Regional Rural Water Supply Scheme for Sapnai & 4 Villages using Renewable Energy

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ABSTRACT
Reliable and sustainable drinking water supply continues to be a major challenge in rural regions of India, mainly due to dependence on groundwater sources, inadequate infrastructure, and high energy costs associated with pumping. The villages of Sapnai, Moha, Gaur, Dahiphal, and Massa Kh. in Dharashiv district face issues such as insufficient water supply, irregular distribution, and increasing operational expenses.
In this study, an effort has been made to improve the existing regional rural water supply system by shifting to a dependable surface water source and upgrading the existing infrastructure. Population forecasting and water demand assessment were carried out as per CPHEEO guidelines [1], considering a design horizon up to the year 2058. The proposed scheme mainly consists of intake arrangements at Chorakhali Dam, a 3.5 MLD water treatment plant, transmission systems, storage reservoirs, and a redesigned distribution network to ensure equitable water supply.
One of the main considerations in this work is to reduce operational costs through the application of solar photovoltaic energy for pumping and treatment operations. Detailed analysis shows that the annual energy requirement of approximately 12.5 lakh kWh, which would cost about ₹1.25 crore using grid electricity, can be significantly reduced by adopting a 1000 kW solar power system, bringing down the annual expenditure to routine maintenance costs. The estimated payback period for the solar installation is around 6 years.
In addition, The study also suggests the use of SCADA-based monitoring systems to improve operational efficiency, enable real-time control, and reduce water losses. The combined application of renewable energy and automation makes the system more reliable, cost-effective, and sustainable. The approach presented in this study can be applied to similar rural areas facing water scarcity and high energy costs.

Keywords: Rural Water Supply, Solar Pumping, Renewable Energy, SCADA, Sustainable Infrastructure, Water Distribution.

I. Introduction

Safe and sufficient drinking water is essential for maintaining public health and daily life. Rural water supply systems in India often suffer from groundwater depletion, seasonal scarcity, poor infrastructure, and high operational costs due to dependency on conventional electricity. The Government of India has emphasized sustainable and resilient water supply systems under initiatives such as Jal Jeevan Mission and AMRUT [5], [7].

Sapnai, Moha, Gaur, Dahiphal, and Massa Kh. villages in Kalamb Taluka, Dharashiv District, face persistent challenges related to insufficient water quantity, uneven distribution, and high maintenance (electricity) cost. The existing systems rely heavily on borewells and tanker water, which are neither sustainable nor dependable. This paper presents a comprehensive analysis and improvement plan for a regional rural water supply scheme using surface water sources and renewable energy-based operation.

The main strength of this study lies in the combined approach adopted for rural water supply planning, in which conventional hydraulic design is combined with renewable energy and improved water management practices. In most of the existing rural water supply schemes, pumping systems are dependent on grid electricity. In the present study, a solar photovoltaic-based system has been considered and analysed with respect to energy requirement, economic feasibility, and payback period.

Along with this, SCADA-based monitoring has also been considered to improve system operation, reliability, and reduction of water losses. Such considerations are generally not included in conventional rural water supply planning. Therefore, the proposed approach can be used as a practical and replicable model for developing sustainable, energy-efficient, and cost-effective rural water supply systems.

II. Study Area

The project area comprises five villages located in Kalamb Taluka of Dharashiv District, Maharashtra. The region experiences semi-arid climatic conditions with an average annual rainfall of approximately 760 mm. Agriculture is the primary occupation, and water scarcity significantly affects both domestic and economic activities.
The combined population of the five villages, as per 2011 census data, is 19,380 and is projected to increase substantially over the next three decades. The absence of an integrated water supply scheme has resulted in unequal access to drinking water across the villages.

