Note on State level Consultation workshop for Greywater Management interventions

The Swachha Bharat Mission 1.0 and 2.0 (launched in 2020) have spurred rapid development of sanitation services and infrastructure in Urban India since 2014. Greywater Management is the neglected topic in Kerala and majority of places in the state connect their greywater to the environment. This causes severe pollution of water bodies. In order to strategize the greywater management, Suchitwa Mission the technical support group of Local Self Government and with the support of WASH Institute have organized a State level Consultation workshop to strategize the Greywater Management interventions in Kerala.

This workshop was conducted to formulate a strategy for Grey water management project formulation and implementation in Kerala by involving Suchitwa Mission officials, Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) officials and Kerala Rural Water Supply and Sanitation Agency (KRWSA) officials who are the important stakeholders in Greywater Management project in Kerala.

Objectives of the workshop

The objectives of the workshop are (i) to learn from the current situation of Greywater Management in Kerala and good practices from West Bengal, Punjab and Odisha and (ii) to formulate a strategy for capacity building, project formulation and technology selection pertaining to Greywater Management (GWM)

Participants

Totally, 58 participants (43 males and 15 females) from Government bodies (Local Self-Government Department, KRWSA, Suchitwa Mission, Kerala Water Authority, MGNREGA), Water Aid, CDD India and Primove attended the consultation workshop.

Strategies for adopting Greywater Management were discussed and elucidated in the proceedings of the workshop.

SUCHITWA MISSION
LOCAL SELF GOVERNMENT DEPARTMENT KERALA

PROCEEDINGS

State - Level Consultative Workshop on Grey Water Management in Kerala Organized by WASH Institute

28th December 2023 | Thiruvananthapuram

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PROCEEDINGS OF

STATE LEVEL CONSULTATION WORKSHOP ON

GREY WATER MANAGEMENT

IN KERALA

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EXECUTIVE SUMMARY

Water pollution in Kerala, exacerbated by the contribution of greywater, presents a critical challenge demanding urgent attention. Despite the establishment of faecal sludge treatment plants and nascent community-level greywater management initiatives, significant hurdles persist in addressing this issue.

A consultative workshop organized by the WASH Institute served as a pivotal platform to confront these challenges head-on. With key objectives aimed at raising awareness, enhancing technical capabilities, and aligning initiatives with Swachh Bharat Mission – Grameen directives, the workshop provided a comprehensive framework for action.

A primary obstacle identified is the inadequate uptake of greywater management at the grassroots level, compounded by a lack of technical expertise and region-specific solutions in Kerala. To tackle this, the WASH Institute devised Groundwater Quality Index maps of districts, furnishing critical insights into groundwater quality and guiding decision-making processes.

Despite the availability of diverse greywater treatment technologies, their adoption remains constrained by various factors, including a dearth of studies on the adverse effects of untreated greywater on water pollution and public health. Additionally, the complexity of selecting appropriate technology is further compounded by contextual nuances unique to each area.

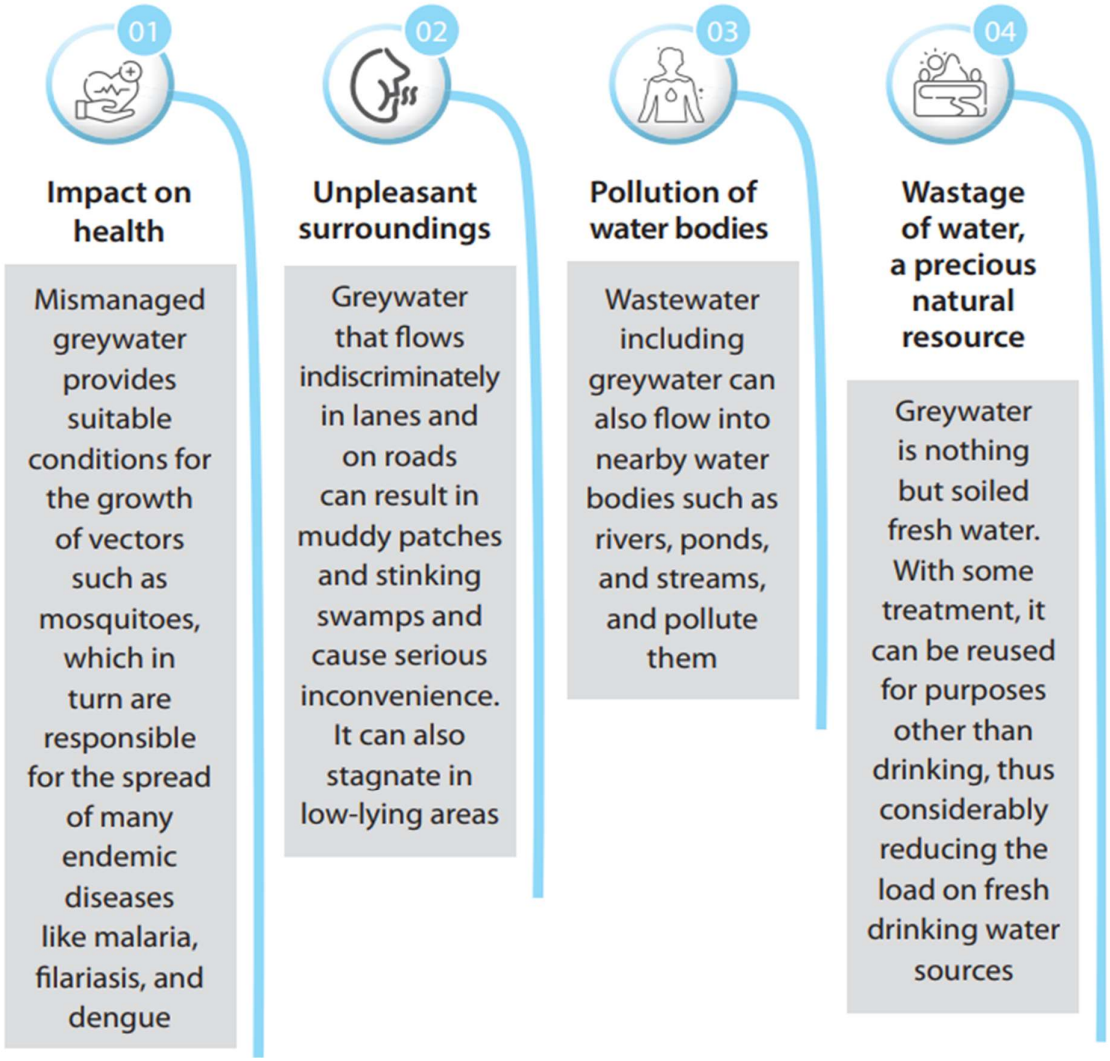
To surmount these challenges, stakeholders must prioritize systematic research on the impact of greywater on water pollution and public health outcomes. Furthermore, fostering a comprehensive understanding of local conditions is essential to effectively selecting and implementing greywater management technologies.

