted of evaluating whether the proposed water source and distribution system could meet the projected 10-year demand while maintaining adequate quantity, pressure, and continuity. The results were then used to formulate the recommended water-supply system for Boneatiro Barat Village.

RESULTS AND DISCUSSION

Characteristics of the Study Area

The study was conducted in Boneatiro Barat Village, Kapontori District, Buton Regency, Southeast Sulawesi, Indonesia. The village is a coastal settlement consisting of two hamlets, namely Boneatiro Barat and Ladirani. The location has characteristics that need to be considered in water-supply planning, particularly the availability of freshwater sources, elevation differences, the distribution of residential areas, and the potential vulnerability of shallow groundwater to seawater intrusion.

The existing water-supply system in Boneatiro Barat depends partly on a water source located outside the village administrative boundary. This condition creates a dependency that may affect the continuity of water services. Therefore, the identification and evaluation of alternative sources located within the village become important aspects of the planning process. The alternative sources identified in the study area consist of a cave spring and deep groundwater that can potentially be developed through a deep-well system.

The proposed water-supply configuration is designed by considering the characteristics of the available sources, the location of the service area, and the elevation difference between the source and consumers. Because the study area requires pressurized water conveyance, a pumping-based distribution system is considered as the main alternative. In accordance with Government

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Regulation No. 122 of 2015, a drinking-water supply system is an integrated infrastructure system intended to provide drinking water and should address the aspects of quantity, quality, and continuity of service (Government of the Republic of Indonesia, 2015).

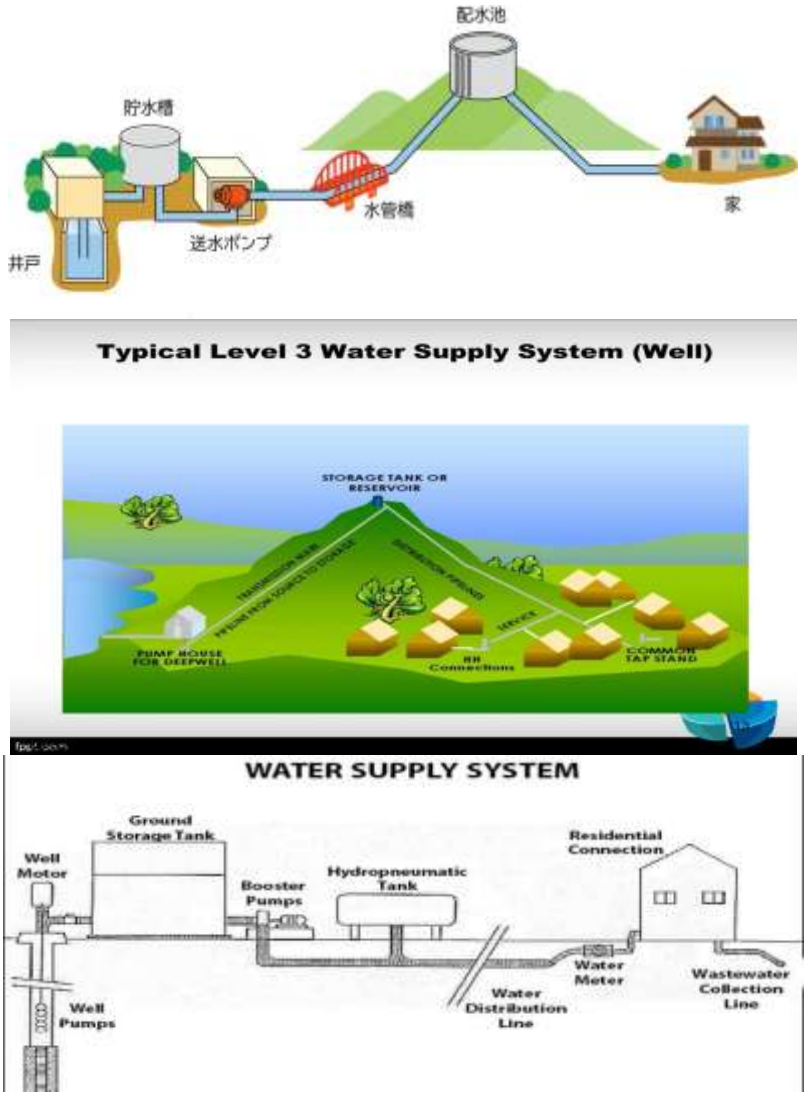


Figure 1. Conceptual configuration of the proposed water-supply system

The conceptual system consists of the alternative water source, intake or spring-capture structure, deep-well unit where required, pumping unit, storage reservoir, transmission/distribution pipeline, and service connections. This configuration is intended to reduce dependence on external water sources while increasing the reliability of water services within the village.