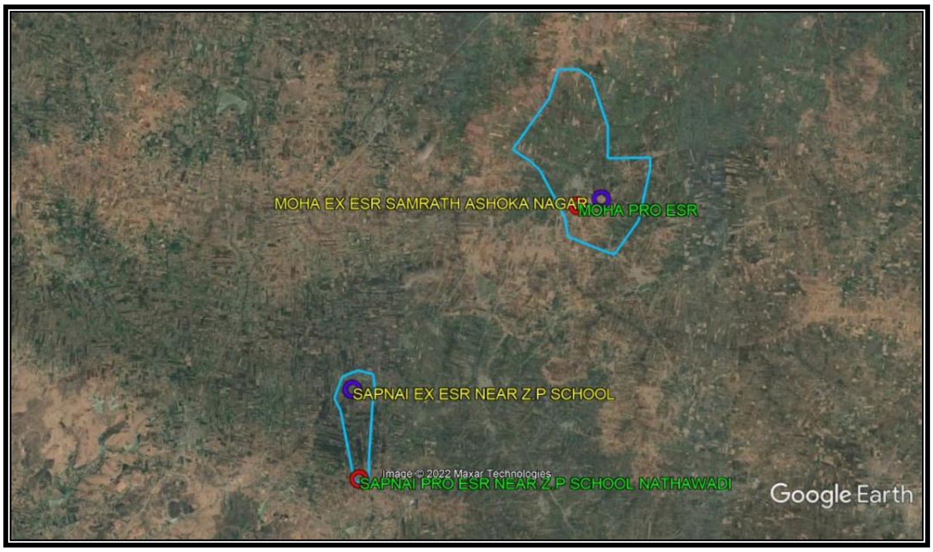

Figure 1: Project area of Sapnai & Moha village involved in the scheme

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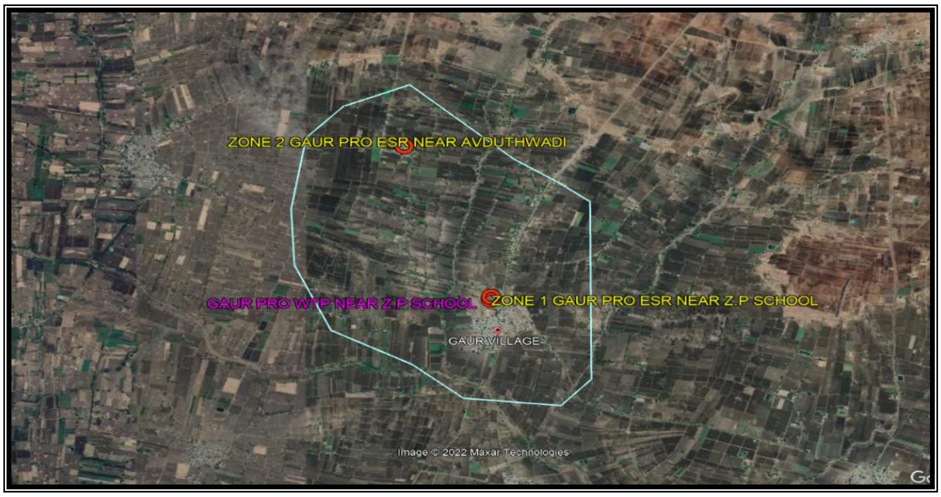