By undertaking these crucial steps, stakeholders can pave the way for the adoption of effective greywater management practices, thereby bolstering water security and environmental sustainability not only in Kerala but also beyond its borders.

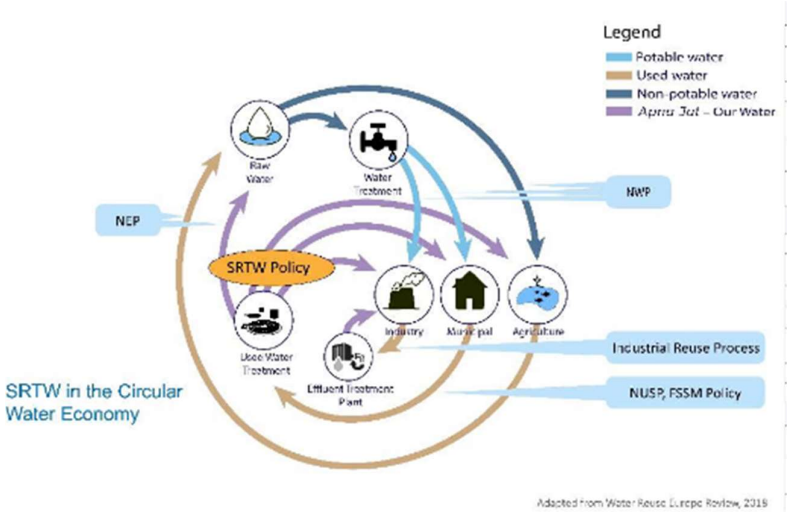
1. INTRODUCTION

1.1 Background of Grey Water Management and its Significance

The rapid population growth and improper water management causes a high stress on existing water resources and eventually leading to uneven water distribution in the country. The Government of India has acknowledged treated wastewater as a valuable resource and so, it labelled treated water as used water to enable masses to use it again for proper water management. Several schemes and policies have been launched at administrative levels to support and encourage the utilization of used water.



In line with this understanding, the National Mission for Clean Ganga (NMCG) under the Ministry of Jal Shakti, in cooperation with the India–European Union (EU) water partnership and GIZ, formulated a National Framework on Safe Reuse of Treated Water (November 2022). It covers non-potable reuse of urban and rural used water by setting guidelines for safe reuse of treated municipal wastewater; providing a guiding framework for states to implement water reuse; roles and responsibilities of key institutions and authorities at both central and state levels; developing short-term targets for states to develop policies for water reuse, sewerage networks, and target reuse volumes.



Given that an entire ecosystem of policies, and standards and compliances exist for grey water management in India, it becomes a state imperative to operationalize and incentivize non-potable reuse of treated water.

Policies	
NEP 2006	National Environment Policy
NUSP, 2008	National Urban Sanitation Policy
NWP 2012	National Water Policy
FSSM 2017	National Policy on Faecal Sludge and Septage Management
MGWB 2005, 2017 (draft)	Model Groundwater (Sustainable Management) Bill 2017
SRTW (draft)	National Policy on Safe Reuse of Treated Water
Programmes	
ABY	Atal Bhujal Yojana
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
JJM	Jal Jeevan Mission
NMCG	National Mission of Clean Ganga
NRDWP	National Rural Drinking Water Programme
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
SBM	Swachh Bharat Mission
Standards and Compliances	
CPCB, SPCB	Central Pollution Control Board, State Pollution Control Board
CPHEEO	Central Public Health Environmental Engineering Organization
NGT	National Green Tribunal

Kerala, one of the most densely populated states in the country, boasts of extensive water and biodiversity resources. Currently, these biodiversity systems are verging severe deterioration due to over exploitation of natural resources from active channels and flood plain areas. Kerala's rivers are increasingly polluted with industrial and domestic wastes; epidemiologic transition from infectious diseases to non-communicable diseases, and a resurgence of water-borne diseases, has led to considerable increase in morbidity and mortality.

To tackle water pollution, the state has taken efforts to establish faecal sludge treatment plants by allocating sites, capacitating LSGs for FSTPs and the state is in nascent stage of establishing community level greywater management interventions and the workshop is a starting point for extensive greywater management interventions in Kerala.

1.2 Purpose and Objectives of the Consultation Workshop

Some of the key objectives of this consultation workshop included:

- Issue Identification: To clearly identify GWM issues, challenges faced by Local Self Governments (LSGs) in undertaking projects, funding problems, and limitations in scaling pilot models.
- Learning from Experience: To explore case stories and implementation processes from outside Kerala, and lessons from state pilots to enrich our understanding.
- Collective Problem-Solving: To engage in collective discussions for solutions to state challenges (capacity building, technology selection, decision matrices, institutional GWM, solid waste management, overcoming implementation hurdles, etc.)

1.3 Summary of Key Activities conducted during the Workshop

Following inaugural and introductory remarks by honourable dignitaries, Smt. Resmi P S (LWM Expert, Suchitwa Mission) and Sri. Akhilesh Ramesh (IEC & CB Specialist, WASH Institute) laid the context for the workshop, highlighting objectives, key areas to be covered, need for greywater management in Kerala's context, and directions from Swachh Bharat Mission – Grameen regarding grey water management.