Population Projection and Water Demand

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Population projection is an important component of the planning process because the design capacity of the water-supply system must accommodate not only the current population but also the expected population during the planning period. In this study, the planning horizon is 10 years, consistent with the planning period adopted in the initial study framework.

The current population used in the planning calculation is **590 inhabitants**. Population growth is projected using the geometric method because this method assumes that population growth occurs proportionally over time. The projected population is expressed as:

$$P_n = P_0(1+r)^n$$

where P_n is the projected population in year n, P_0 is the initial population, r is the annual population growth rate, and n is the projection period.

Because the five-year population series required to calculate the observed annual growth rate was not included in the available study data, the final numerical projection for year 10 should be calculated using the population records obtained from the village administration. This avoids introducing an unsupported growth rate into the engineering calculation.

Table 1. Population and Projection Variables

Parameter	Value/Description
Current population	590 inhabitants
Planning period	10 years
Projection method	Geometric method
Initial population	590 inhabitants
Annual growth rate	Calculated from historical population data
Projected population	$P_{10}=590(1+r)^{10}$

The population projection directly determines the required water-supply capacity. An increase in population will increase domestic consumption and consequently affect the required source capacity, reservoir volume, pump capacity, and pipe diameter.

Domestic and Non-Domestic Water Demand

The water demand analysis considers domestic consumption, non-domestic consumption, and distribution losses. The domestic requirement is determined from the projected population and the applicable per-capita water-use standard. The non-domestic requirement accounts for public facilities and other social activities within the service area.

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The general water-demand relationship can be expressed as:

$Qd=86{,}400Pn\times q$

where Qd is domestic water demand in L/s, Pn is the projected population, and q is the unit water requirement in L/person/day.

For the service system, the total design demand should also incorporate non-domestic consumption and physical water losses. Therefore:

$Qtotal=Qd+Qnd+Ql$

where Qnd represents non-domestic demand and Ql represents water losses.

Table 2. Components of Water Demand

Demand Component	Main Variable	Function in Planning
Domestic demand	Population × unit consumption	Household requirements
Non-domestic demand	Public facilities	Schools, worship facilities, health facilities, etc.
Water losses	Percentage of demand	Leakage and operational losses
Average demand	Total daily demand	Basic system capacity
Maximum daily demand	Peak factor × average demand	Source and transmission design
Peak hourly demand	Hourly peak factor × average demand	Distribution and pumping design

The analysis indicates that water demand should not be based solely on the current population. A system designed only for present consumption may become inadequate as population increases. Consequently, the 10-year projected demand should become the basis for determining the capacity of the proposed water-supply infrastructure.

Evaluation of Alternative Water Sources

Two potential freshwater sources were identified for the development of the Boneatiro Barat water-supply system: a cave spring and deep groundwater obtained through a bore well. These sources have different technical characteristics and therefore require separate evaluation before being incorporated into the final system.

The evaluation should consider four principal criteria: **quantity, quality, continuity, and accessibility**. Government Regulation No. 122 of 2015 recognizes surface water, groundwater, rainwater, and seawater as potential raw-water sources when they meet the required raw-water quality criteria.

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Table 3. Alternative Water Sources

Evaluation Aspect	Cave Spring	Deep Groundwater
Source type	Groundwater discharge	Deep aquifer
Collection method	Spring-capture structure	Bore well and pump
Main advantage	Relatively simple collection	Potentially stable source
Main concern	Seasonal discharge variation	Over-pumping and salinity
Required measurement	Spring discharge	Well discharge and pumping test
Quality assessment	Physical, chemical, microbiological	Physical, chemical, microbiological
Coastal concern	Possible contamination depending on location	Possible seawater intrusion
Development option	Spring intake + reservoir	Bore well + pump + reservoir

The actual selection of the primary source must be based on field measurements. In particular, the discharge of the cave spring and the sustainable yield of the deep well should be compared with the projected maximum daily water demand. A source should only be selected as the principal source when its reliable yield is sufficient to satisfy the design demand.