Figure 2: Project area of Gaur village involved in the scheme

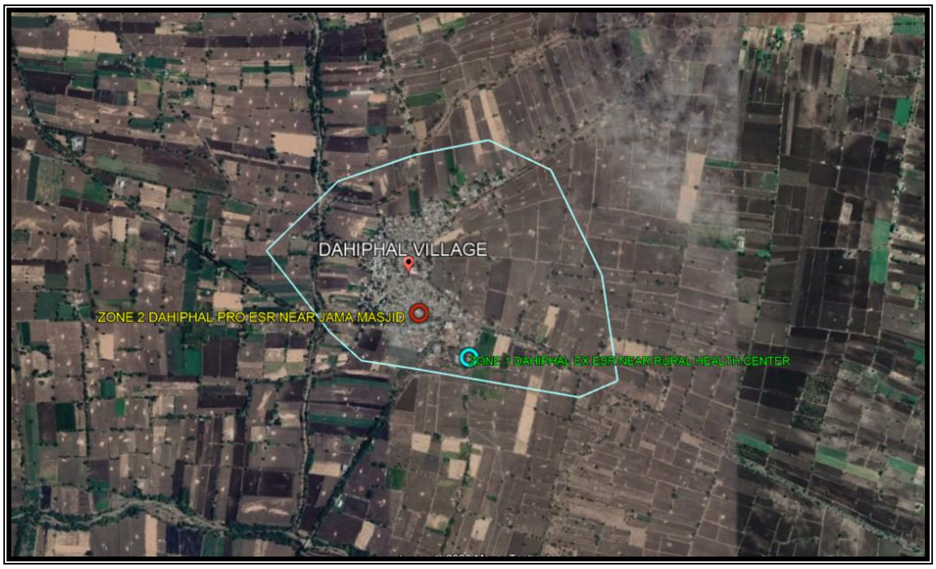

Figure 3: Project area of Dahiphal village involved in the scheme

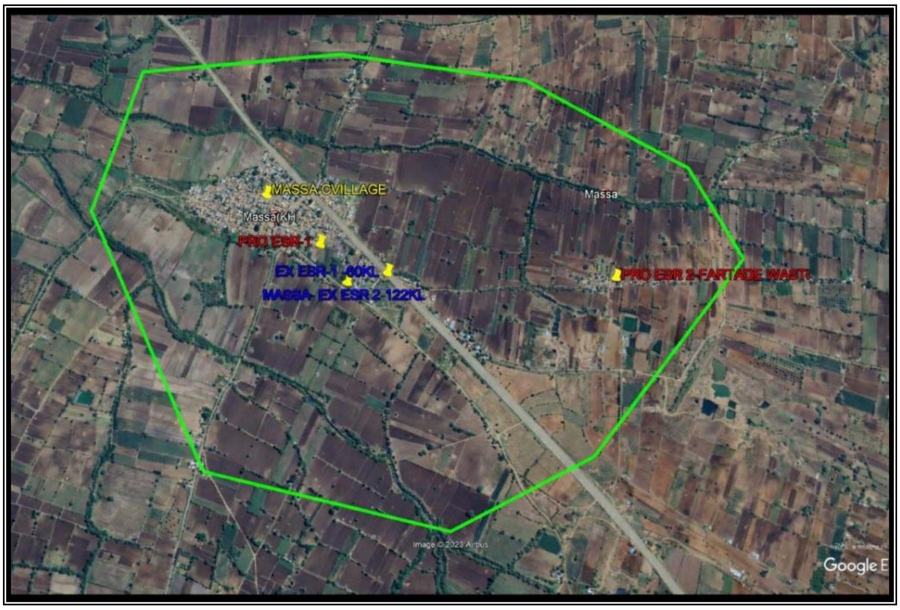

Figure 4:Project area of Massa Kh. village involved in the scheme

III. Objective

The project report " Regional Rural Water supply scheme for Sapnai & 4 Villages using Renewable Energy " aims to provide a comprehensive solution to the challenges faced by Sapnai, Moha, Gaur, Dahiphal, and Massa Kh. villages in delivering a continuous water supply to its residents. The key objectives of the project are outlined as follows:

- To assess the existing rural water supply infrastructure and identify critical gaps.
- To estimate future population growth and corresponding water demand as per CPHEEO norms.
- To develop a sustainable regional water supply scheme using surface water sources.
- To integrate renewable solar energy for pumping stations and treatment operations.
- To incorporate smart monitoring systems such as SCADA and water meters.
- To ensure equitable, reliable, and cost-effective water supply for all villages.

The overarching objective of the project is to present a detailed and actionable plan for the Regional Rural Water supply scheme for Sapnai & 4 Villages using Renewable Energy.By implementing the proposed solutions, the aim is to ensure an uninterrupted, high-quality water supply that meets the current and future needs of Sapnai, Moha, Gaur, Dahiphal, and Massa Kh. villages residents.

IV. Problem Statement

- According to the existing scenario, the drinking water supply for Sapnai, Moha, Gaur, Dahiphal, and Massa Kh. villages are primarily dependent on groundwater sources. The present per capita water supply is limited to approximately 25 LPCD, which is significantly lower than the 55 LPCD recommended under prevailing Government of India and CPHEEO norms [1]. This shortfall has resulted in chronic water scarcity and inadequate service levels across the project area.
- At present, water distribution is carried out through a limited number of existing Elevated Service Reservoirs (ESRs) and Ground Storage Reservoirs (GSRs). Due to the inadequacy of storage capacity and poor hydraulic balancing, the system experiences low per capita supply, restricted hours of water availability, insufficient terminal pressures in peripheral habitations, and highly non-uniform distribution patterns. As a result, several areas within the villages do not receive regular or reliable water supply.
- The existing distribution network was laid several decades ago, and approximately 40% of the distribution area is covered by old pipeline infrastructure. These pipelines are composed of mixed materials, predominantly PVC pipelines with a pressure rating of 4 kg/cm² and limited stretches of HDPE pipelines rated at 6 kg/cm². While a portion of the network—about 1166 m of HDPE and 8500 m of PVC pipelines—is currently in serviceable condition, a significant length of the network is vulnerable to frequent leakages, pressure losses, and structural deterioration.
- It is important to note that the existing PVC pipelines do not comply with the latest CPHEEO guidelines, which recommend a minimum pressure rating of 6 kg/cm² for distribution systems [1]. The non-compliance with updated design standards compromises system reliability and limits the scope for future augmentation. Furthermore, the absence of network expansion into newly developed habitations and the lack of defined hydraulic zoning have resulted in inefficient water distribution and operational challenges.
- In addition to infrastructural deficiencies, the water supply system suffers from high operational costs due to complete dependence on conventional grid electricity for pumping and operations. Frequent power interruptions and escalating energy tariffs further affect the reliability and financial sustainability of the system, particularly in rural settings where uninterrupted power supply cannot be assured.
- Moreover, the existing system lacks adequate monitoring, metering, and loss control mechanisms. The absence of household water meters, bulk flow meters, and real-time monitoring tools makes it difficult to

quantify actual water consumption, detect leakages, or assess non-revenue water losses. This lack of data-driven management hinders efficient operation, revenue recovery, and long-term sustainability of the water supply scheme.