Mr. Praveen Nagaraja (Project Director, WASH Institute) then undertook to explain the various greywater management treatment approaches utilizing the subsidiarity principle (also a core concept of Kerala's governance structure) at three different levels – unit-level (most decentralized), neighbourhood-level, and conveyance-level. Community-level treatment solutions were not given prominence given geographic and administrative concerns that predominate Kerala's sanitation landscape.

Case study presentations by Smt. Swarna P (Wastewater Engineer, WASH Institute) and Shri. Sheik Mohammed Shibl highlighted the on-ground situation in many rural areas of Kerala.

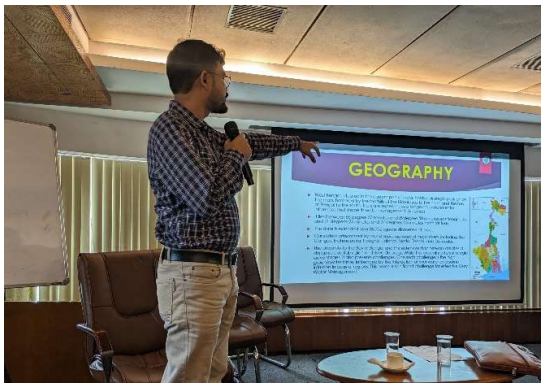
Highlights from discussions, presentations, and interactive sessions

The presidential address by Sri. T M Muhammed Ja (Executive Director i/c, Suchitwa Mission) presented a bird's eye view of Kerala's current grey water management status while highlighting that even the first instalments allotted for Kerala's grey water management were yet to be released owing to poor expenditure. Highlighting a target expenditure of Rs. 600 crore, Sri. Ja directed participants to think how more GWM projects could be taken up in a decentralized manner, and to ponder on the reasons for poor demand generation despite prevalent issues of water logging and flooding.

Dr. Arumugam Kalimuthu (Executive Director, WASH Institute) provided a longer perspective on the lifecycle of grey water management projects. He was vocal about the issues facing poorly managed grey water management projects and stressed that monitoring and follow-up of grey water management projects was a prerequisite for success.

In line with the previous addressed, Sri. Sandeep K G (Chief Engineer, LSGD) was keen to highlight the technical gaps that existed at the ground level. He highlighted that AEs are unaware of grey water challenges and unprepared to manage such projects during high rainfall intensity periods, making operation and maintenance a concern. He also raised the need for a hybrid model and to involve elected representatives in the process to truly make it a people-led movement.

The formal inaugural address by Smt. Saradha Muraleedharan (Additional Chief Secretary, Government of Kerala) provided a comprehensive overview of the background of wastewater management in the state. By laying out the entire ecosystem of responsibilities, she stressed on the role of LSGs in implementing GWM projects; the importance of strategizing for joint political, technical and community engagement; utilizing existing well-developed structures such as the Haritha Kerala Mission and Haritha Karma Sena, health extension services including the Junior Health Inspector, the Ekopana Samiti and the District Planning Committee; and, last but not least, the crucial need for scheme convergence to ensure that projects materialize on ground.



Following the inaugural sessions, a contextual understanding was provided by Shri. Praveen Nagaraja (Project Director, WASH Institute); it laid the groundwork for participants to begin their discussions from. Feedback was also invited from participants with the aim to better understand their concerns and the roadblocks they face at the ground level. Common issues highlighted the lack of technical exposure for ground-level functionaries to prepare estimates and specifications; terrain-related concerns; weak implementation of the Gram Panchayat Development Plan (and therefore lack of an overall vision or priority action); the lack of model documents for tendering and DPR preparation; and the need for ground-level handholding. Additional on-ground information was provided by WASH Institute's Shri. Sheik Mohammed Shibl and Smt. Swarna P. The section on snapshots on greywater management situation has an elaborate discussion on the mentioned presentation. `

Presentations were conducted (both online and offline) by experts Shri. P. C. Mohanty (Technical Specialist, WaterAid), Shri. A. S. Mazumdar and Shri. V. Pareekh (Technical Consultants – SBM(G), West

Bengal), Shri. A. Jacob (Senior Program Manager, CDD India), and Shri. K. C. Rao (Director – WASH Advisory, WASH Institute). The presentations highlighted best practices currently operated in other states; it included technical, procedural, and methodological solutions.

Expert presentations were concluded by group-wise round table discussions that brainstormed several management ecosystems issues the state currently faces. Problems such as lack of on-ground takers for grey water management; poor technical awareness of grey water project formulation at the GP-level; lack of Kerala-specific technical solutions; and limited understanding of the importance of grey water management at ground level. Discussed concerns have been detailed below.

1.4 Discussion 1

S.NO	PROBLEM STATEMENT	SYMPTOMS	ROOT CAUSES
1.	Even though the State has pushed trainings and GWM implementation, GPs are yet to take up projects. When approached, they do not give it so much importance.	• Poor interest among private service delivery	• Lack of technical expertise regarding GWM
2.	Gram Panchayats are unable to formulate projects related to GWM.	• Land availability	• Lack of awareness or acceptance for GWM infrastructure • Misrepresentation and assumptions on GWM/LWM • Lack of awareness on operation & maintenance for soak pits (e.g. use of fish wastewater in soak pits). • Trust issues with LSG: Most households prefer individual soak pits through MGNREGA, KRWSA
3.	SBM(G)-recommended solutions are not relevant to Kerala's context. While manuals exist on technology options, technology selection remains unclear.	• GWM projects not visible on ground • Unsupervised implementation of poor plumbing solutions in multi-storey residential areas • Poor local-level intervention or monitoring • Poor uptake and inclination for GWM technology	• Weak implementation of existing legal provisions (e.g. rainwater harvesting) • No clarity on priority interventions for GWM based on sector, geography, or environmental impact. • Poor uptake due to poor O&M awareness, fear of associated costs, and undefined responsibilities on sludge disposal. • Lack of comprehensive studies and local-level data; local body unable to identify which areas are highly polluted. • Administrative apprehension due to lack of expertise – unable to analyse on-ground problems contextually. • No departmental clarity of roles and responsibilities • Lack of policy/legislation at residential scale (individual

			households), especially for existing households. ● Local-level apprehensions that GWM projects will not be managed or will create additional maintenance problems. ● No methodology current exists to manage sludge
4.	Lack of clarity and limited understanding of GWM among district-, block-, and GP-level functionaries.	● No sustained practice of GWM after awareness campaign	● Not a priority for the LG ● Awareness on reduction in daily water to reduce grey water production. ● Lack of treatment at primary source