Water Quality Considerations in the Coastal Area

The coastal location of Boneatiro Barat requires special attention to groundwater quality. In particular, deep groundwater should be evaluated for parameters associated with seawater influence, including total dissolved solids (TDS), chloride, conductivity, and other relevant chemical parameters.

Current Indonesian drinking-water health requirements are regulated by **Minister of Health Regulation No. 2 of 2023**, which establishes environmental health quality standards and health requirements for drinking water. The regulation includes microbiological, physical, chemical, and radioactive parameters. Among the mandatory parameters are *Escherichia coli*, total coliform, TDS, turbidity, color, odor, pH, nitrate, nitrite, iron, manganese, arsenic, lead, fluoride, and residual chlorine.

Table 4. Selected Drinking-Water Quality Parameters

Parameter	Maximum/Required Value	Unit
Escherichia coli	0	CFU/100 mL
Total coliform	0	CFU/100 mL
TDS	<300	mg/L

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Turbidity	<3	NTU
Color	10	TCU
Ph	6.5–8.5	—
Iron (Fe)	0.2	mg/L
Manganese (Mn)	0.1	mg/L
Nitrate	20	mg/L
Nitrite	3	mg/L
Residual chlorine	0.2–0.5	mg/L

Source: Ministry of Health of the Republic of Indonesia (2023).

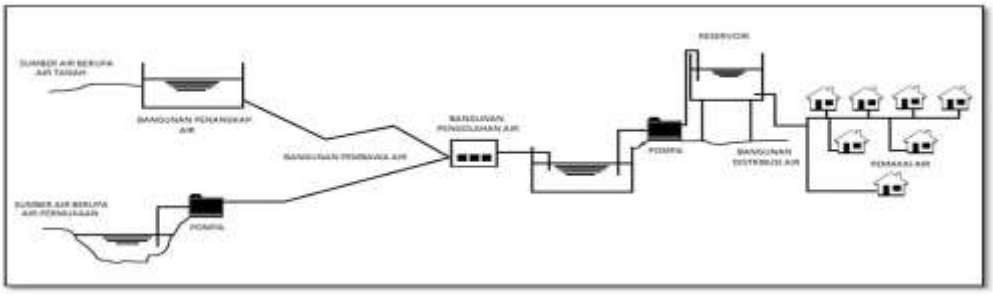
The results emphasize that the identification of a freshwater source based solely on discharge is insufficient. A source may have adequate quantity but still require treatment if its quality does not meet the applicable requirements. Therefore, water-quality testing should be incorporated into the final design before the source is used for drinking-water service.

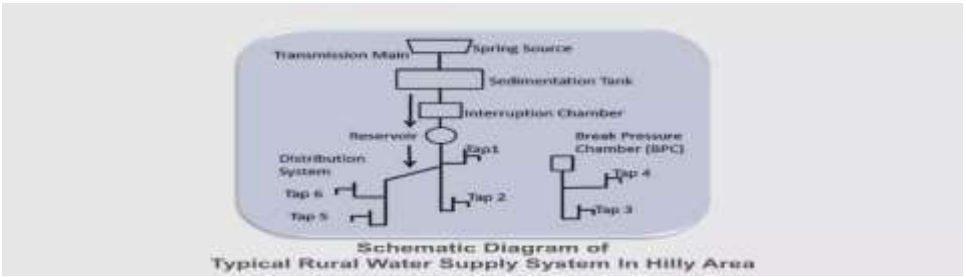
Proposed Water-Supply System

Based on the characteristics of the study area, a pumping-based water-supply configuration is considered appropriate where elevation differences prevent reliable gravity flow. The proposed system consists of source collection, pumping, storage, and distribution.