V. Methodology

The methodology adopted for the study includes the following steps:

- **Data Collection:**

Infrastructure data were collected through field surveys and official records to assess the condition and performance of existing water supply components.

- **Population Projection:**

Future population was projected using arithmetic, geometric, and incremental increase methods as recommended by CPHEEO guidelines [1].

- **Water Demand Estimation:**

Water demand has been calculated based on a per capita supply of 55 LPCD, considering system losses to determine gross demand [5].

- **Source Evaluation:**

Potential surface water sources were technically evaluated based on availability, quality, hydraulic feasibility, and sustainability.

- **Hydraulic Design:**

Hydraulic design of pumping mains, transmission pipelines, and distribution networks was carried out in accordance with CPHEEO norms.

- **Renewable Energy Integration:**

Solar photovoltaic systems were incorporated to reduce dependence on grid electricity and improve operational sustainability.

- **Smart Management and NRW Reduction:**

SCADA-based monitoring and water metering were planned to enable real-time control and reduce non-revenue water.

Table-1 Water Demand Calculations

Year	Projected Population	Rate of water supply in LPCD	Net Demand In MLD	Institutional Net + Floating Net in MLD	Total Net Demand in MLD	Gross Demand in MLD With 15% Losses
2028	22660	55	1.246	0.497	1.743	2.051
2043	26052	55	1.432	0.497	1.929	2.270
2058	29572	55	1.626	0.497	2.123	2.498

VI. Existing Scheme Details

There is one old existing water supply scheme in partial operation for these villages. It has been informed that the scheme was constructed several years ago. The design period has already been over. The scheme is partially in operation with major problems in transmission and distribution system. The RCC structures are also partial in serviceable condition. The RCC structure which is in good condition are used in proposed system. The Distribution Network Which is in good condition are used in proposed system. Hence there is a need to design new water supply scheme to this rapidly developing area.

VII. Proposed Scheme

The Regional Rural Water supply scheme for Sapnai & 4 Villages, aims to enhance the existing infrastructure and meet future demand. The scheme includes constructing a new 3.5 MLD Water Treatment Plant. Raw water will be sourced from the Chorakhali Dam through an existing jack well and pumped to the WTP using 250 mm dia. DI-K9 rising mains.

The scheme involves the Under construction Elevated Service Reservoirs (ESRs) for efficient storage and distribution. Key storage capacities include a ESRs ranging from 17 KL to 168 KL liters with a staging height of 9 TO 15 m. The distribution network will cover 55,373 meters using HDPE pipes of varying diameters (90 mm to 180 mm).

i. **Head Work Arrangement:** The Proposed intake arrangement is located on the bank of the Chorakhali Dam. It consists of the following sub works:

- Proposed Intake Well: - Proposed R.C.C. Intake well in Chorakhali Dam of Dia 3 m and Depth 3.85 m.
- Proposed Inspection Well: - Proposed R.C.C. Inspection well in Chorakhali Dam of Dia 2 m and Depth 8.45 m.
- Proposed Connecting Pipe: - Proposed Connecting pipe of diameter 400 mm dia. DI K7 pipeline of length 70 m to convey water from intake well to Jack Well.
- Proposed Jack Well and Pump House: - Proposed R.C.C. Jack well of Diameter 8 m and Depth 17.85 m with overhead Pump House.

Figure 5:Source Location at Chorakhali Dam involved in the scheme

ii. **Raw Water Pumping Machinery:** Raw water will be pumped from the proposed jack well to the proposed WTP.

Table-3 Raw water Pumping machinery details

Sr. No	Type of Pump	Location	HP	Head	Discharge
1	Vertical Pump.	From Proposed JW to Proposed WTP	120 (1W+1S)	129 m	1,58,889 lph

iii. **Raw Water Rising Main:** Raw water Rising Main has been proposed from Jack well to Proposed Water Treatment Plant.

Table-4 Raw water rising main details

Sr. No.	Location	Material	Length	Diameter
1	From Proposed Jack well to Proposed Water Treatment Plant	DI-K9	9,275 m	250 mm

iv. **Water Treatment Plant:** Conventional type Water Treatment Plant is proposed to be constructed at about 9275 m from source. It will have 3.50 MLD capacity. It has been designed for Design stage Year 2054 as per the CPHEEO guidelines.

The conventional Type Water Treatment Plant will have following units.