1.5 Discussion 2

1. TECHNOLOGY SELECTION: By leveraging innovative solutions tailored to specific needs and contexts, sustainable greywater management practices can be implemented to conserve water resources and minimize environmental footprint.
    a. Objectives:
        i. To identify Government of India (GOI)-recommended SBM-G technologies that are relevant to Kerala's context.
        ii. To create a decision matrix that GPs can refer to for GWM?

POST-MONSOON GROUND WATER LEVEL	HOUSEHOLD LEVEL INTERVENTION	LANE/CLUSTER LEVEL INTERVENTION	END OF DRAIN/GP-LEVEL INTERVENTION
0 – 2 below ground level	Kitchen garden Reed bed Evapotranspiration	Vertical Flow Constructed Wetland (up to 20 houses) Additional structural support required for small bore piping to prevent water uplift	DEWATS different configurations based on land availability and site parameters
2-5 m below ground level	Kitchen garden <u>For GWL > 3 m</u> Soak pit Leach pit Magic pit	Vertical Flow Constructed Wetland (GWL 2 – 5 m and distance greater than 10 m from water body) Community Leach Pit (GWL > 3m, and distance greater than 10 m from water body)	DEWATS (different configurations may be used based on land availability and site parameters) Conveyance - level treatment (treatment alongside drain)
>5 m below ground level	Technology suggested within SBM-G manual, subject to space considerations	Technology suggested within SBM-G manual, subject to space considerations	Technology suggested within SBM-G manual, subject to space considerations

Details of technologies mentioned above have been provided in latter sections of this document.

1.6 Capacity Building Plan

Investing in capacity building for greywater management is essential for fostering sustainable water practices and addressing water scarcity challenges. This section elucidates the capacity building plan for greywater management.

Objectives:

1.5.1. Identify stakeholders involved in GWM at district-, block- and GP-levels;
1.5.2. List down stakeholder training needs to achieve outcomes such as:
   a) Generating demand for GWM.
   b) Preparing a Village Action Plan for GWM.
   c) Planning and implementing GWM (project formulation); and,
   d) Monitoring GWM projects (O&M).
1.5.3. Discuss a methodology of how trainings can be structured and conducted at scale.

	STAKEHOLDERS	TRAININGS REQUIRED	METHODOLOGY
GRAMPANCHAYAT LEVEL	Household level Small markets/shops Institutions (Govt. offices, educational institutions) High School Teachers, Officials, NSS, NCC Health Education Standing Committee and its Associate Staffs Village Administrative Officer (VAO) Assistant Engineer (AE), Overseer Community Development Society	Information, Education, and Communication (IEC) / Behaviour Change Communication (BCC) Penalties for Littering and Violating GWM Regulations Public Health and Technology Awareness Financial Literacy for GWM Projects O&M at the Community Level	**HH Level:** Conduct awareness programs through Area Development Society, Community Development Society. **Institutions:** Half-day orientation sessions, engage teachers for spreading awareness. **Community Development Society:** Regular meetings, use of brochures and pamphlets.

BLOCK LEVEL	Health & Education Standing Committee Groundwater Extension Officer (GEO) Block Development Officers (BDOs) Assistant Executive Engineer (AEE) Assistant Engineer (AE) Overseers MGNREGA team	Importance of Local Water Management (LWM) Technological Options for GWM Financial Aspects of GWM Projects Operation and Maintenance (O&M) of GWM Projects	**Who will train:** Subject matter experts, experienced practitioners in GWM. **Trainers:** Professionals from water management organizations, local experts. **Training Agency:** Collaborate with water management institutes, NGOs. **Content for Training:** Develop comprehensive modules covering each training need. **Mode of Training:** Mix of classroom sessions, field visits, and workshops.
DISTRICT LEVEL	District Mission Zilla Panchayat President Joint Director (JD) District Collector Local Self Government Department Executive Engineer (LSGD EE) Suchitwa Mission Finance Department Representative	Project Formulation for GWM Monitoring of GWM Projects O&M of GWM Projects Financial Management for GWM Use of Social Media Technology in GWM Advocacy	Same as at Block level, but with more emphasis on project management. Include case studies, discussions, and collaborative project planning.

1.7 Stages of Process Flow

Objectives:

1.6.1. Identify stages/stakeholders in developing Village Action Plan, project formulation and planning for implementation.