The proposed flow sequence is:

Alternative Water Source → Intake/Bore Well → Pump → Reservoir → Distribution Pipeline → Service Area





Schematic Diagram of
Typical Rural Water Supply System In Hilly Area

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Figure 2. Proposed water-supply system configuration

The reservoir serves an important operational function because it provides temporary storage and helps balance differences between water production and water consumption. The pumping system transfers water from the source to the reservoir or directly to the distribution system depending on the final hydraulic configuration.

The proposed system also provides greater operational flexibility. When the source produces water continuously but consumer demand fluctuates throughout the day, the reservoir can store water during periods of low consumption and supply water during periods of higher demand. This configuration can improve service reliability and reduce the need for continuous operation of the pump at peak demand.

Hydraulic Analysis of the Distribution Network

Hydraulic analysis is required to determine whether the proposed pipeline system can deliver the required discharge while maintaining acceptable pressure and flow velocity. The principal parameters include pipe diameter, discharge, flow velocity, elevation, friction loss, minor losses, and residual pressure.

The basic continuity relationship is:

$Q=AV$

where Q is discharge, A is pipe cross-sectional area, and V is flow velocity.

For pipe friction losses, the Hazen–Williams equation can be used for preliminary water-distribution analysis:

$hf=10.67C1.852D4.87LQ1.852$

where hf is friction head loss, L is pipe length, Q is discharge, C is the Hazen–Williams roughness coefficient, and D is internal pipe diameter.

The total hydraulic head required by the pumping system is determined from the elevation difference and the total head losses:

$$Hp = \Delta z + hf + hm + Hres$$

where Hp is required pump head, Δz is elevation difference, hf is major head loss, hm is minor head loss, and Hres is the residual head required at the service point.

Table 5. Main Hydraulic Design Parameters

Parameter	Symbol	Unit	Design Consideration
Discharge	Q	L/s or m^3/s	Based on design demand
Pipe diameter	D	mm	Determined hydraulically
Flow velocity	V	m/s	Must remain within acceptable range
Pipe length	L	m	Based on field survey
Elevation	Z	m	Based on GPS/topographic survey
Major head loss	hf	m	Pipe-wall friction
Minor head loss	hm	m	Valves, bends, fittings
Pump head	Hp	m	Elevation + losses + residual head
Reservoir capacity	Vr	m^3	Based on operational demand

The hydraulic design should be checked at the most hydraulically critical points, particularly the highest and farthest service locations. If pressure is insufficient, the pipe diameter, pump head, reservoir elevation, or network configuration should be adjusted. Conversely, excessive pressure should also be controlled because it can increase leakage and place additional stress on pipe joints and fittings.

Proposed Reservoir and Pumping Arrangement

The reservoir is proposed as an intermediate storage component between the water source and the distribution network. Its capacity should be determined from the difference between water production and the temporal pattern of water demand. The reservoir should also provide sufficient operational storage to maintain service during short interruptions in pumping.

The pump capacity should be determined from the required design discharge and total dynamic head. The pump selection should therefore not be based only on discharge. It must simultaneously satisfy the required flow rate and head while considering efficiency and operational reliability.

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Table 6. Pump and Reservoir Design Considerations

Component	Design Requirement
Pump discharge	≥ required design flow
Pump head	Sufficient for elevation difference + head losses
Reservoir	Provides balancing and operational storage
Pump operation	Adapted to daily demand pattern
Pipe material	Selected based on pressure, durability, and installation conditions
Control equipment	Valves, check valve, air-release valve, and flow-control equipment
Coastal protection	Consider corrosion and groundwater salinity

For building-level plumbing, SNI 8153:2015 remains listed by the National Standardization Agency of Indonesia as a valid standard for building plumbing systems. The planning of the village distribution system should nevertheless be distinguished from internal building plumbing and should focus primarily on the source, transmission, reservoir, distribution network, and service connections.

Discussion: Sustainability of the Proposed System

The results indicate that the development of an internally sourced water-supply system has strategic importance for Boneatiro Barat because it can reduce dependence on a source located outside the village administrative boundary. The utilization of the cave spring and/or deep groundwater can strengthen local water-resource independence provided that the source has sufficient sustainable yield and acceptable quality.

However, the coastal setting requires a precautionary approach to groundwater abstraction. Excessive pumping may lower the groundwater table and increase the risk of seawater intrusion. Therefore, deep-well development should be preceded by hydrogeological assessment and pumping testing. Monitoring of TDS, electrical conductivity, chloride, groundwater level, and discharge should also be considered as part of long-term system operation.