1. Aeration fountain
2. Flash mixer
3. Flocculator
4. Clarifier
5. Rapid Sand Filter House
6. Filter Sand, Wash Water Tank
7. Wash Water Pump
8. Air Blower
9. Chemical House in two stories
10. Solution Tank
11. Pure water Sump and Pump House

v. **Pure Water Pumping Machinery:** To meet the projected demand, the proposed pumping machinery in the pumphouse at the WTP sump and other Pumping stations is as follows:

Table-5: - Pure Water Pumping Machinery Details

Sr. No	Type of Pump	Location	HP	Head	Discharge
1	Submersible Pumps.	From Proposed WTP Sump to ESR's of Sapnai Villages	5 (1W+1S)	38 m	18244 LPH
2	Submersible Pumps.	From Proposed WTP Sump to Sump at Dahiphal for 4 villages	15 (1W+1S)	16 m	130725 LPH

3	Submersible Pumps.	From Proposed Pure water Sump at Dahiphal to ESR's of Gaur Villages	7.5 (1W+1S)	30 m	25003 LPH
4	Submersible Pumps.	From Proposed Pure water Sump at Dahiphal to ESR's of Dahiphal Villages	5 (1W+1S)	22 m	24675 LPH
5	Submersible Pumps.	From Proposed Pure water Sump at Dahiphal to Sump at Moha Junction for 2 Villages	40 (1W+1S)	57 m	81047 LPH
6	Submersible Pumps.	From Proposed Pure water Sump at Moha Junction to ESR's of Moha Villages	15 (1W+1S)	45 m	43641 LPH
7	Submersible Pumps.	From Proposed Pure water Sump at Moha Junction to ESR's of Massa Kh. Villages	20 (1W+1S)	59 m	37406 LPH

vi.Pure Water Rising Main:

Table-6: - Pure Water Rising Main Pipelines Details

Sr. No.	Location	Material	Length	Diameter
1	5.1PWRM-WTP SUMP NODE 1	DI-K9	35m	100 mm
2	5.2 NODE 1 TO SAPNAI EX ESR 150KL	DI-K9	30 m	100 mm
3	5.3 NODE 1 TO SAPNAI PRO ESR 17 KL	DI-K9	3600 m	100 mm
4	6 PWRM-WTP SUMP TO SUMP AT DAHIPHAL	DI-K9	2900 m	250 mm
5	7.1 PWRM-SUMP AT DAHIPHAL TO NODE 101	DI-K9	50 m	100 mm
6	7.2 NODE 101 TO DAHIPHAL PRO ESR-134 KL	DI-K9	30 m	100 mm
7	7.3 NODE 101 TO DAHIPHAL EX ESR 55 KL	DI-K9	380 m	100 mm
8	8.1 PWRM-SUMP AT DAHIPHAL TO NODE 201	DI-K9	2250 m	150 mm
9	8.2 NODE 201 TO GAUR PRO ESR 2 -25KL	DI-K9	1250 m	100 mm
10	8.3 NODE 201 TO GAUR PRO ESR 1 166KL	DI-K9	735 m	100 mm

11	9 PWRM-SUMP AT DAHIPHAL TO SUMP AT MOHA JUNCTION	DI-K9	6450 m	200 mm
12	10.1 PWRM-SUMP AT MOHA JUNCTION TO NODE 301	DI-K9	2560 m	150 mm
13	10.2 NODE 301 TO MOHA PRO ESR	DI-K9	215 m	100 mm
14	10.3 NODE 301 TO MOHA EX ESR	DI-K9	840 m	100 mm
15	11.1 PWRM-SUMP AT MOHA JUNCTION TO NODE 401	DI-K9	7350 m	150 mm
16	11.2 NODE 401 TO NODE 402	DI-K9	200 m	150 mm
17	11.3 NODE 402 TO MASSA KH EX ESR 2	DI-K9	30 m	100 mm
18	11.4 NODE 402 TO MASSA KH PRO ESR 1	DI-K9	30 m	100 mm
19	11.5 NODE 401 TO NODE 403	DI-K9	120 m	100 mm
20	11.6 NODE 403 TO EX ESR 1 MASSA	DI-K9	30 m	100 mm
21	11.7 NODE 403 TO PRO ESR 2 MASSA	DI-K9	1260 m	100 mm

vii.**Elevated Service Reservoir/Ground Storage Reservoir Details**: Zone wise ESR / GSR Details is as below

Table-7: - Pure Water Gravity Main Pipeline Details

Sr. No.	ESR	Capacity In Lit	Staging in m
1	Z 1 SAPNAI EX ESR NEAR Z. P SCHOOL	1.50 Lakh	9
2	Z 2 SAPNAI PRO ESR NEAR Z. P SCHOOL NATHAWADI	0.17 Lakh	9
3	Z 1 MOHA EX ESR NEAR SAMARATH ASHOKA NAGAR	1.65 Lakh	12
4	Z 2 MOHA PRO ESR NEAR ANGANWADI	1.68 Lakh	9
5	Z 1 GAUR PRO ESR 1 NEAR Z.P SCHOOL	1.66 Lakh	15
6	Z 2 GAUR PRO 2 ESR NEAR AVDUTHWADI	0.25 Lakh	9
7	Z 1 DAHIPHAL EX ESR NEAR RURAL HEALTH CENTER	0.55 Lakh	10