1.6.2. Discuss external support required (empanelment of consultants/technical agencies)

1.6.3. Identify who will review and vet the Village Action Plan, project, and technical proposals.

PROJECT STAGE	WHO WILL DO IT	HOW?	REQUIRED SUPPORT
Develop Village Action Plan/ Ward Action Plan for GWM	Ward-level Sanitation Committee	Based on pre-approved template with requirements	VEO, RP, RGSA – can monitor the Ward-level Sanitation Committee HR support required
Identify and formulate projects	LSG (GP or Block Panchayat)	Formulation in Sulekha portal	Estimates and cost, Council approval
Preparation of detailed project reports	Empanelled agencies / Accredited agencies for DPR	Limited tender/DBOT	Site visit, sampling, survey, and other facilitation support from LSG Engineering Department
Vetting of DPRs / technical proposals	Block-, District-, or State-Level Technical Committee	Technical scrutiny and review by committee members, based on the existing regulations	Timely submission of proper DPR as per Template issued by Suchitwa Mission
Hiring of agencies/contractor for implementation (construction)	LSG (GP or Block Panchayat)	Tender process	Tender Document, BOQ in e-tendering format in PRICE 3.0 format (Engineering Wing to prepare)
Monitoring the implementation	LSG (GP or Block Panchayat), Block Coordinator, Block Development Officer	Bi-weekly monitoring and updating standardized templates	Key Performance Indicators & monitoring protocols
Operation and maintenance of systems	Based on DPR agency, or as per conditions laid down in the tender	Based on conditions laid down in the DPR	LSG Engineering Wing, DPR Consultants

In course of discussion, solutions were also put forward by the participants. A summary of proposed solutions has been included herewith:

1. Even though the State has pushed trainings and GWM implementation, GPs are yet to take up projects. When approached, they do not give it so much importance.
    a. Actions for GWM need to be strictly implemented at ground level.
    b. IEC campaigns and awareness programmes need to be done from school-level.

c. Social & health awareness campaigns can be used to inform local populace.
d. Providing an opportunity for local officials to prepare a GWM checklist will help understand local-level issues better.
e. Suggestion that SBM-G funds may be included in the validation process.
f. The Swaraj Trophy can be linked to the creation of GWM assets at GP-level, as it has been a time-tested solution to incentivize GPs.
g. Grama Panchayat Action plans can help create a concrete agenda towards implementing GWM projects at local/decentralized level.

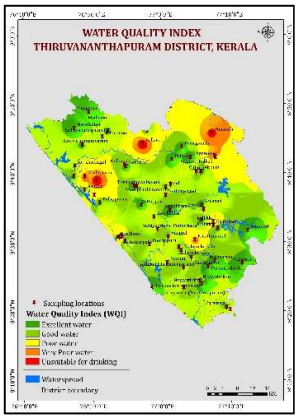
2. Lack of clarity and limited understanding of GWM among district-, block-, and GP-level functionaries.
    a. Awareness creation via the Haritha Karma Sena, SHGs, elected representatives and residential/commercial associations can help generate demand.
    b. Create pilot assets & exposure visits to identify and replicate success models; increase the present number of exposure visits.
    c. Utilizing and integrating best practices of solid waste management approaches to LWM solutions.
    d. Incorporating GWM implementation plan in Suleka software
    e. Conduct campaigns, IEC activities and training.
    f. Select diverse groups based on terrain, topography, population, and livelihoods; RPs, TCs and other stakeholders to be identified and trained to facilitate different groups based on their need - a block level engineer (outsourced) may be incorporated to coordinate this.

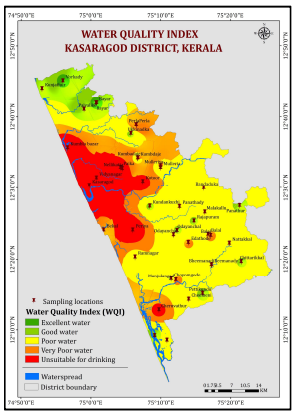
2. GREYWATER MANAGEMENT STRATEGY

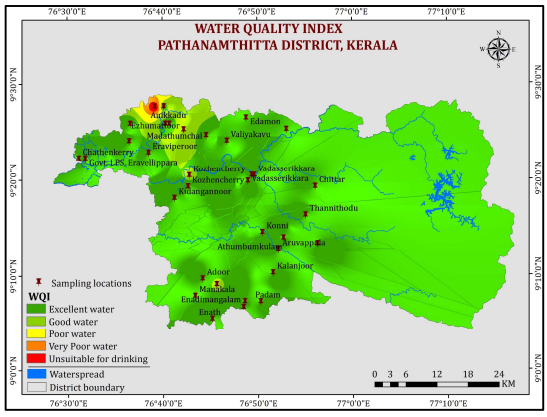
Based on comments derived during the workshop, it is suggested that a two-prong approach be followed across Kerala state.

1. The first shall deal with a robust IEC campaign that brings in the importance of grey water management, clarifies the roles and responsibilities of different stakeholders, and makes clear the technologies available for grey water management. This shall be linked to necessary government orders and legislation to ensure that grey water management becomes a mandatory practice across households within the state.
2. The second shall be a sanitation situation assessment-based priority hotspots where grey water technology can be implemented on a pilot basis. Pilot identification can depend on two concerns:
    a. Availability of land, simplicity of technology and possibility of quick implementation. These projects shall serve to generate public interest in grey water management, allow officials to study O&M procedures, and serve as Proof of Concept (PoC).
    b. Criticality of water resources (pollution/faecal sludge contamination/health implications) and greater sustainability return on investment (S-ROI). These projects that shall have the greatest impact and benefit on human life, economy, and biodiversity.

To this end, WASH Institute has also developed Ground Water Quality Index maps for nine districts using data sourced from the Report on Groundwater Monitoring in Kerala (Central Ground Water Board, Government of India, 2023), the Groundwater Quality Monitoring Report (Kerala State Groundwater Department, 2019), and the Report on Mapping of Hard Rock Aquifer System and Aquifer Management Plan (Central Ground Water Board, 2018). It is suggested that these maps be used for a preliminary identification of various hotspots across the State.







The state receives good amount of rainfall and have 44 number of rivers flowing across. The abundancy of water in Kerala is figured as shown in table below.

Table 1: Availability of water resource in Kerala (Source: ENVIS, KSCSTE)

Total average annual yield from 44 rivers	70,323 million Cubic Meters
Total utilisable yield of rivers in Kerala	42,772 million Cubic Meters
Total surface water availability in Kerala, after accounting for losses due to evapotranspiration and interception	54,410 million Cubic Meters
Amount of surface water available as runoff	41,000 million Cubic Meters
Amount of surface water which infiltrates to recharge ground water	7900 million Cubic Meters
Amount of surface water which is stored in reservoirs	5510 million Cubic Meters

Even though we are receiving a good amount of rainfall we don't have a terrain which suits for the storage of the huge volume of freshwater that we are receiving as rain yearly!! Unlike other water resource regions of India, the Kerala region, with the steep gradient of the landscape (125 km at the widest transect and a height of 3000 m) makes the residence time of rainwater fall under 48 hr, whereby a huge volume of water is flowing to Lakshadweep Sea which truly makes several packets of Kerala water stressed.