The proposed system should therefore not be evaluated solely from the perspective of engineering capacity. Sustainable operation requires integration of **source protection, water-quality monitoring, controlled abstraction, adequate storage, hydraulic reliability, and routine maintenance**. This is consistent with the broader SPAM framework, which emphasizes the development and management of infrastructure to ensure water quantity, quality, and continuity (Government of the Republic of Indonesia, 2015).

Overall Results

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The overall results of the planning analysis can be summarized in Table 7.

Table 7. Summary of Results and Design Implications

No.	Analysis Component	Result	Design Implication
1	Study area	Boneatiro Barat Village, Kapontori District	Coastal water-supply planning required
2	Current population	590 inhabitants	Initial basis for demand calculation
3	Planning period	10 years	System must accommodate future demand
4	Alternative sources	Cave spring and deep groundwater	Source comparison required
5	Main coastal issue	Potential seawater intrusion	Groundwater quality and abstraction must be monitored
6	Distribution concept	Pumping-based system	Appropriate where gravity pressure is insufficient
7	Storage	Reservoir	Balances production and consumption
8	Hydraulic analysis	Flow, velocity, pressure, and head loss	Determines pipe and pump requirements
9	Water quality	Requires laboratory verification	Source must comply with applicable health requirements
10	Sustainability	Local-source development	Reduces dependence on external sources

Overall, the planning results support the development of an alternative water-supply system based on local freshwater resources. The most appropriate configuration is a source–pump–reservoir–distribution system, subject to verification of the actual spring discharge, sustainable bore-well yield, water quality, elevation data, and projected population. The final pipe diameter, pump capacity, reservoir volume, and network configuration should therefore be established from the measured field data rather than assumed values.

Results and discussion section contain about the results of the study that an answers analysis based on research objectives that have been stated in the introduction. Explanations can use pictures/graphs/tables to facilitate visualization.

This section is an important part because it contains a clear description about results data and analysis of research data, interpretation of the findings in the field, the relevance of research

results with relevant concepts, theories, or previous or other research results, or can even find new theories or modify that already exist and implications for scientific developments in their fields.

CONCLUSION

The planning study of the clean water supply system in Boneatiro Barat Village, Kapontori District, Buton Regency, demonstrates that the availability of local water resources is an important opportunity to improve the independence and sustainability of water services in the coastal area. The village currently relies partly on a water source located outside its administrative boundary, creating a potential risk to the continuity of water supply. The identification of alternative sources within Boneatiro Barat, particularly the cave spring and deep groundwater, provides a potential solution to reduce this dependency.

The water-demand analysis shows that the planning of the water supply system must consider population growth over a **10-year planning period**. The current population used as the basis for planning is **590 inhabitants**, and population projection using the geometric method can be used to determine future water requirements. The projected demand should include domestic consumption, non-domestic requirements, and distribution losses so that the planned system can accommodate future needs rather than only the current demand.

From the technical perspective, the proposed water-supply system consists of a **water source, intake or bore well, pumping system, reservoir, and distribution pipeline**. A pumping system is considered appropriate where elevation conditions and the location of the service area do not provide sufficient pressure for gravity-based distribution. Hydraulic analysis involving discharge, pipe diameter, flow velocity, elevation, major and minor head losses, and residual pressure is required to ensure that water can reach the entire service area adequately.

Because Boneatiro Barat is a coastal area, the development of deep groundwater must also consider the potential for seawater intrusion. Therefore, source selection should not be based solely on discharge availability but also on **water quality, quantity, continuity, and accessibility**. Laboratory testing and continuous monitoring of groundwater quality are recommended before the source is utilized as the main drinking-water source.

Overall, the study concludes that the development of an alternative water-supply system using **local water resources supported by pumping and reservoir storage** is technically relevant for Boneatiro Barat Village. The proposed system has the potential to improve water-supply reliability and reduce dependence on external water sources. However, the final dimensions of the pipes, reservoir capacity, pump specifications, and source capacity must be determined using the

actual field measurements of spring discharge, deep-well yield, elevation, water quality, and the complete historical population data.

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