8	Z 2 DAHIPHAL PRO ESR NEAR PSC UP KENDRA	1.34 Lakh	12
9	Z 1-EX ESR NEAR SUBSTATION	0.60 Lakh	11
10	Z 2 EX ESR-AT GAOTHAN	1.22 Lakh	12
11	Z 3-PRO ESR 1 AT GAOTHAN	0.78 Lakh	9
12	Z 4-PRO ESR 2- FARTADE VASTI NEAR ZP SCHOOL	0.26 Lakh	15

viii. **Distribution Network:** The distribution network will cover 55,373 meters using HDPE pipes of varying diameters (90 mm to 200 mm). Proper zoning has been designed for the distribution network so that proper water distribution can be done throughout the all villages in scheme.

VIII. Novel Application of Renewable Energy in Rural Water Supply System:

Energy consumption is one of the major operational costs in rural water supply schemes, particularly where pumping of raw and treated water is required. Conventional systems depend entirely on grid electricity, which leads to high operational expenditure and frequent interruptions due to unreliable power supply in rural areas. To enhance the sustainability and economic viability of the proposed Regional Rural Water Supply Scheme for Sapnai and four villages, the integration of renewable energy systems has been considered.

Solar photovoltaic (PV) technology is found to be suitable renewable energy option for the project area due to the high solar radiation availability in the Dharashiv district of Maharashtra. The region receives an average solar radiation of approximately 5–5.5 kWh/m²/day, making solar energy a reliable source for powering water supply infrastructure.

In the proposed scheme, solar photovoltaic systems are planned to support the operation of pumping machinery installed at the intake structure, water treatment plant, and intermediate pumping stations. The solar power generated will be used to operate pumps during daytime hours, thereby reducing dependence on conventional grid electricity. Excess energy generated during peak sunlight hours can be utilized to operate additional pumping cycles or stored through hybrid systems where required.

The renewable energy system will consist of the following major components:

- Solar photovoltaic panels for electricity generation
- Inverter units to convert DC power into AC power suitable for pump operation
- Pump controllers and protection systems
- Mounting structures for solar panels
- Monitoring and control systems integrated with SCADA

The operational strategy of the system is designed to optimize energy utilization. During daytime hours, solar energy will be used to pump raw water from the intake structure to the water treatment plant and to pump treated water to elevated service reservoirs. Water stored in ESRs will then be supplied to the villages through gravity distribution systems, ensuring continuous supply even during non-solar hours.

The use of solar energy offers several advantages for rural water supply systems. It significantly reduces electricity costs associated with pumping operations, improves the reliability of water supply during grid power outages, and minimizes environmental impacts by reducing carbon emissions. Furthermore, the use of renewable energy aligns with national sustainability initiatives such as the Jal Jeevan Mission, which encourages energy-efficient and environmentally sustainable infrastructure development.

Overall, the incorporation of solar photovoltaic energy systems enhances the long-term sustainability, operational efficiency, and resilience of the proposed regional rural water supply scheme.

1. Pump Energy Requirement:

Sr. No	Location	HP	Head	Discharge
Raw Water Pumping Machinery				
1	From Proposed JW to Proposed WTP	120 HP	129 m	1,58,889 lph
Pure Water Pumping Machinery				
1	From Proposed WTP Sump to ESR's of Sapnai Villages	5 HP	38 m	18244 LPH
2	From Proposed WTP Sump to Sump at Dahiphal for 4 villages	15 HP	16 m	130725 LPH
3	From Proposed Pure water Sump at Dahiphal to ESR's of Gaur Villages	7.5 HP	30 m	25003 LPH
4	From Proposed Pure water Sump at Dahiphal to ESR's of Dahiphal Villages	5 HP	22 m	24675 LPH
5	From Proposed Pure water Sump at Dahiphal to Sump at Moha Junction for 2 Villages	40 HP	57 m	81047 LPH
6	From Proposed Pure water Sump at Moha Junction to ESR's of Moha Villages	15 HP	45 m	43641 LPH
7	From Proposed Pure water Sump at Moha Junction to ESR's of Massa Kh. Villages	20 HP	59 m	37406 LPH
Water Treatment Plant Load				
1	WTP at Sapnai for 5 Villages	60 HP		
	Total	287.5		

2. **Annual Electricity Cost (Grid Power):**

1 Total HP Required per Day = 287.5 HP

2 Total kW Required per Day = 287.5 x 0.746 kW
= 214.475 kW

3 For 16 hours of pumping =287.5 x 16 x 0.746 x 365

Electrical energy Required =12,52,534 Units (Yearly)