More than 75% of the surface water flows out as runoff, roughly 15% gets infiltrated as groundwater, and the state captures approximately 10% through reservoirs which is then supplied through public water supply schemes. Generally, the major sources of freshwater on which the Kerala population rely can be classified as three viz:

1. Surface water
2. Groundwater
3. Piped water supply

As per the report by KSCSTE in ENVIS, the source wise dependence by rural households for domestic water supply dependent on traditional ground water systems is 80%, 10-15% use piped water supply systems, and 5% use traditional-surface and other systems.

2.1 Surface Water Resources

Kerala is rich with 44 rivers which together yield 70,300 mm^3 of water annually. However, the total utilizable yield is only 60% of the annual yield. Kerala possesses only four medium rivers and 40 minor rivers. In the Indian perspective the rivers of Kerala are not so significant than even the largest of them cannot find a place among the major Indian rivers. The combined discharge of these four medium rivers in Kerala is less than half of that of river Krishna. The remaining forty rivers are only minor ones, the combined discharge of all of them together is only about one-third of that of Godavari. Western ghats from where the river originate is devoid of snow and therefore these river systems do not have the benefit of water supplied during the summer seasons as in the north Indian rivers.

2.2 Groundwater Resources

Groundwater has traditionally served as the primary source for meeting domestic requirements, sustaining over 80% of the rural population and approximately 50% of urban dwellers. Additionally, it plays a pivotal role in fulfilling the irrigation needs of around 50% of the cultivated land. The ease and simplicity of extracting groundwater have contributed significantly to its widespread utilization.

The open well density in Kerala is perhaps the highest in the country – 200 wells per sq. km in the coastal region, 150 wells per sq. km in the midland and 70 wells per sq. km in the high land!! On an average, more than 90 per cent of wells are used for domestic purposes.

However, a notable challenge emerges during the summer months, as a considerable portion of these dug wells tends to dry up, contributing to seasonal water scarcity and impacting public water supply. The escalating demand for water each year exacerbates the strain on the state's aquifer systems. Approximately 88% of the state's total geographical area is underlain by crystalline rocks, lacking primary porosity, and providing limited opportunities for groundwater. In areas with alluvial formations hosting multiple aquifer systems, the development of available resources is sometimes hindered by quality constraints.

However, in recent times, concerns have emerged regarding the sustainability of groundwater resources. Issues such as a decline in the water table, contamination of groundwater, and instances of seawater intrusion are being reported in various locations. As the demand for water continues to rise, it becomes imperative to address these issues through effective policies and conservation measures to ensure the continued availability and quality of this vital resource.

2.3 Piped Water Supply

The Kerala Water Authority (KWA) and Kerala Rural Water Supply and Sanitation Agency (KRWSA) are the major implementing agencies in drinking water and sanitation sector. Local Governments also play an important role.

KWA provides water supply to nearly 2.46 crore people from its 911 Water Supply Schemes maintained by it, through 40.76 lakh connections and 1.81 lakh public taps in Kerala. The average per capita availability of piped water is 83 litres per day (LPCD is varying in different habitations in all the districts).

However, as on August 31, 2022 66.26 per cent population of Kerala has been covered with piped water supply of KWA (62.15 per cent in rural and 79.62 per cent in urban).

Details of Drinking Water Supply Schemes Implemented by Groundwater Department from 2016-17 to 2020-21					
District	**No. of Panchayath**	**No. of Schemes**	**Beneficiaries (Family)**	**Litre/Day**	**MLD**
Thrissur	35	917	31110	9333000	9.333
Thiruvananthapuram	34	172	6803	2040900	2.0409
Kannur	68	132	5540	1662000	1.662
Alappuzha	29	121	4192	1257600	1.2576
Palakkad	26	54	3497	1049100	1.0491
Idukki	19	33	2221	666300	0.6663
Malappuram	52	75	2205	661500	0.6615
Ernakulam	29	35	1895	568500	0.5685
Kottayam	42	66	1890	567000	0.567
Kollam	24	51	1867	560100	0.5601
Pathanamthitta	16	38	1132	339600	0.3396
Wayanad	22	89	1049	314700	0.3147
Kasaragode	14	63	520	156000	0.156
Kozhikkode	11	16	330	99000	0.099
Total	**421**	**1862**	**64251**	**19275300**	**19.275**

Table 2. District-wise proportion of households covered by water supply schemes as on August 31,2022 (Source: Economic review report,2022)

2.4 Water Demand v/s Availability

The data on water availability in Kerala may suggest a surplus, but it's essential to assess the situation considering the state's actual water demand. While Kerala is often considered a water-rich region, the demand is seemingly higher than the national average, primarily due to established social norms emphasizing hygiene and sanitation.

In terms of area, though Kerala forms only 1.2% of the total area of India, 3% of country's population inhabits the State. As of 2021, in a report published by CWRDM water requirement for the state stood at 48,600 million cubic meters (MCM). The breakdown revealed irrigation as the primary consumer at 28,900 MCM (59.5%), followed by domestic and industrial uses at 7500 MCM (15.4%), salinity control at 7200 MCM (14.8%), and improving Karilands (removing toxicity) at 5000 MCM (10.3%). However, the utilizable surface water potential in Kerala is only 42,700 MCM, creating a shortfall of 5800 MCM.

This deficit raises concerns about the adequacy of available water to meet the growing demands of the state. The consequences are evident in the form of frequent droughts experienced across Kerala. It becomes imperative for policymakers and stakeholders to address this imbalance and implement sustainable water management practices to ensure a secure water future for the state.

2.5 Population Density & Water Stress

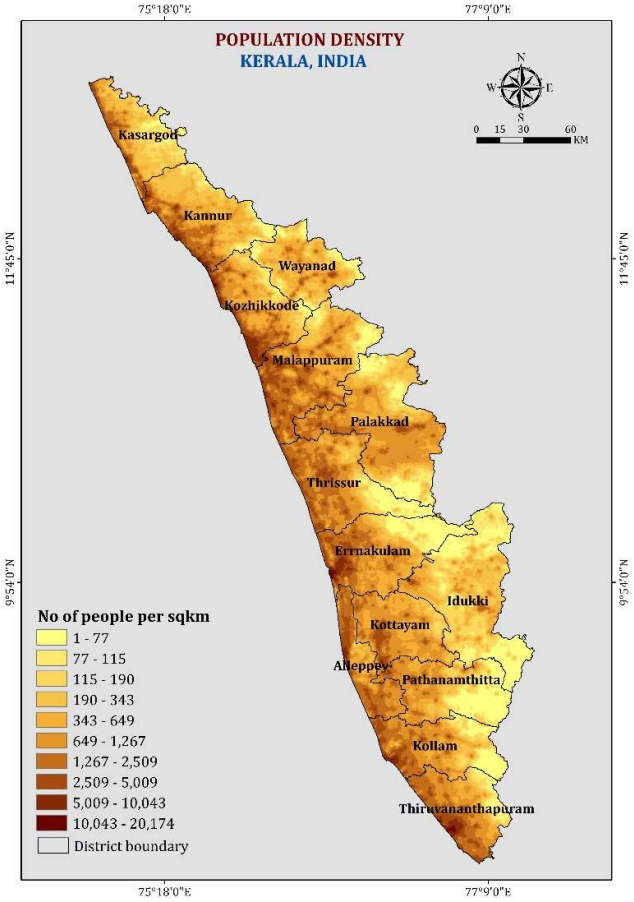


Figure 1. Population Density of Kerala

The population density map of the state reveals higher concentrations along the coastal areas, indicating increased demand for water in these regions due to the higher population density. The correlation between population density and water demand underscores the need for effective water resource management strategies, especially in coastal areas where demand is more pronounced. This insight is crucial for developing targeted approaches to ensure sustainable water supply and meet the growing needs of densely populated coastal communities.

2.6 Water Pollution in Kerala

Kerala has both freshwater abundancy and scarcity. In such a water stress condition, it is highly noted that the increase in population and industrial activities in the State is causing for the deterioration of the quality of water.

The major sources of water pollution in Kerala are:

a) Drastic urbanisation by encroaching and filling up of rivers;
b) Uncontrolled release of domestic sewage;

c) Illegal discharge of untreated sewage and effluent from industrial areas and commercial establishments.
d) Agricultural runoff; and,
e) Dumping of solid waste in water bodies.

There is much research work across Kerala undertaken by various Government, Non-Government and academic institutions which clearly depict the scale of water pollution in Kerala. Through major field visits and surveys, we identified many hotels, markets, slaughterhouses, colonies are directly letting out the sewage into the nearby waterbodies. However immediate actions should be taken to regulate and control the pollution of our freshwater resources by preventing these actions which hampers the water quality in our State.

We have the Order from Honourable National Green Tribunal which has specifically stated that "contamination of water and deterioration of water quality are matters to be taken seriously as they affect public health and right of the citizen to have access to potable drinking water". Thus, it is inevitable to take actions for proper handling of wastewater generated from the sources so that it doesn't causes for the contamination of the water resources.

The results from various research studies across the State has been depicted for understanding the level of water pollution in Kerala:

Surface water pollution

1. 1. It was reported that most of the rivers in central part of Kerala (Periyar & Muvattupuzha) and Chaliyar river in northern Kerala shows very poor water quality. (S.N. et al. 2021)
1. 2. By the analysis of physicochemical parameters of the water sample taken from Chalakudi river near to Kerala Chemicals and Proteins Ltd. (KCPL) at Kathikudam, Thrissur district, Kerala revealed the river water is highly deteriorated and proves that the industrial activities and dumping of domestic sewage is the reason for deterioration of water quality (Joseph and Tessy, 2010)
1. 3. Higher content of nitrate and iron is reported in groundwater in many parts of the state. Bacterial contamination is being reported from all districts in dug wells and is growing in alarming stage based on a study conducted by the Department of Geology, University of Kerala, Kariavattom.
1. 4. Surface water pollution was indicated through Thelineer Ozukkum Navakeralam campaign showed 79% faecal contamination.

Piped water supply contamination

A study on tap water quality in 14 districts of Kerala found contamination by coliform bacteria in all samples. Rural areas showed relatively lower contamination than urban areas, suggesting urban mismanagement of solid and liquid waste as a contributing factor. (Karthick et al., 2010)

Groundwater contamination

Open wells of Kerala have the problem of bacteriological contamination and studies have shown that faecal contamination is present in 95% of drinking water wells.

Water quality analysis of open wells around the Kerala Minerals and Metals Ltd industrial area, Chavara (Kollam district) was studied for a period of six months and the result revealed that the well water is unsuitable for domestic purpose with high BOD, COD, heavy metals, and low dissolved oxygen (Shaji, Nimi, and Bindu 2009).

2.7 Contribution of Greywater to Water Pollution in Kerala

The research findings underscore a widespread issue of water contamination in Kerala, with a significant contributor being domestic sewage. This sewage comprises both blackwater, encompassing urine, faecal matter, and flush water, and greywater, which includes water spend for our needs like bathing, cooking, and washing.

Remarkably, despite greywater constituting 70-75% of sewage, its contribution to pollution is relatively low. In the context of Kerala's population, estimated at approximately 3.34 crores, the daily generation of greywater is substantial, reaching around 2525.4 million litres. Unfortunately, a considerable portion of this greywater is mismanaged, flowing untreated into freshwater sources.