4 Charges at Rs 10.00 per Unit =12,52,534 x 10.00

Electrical energy Charges =1,25,25,340.00

Total Annual Electricity Cost Rs. =1,25,25,340.00

3. One Time Solar Installation Cost:

1 Total HP Required = 287.5 HP

2 Total kW Required = 287.5 x 0.746
= 214.5 kW

3 Total units Consumed per day = 214.5 x 16
= 3432 kWh

4 Solar power generation capacity = 3432 / 3.69
= 930.08 kW

5 Add 5% Extra Load = 930.08 x 1.05

6 Total Solar Requirement for Scheme. = 976.58 kW

7 Proposed Solar Plant for Scheme. = 1000 kW

Rate for 1 Kw as per Schedule of Rates (PWD) is 58720.

Total Cost Required =1000 x 58720
= 5,87,20,000.00

4. Economic Comparison:

Sr. No.	Parameter	Annual Electricity Cost (Grid Power)	Solar Installation Cost
1	Capital Cost	Less	5.87 Cr
2	Annual Energy Cost	1.25 Cr	11.74 Lakh (O&M)
3	Annual Saving	-	1.13 Cr
4	Payback Period	-	≈ 6 years

The analysis of energy consumption for the proposed regional rural water supply scheme indicates that the total annual electricity requirement for pumping and treatment operations is approximately 12,52,534 kWh. If operated entirely using conventional grid electricity, the annual energy cost is estimated to be approximately ₹1.25 crore. By integrating a 1000 kW solar photovoltaic system, the scheme can significantly reduce dependence on grid power and lower the annual operational energy cost to only routine operation and maintenance expenses.

In addition to economic benefits, the adoption of solar energy contributes to environmental sustainability. Considering an electricity emission factor of 0.82 kg CO_2 per kWh, the proposed renewable energy system has the potential to reduce approximately 1027 tonnes of CO_2 emissions per year. Therefore, the integration of solar photovoltaic power not only improves the financial viability of the scheme but also supports environmentally sustainable and energy-efficient rural water supply infrastructure.

IX. Smart Water Management:

The project integrates modern technology solutions such as Supervisory Control and Data Acquisition (SCADA) systems. These advancements will enable real-time monitoring, automated control, and efficient management of water consumption, ensuring transparency and resource optimization.

SCADA is vital as it is made available to enhance operational efficiency and monitoring along the water supply network. SCADA system's objective and features comprise:

- Centralized Control: SCADA system is to be central at WTP, which shall control remote stations like ESRs and pumps through a credible communication network.
- Real-Time Monitoring: The system will capture real-time information from a range of locations, such as water treatment facilities, intake structures, and ESRs, enabling operators to see how well they are performing and quickly spot problems as they occur.
- Failure Event Logging: SCADA will record every failure event, such as the failure of pumps or voltage conditions, so immediate corrective measures can be implemented.
- Data Acquisition & Reporting: The system will monitor the most important parameters like voltage, current, power factor, and water flow and generate customizable reports for future use.
- Alarm and Fault Alarming: SCADA will offer alarms for power supply faults, pump malfunctioning, and voltage deviation to ensure continuous operations.
- Water Quality Monitoring: Equipment like pH and turbidity meters will be linked to SCADA to make sure that the quality of the water complies with regulations.

X. Literature Review:

The provision of Regional Rural Water Supply Scheme in rural areas is a critical goal for improving public health, ensuring equitable distribution, and enhancing the efficiency of water resource management. Several case studies and reference documents have been reviewed to understand best practices, challenges, and key components of continuous water supply projects with low Operation and maintenance cost. The following literature has been examined for insights into planning, implementation, and sustainability of Regional Rural Water Supply Scheme:

1. Drink from Tap Mission – A Case Study of 24x7 Water Supply in Puri City (CPHEEO, MoHUA, Government of India, November 2021) [7]

Puri, Odisha, was the first city in India to introduce a city-wide 24x7 water supply network under the 'Drink from Tap Mission'. It was a part of AMRUT 2.0 and had the vision of eradicating the end consumer's need for water purification.

2. Success Story of Malkapur Water Supply System (Maharashtra Jeevan Pradhikaran, Government of Maharashtra) [10]

Malkapur, Maharashtra, is among the path-breaking towns in India where the intermittent water supply system was shifted to a continuous one.

3. Latest CPHEEO Manual on Water Supply and Treatment System (Ministry of Housing and Urban Affairs, Government of India) [1]

The new CPHEEO handbook offers detailed directions for the enforcement of schemes of water supply, highlighting: Service Level Benchmarks: Minimization of NRW to less than 20% and residual pressure maintenance.

Infrastructure Planning: Significance of zoning, hydraulic modelling, and ongoing monitoring. Technology Integration: SCADA, and GIS-based asset management recommendations.

4. Technical Data Book, Indian Water Works Association (IWWA) [3]

Network Design: Hydraulic considerations for continuous water supply. Water Demand Estimation: Guidelines for per capita demand assessment. Leakage Management: Methods for NRW reduction through proactive monitoring and repairs.

XI. Discussion:

The proposed plan helps in addressing the existing gaps and the future needs at the same time. The objective of the project is to incorporate smart technologies with the aim of reducing inefficiency in operations and improving service delivery. With the addition of real time monitoring, maintenance can be performed proactively which greatly reduces losses while ensuring proper distribution.

XII. Conclusion:

The work carried out in this study focuses on to develop a sustainable and reliable water supply system for the villages of Sapnai, Moha, Gaur, Dahiphal, and Massa Kh. in Dharashiv district. The assessment of the existing system indicates that it is unable to meet current and future water demand due to limitations in source availability, storage capacity, and distribution efficiency. In addition, dependence on groundwater sources and conventional electricity has increased both operational difficulties and recurring costs.

To address these challenges, a regional water supply scheme has been proposed by adopting a dependable surface water source and improving the overall infrastructure, including transmission, storage, and distribution systems. The design has been carried out based on projected population and water demand as per CPHEEO guidelines [1], ensuring that the system remains effective over the design period.

A important outcome of the study is the evaluation of energy requirements and the comparison between conventional and renewable energy options. The total annual energy requirement of the system is estimated to be about 12,52,534 kWh. If operated using grid electricity, the annual expenditure is approximately ₹1.25 crore. However, by adopting a solar photovoltaic system of about 1000 kW capacity, the energy cost can be reduced significantly, limiting expenses mainly to operation and maintenance, which is around ₹11.74 lakh per year. This results in an annual saving of nearly ₹1.13 crore, with a payback period of about 5 to 6 years. These findings are consistent with the growing adoption of solar-based pumping systems in India due to their economic and operational advantages [2], [14].

In addition to economic benefits, the use of solar energy also contributes to environmental sustainability. Based on standard emission factors, the proposed system has the potential to reduce approximately 1027 tonnes of CO_2 emissions annually, which supports national efforts towards sustainable infrastructure development.

The study also emphasizes the role of SCADA-based monitoring systems in improving the performance of water supply schemes. With real-time data monitoring, better control of pumping operations, and early detection of faults, the system can operate more efficiently and reduce water losses, as also recommended in modern water management practices [1], [9].

Overall, the study shows that combining improved infrastructure with renewable energy and basic automation can significantly enhance the reliability, efficiency, and cost-effectiveness of rural water supply systems. The approach presented in this work can be applied to other similar regions where water scarcity and high energy costs are major concerns.

XIII. References

[1] CPHEEO Manual on Water Supply and Treatment - Central Public Health and Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, Government of India, 2023.

[2] Factors influencing farmers' adoption of solar water-pumping systems in Gujarat. Clean Energy Journal, Sathish Kumar, M. et al. (2024).

[3] Solar powered water pumping systems for irrigation. Materials Today Proceedings, Kumar, S. S., et al. (2020).

[4] Council on Energy, Environment and Water (CEEW), Solar Pumps for Sustainable Irrigation in India.

[5] Jal Jeevan Mission Guidelines, Ministry of Jal Shakti, Government of India, 2020.

[6] Technical Data Book, Indian Water Works Association (IWWA) 5th Edition, 2019.

[7] Atal Mission for Rejuvenation and Urban Transformation (AMRUT) Guidelines, Ministry of Housing and Urban Affairs, Government of India, 2015.

[8] Swachh Bharat Mission (SBM) Guidelines, Ministry of Housing and Urban Affairs, Government of India, 2014.

[9] Sustainable Urban Water Management Guidelines, National Institute of Urban Affairs (NIUA), 2019.

[10] Drink from Tap Mission – A Case Study of 24x7 Water Supply in Puri City (CPHEEO, MoHUA, Government of India, November 2021).

[11] National Rural Drinking Water Programme (NRDWP) Guidelines, Ministry of Drinking Water and Sanitation, Government of India, 2010.

[12] Maharashtra Jeevan Pradhikaran (MJP) Guidelines, Maharashtra State Water Supply and Sanitation Department.

[13] Manual on Urban Water Supply and Sewerage - Central Public Health and Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, Government of India.

[14] Ministry of New and Renewable Energy (MNRE) – Guidelines for Solar Photovoltaic Water Pumping Systems, Government of India, 2022.

[15] Maharashtra Energy Development Agency (MEDA) – Solar Energy Policy, 2021.