Effectively addressing the management of this vast volume of wastewater, particularly greywater, emerges as a pivotal opportunity. Implementing proper treatment measures can significantly mitigate the pollution load and, consequently, enhance the overall water quality in the state. This becomes imperative for safeguarding the essential water resources necessary to meet the diverse needs of Kerala's populace.

3. PROBLEM DOCUMENTATION & CASE STUDIES

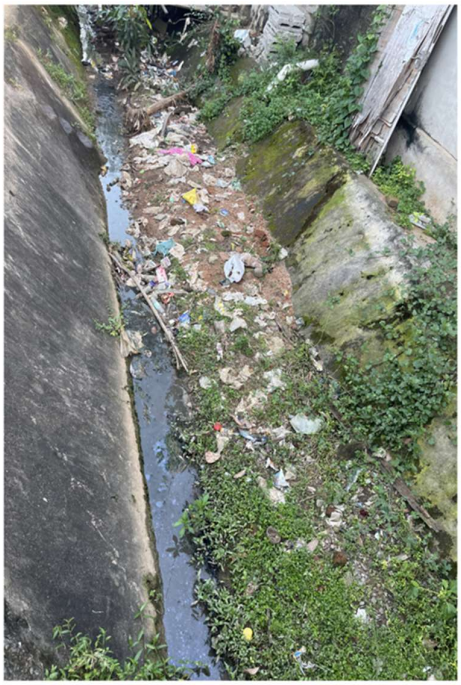
Greywater Management is grossly neglected topic in Kerala and majority of places in the state discharge it directly into their surroundings without any treatment. WASH Institute has documented the 'on-the-ground' greywater handling practices across the state. Field studies were conducted in Grama Panchayats as shown in table below, with additional case studies documented in municipal areas.

Sl. No	Grama Panchayat	District
1	Pallichal	Trivandrum
2	Vellarada	Trivandrum
3	Karimkulam	Trivandrum
4	Ponmundam	Malappuram
5	Othukungal	Malappuram
6	Kuthiathode	Alappuzha
7	Chandiroor-Aroor	Alappuzha
8	Arookutty	Alappuzha

Table 3. Location of case study documentations

3.1 Case of Pallichal Grama Panchayat

Significant hotspot in Pallichal Grama Panchayat involves the direct discharge of greywater from colony settlements into the Marukil Irrigation Canal. This 2.5 km long, 2.10 m wide canal, originally designed for irrigation, faces issues like indiscriminate solid waste dumping and greywater release from nearby houses. Greywater from bathrooms, kitchens, and wash areas is directly released into the canal through PVC pipes.



Latitude: 8.45061672° N (43N 934685.856m)
Longitude: 77.01082872° E (43N 721385.342m)

These pipes, visible along the canal, exhibit varying inverts at different levels, with some positioned close to the canal bottom and the majority at approximately 1 meter above. Although the study focused on a 280 m stretch, it's essential to recognize the potential for pollution along the entire canal length due to its extensive course through settlement areas. Residents on both sides of the canal is contributing to the pollution of the waterbody, without knowing the impacts.

Fig. 2. Direct release of greywater into the canal

The major issues identified at this study area is recorded below with the severity level based on visual inspection.

Sl. no	Issues identified	Severity levels		
		Critical	Moderate	Low
1	Lack of awareness among residents on proper greywater management practices			
2	Lack of solid waste management services provided to the residents by the local body			
5	Direct release of greywater into irrigation canal			
6	Adequacy of fresh water supply			
7	Non-availability of space for planning greywater management infrastructures			

3.2 Case of Vellarada Grama Panchayat

The significant hotspot identified in Vellarada Grama Panchayat is Panachamoodu Market.

The major issues identified from this location are:

1. The greywater causing problems in the market area didn't originate from within the market itself. Instead, it was collected from nearby residential area and channelled through the market area into the nearby public drainage system. Previously, this greywater had a direct path to the public drainage, but it became blocked within the market. Unfortunately, no alternative plans were put in place to reroute or control the flow, which worsened the problems linked to untreated greywater in the vicinity.
2. There is no designated provision for the treatment of greywater, resulting in unmanaged discharge which floods the marketplace.
3. Stagnant water becomes a breeding ground for mosquitoes and flies, posing health and sanitation concerns.
4. Local representatives and engineers lack sufficient knowledge in handling wastewater, hindering effective problem resolution.
5. There is a deficiency in data related to the existing greywater management system, impacting informed decision-making and planning.

3.3 Case of Karimkulam Grama Panchayat

In the coastal village of Karimkulam, situated within Trivandrum district, a pressing issue has emerged concerning greywater management. The colony settlement is characterized by closely spaced households and narrow streets connecting to small roads. In most cases 2- 3 feet-wide pathways are seen which provide access to the houses. The area relies on intermittent water supplied by the Kerala Water Authority (KWA). To address consistent water needs, residents often resort to bore wells and dug wells.

However, a glaring gap in infrastructure exists regarding the containment and treatment of greywater. Instead of proper disposal mechanisms, greywater from households directly finds its way into stormwater drains, ultimately emptying into the sea. In instances where people are not able to directly discharge greywater to storm drains, it is left to flow openly around residential areas. Moreover, certain shops exacerbate the problem by discarding solid waste such as plastics and oil into the drains.

This lax approach to greywater management poses significant environmental and health hazards, A greywater puddle has been found at the end of the drain at the shore. This necessitates urgent intervention and the implementation of effective greywater treatment measures to mitigate pollution and safeguard community well-being.

Sl. no	Issues identified	Severity levels		
		Critical	Moderate	Low
1	Lack of awareness among residents on proper waste management practices			
2	Greywater discharge in nearby soil or environment			
3	Limited space available for laying greywater conveyance lines due to congestion in the colony area.			
4	Visually polluted water observed in dug wells			
5	Unwillingness and lack of acceptance from the residents for the implementation of greywater management project			
5	Direct release of oil, solid waste to drains			
6	Adequacy of fresh water supply			

3.4 Case of Ponmundam and Othukungal, Malappuram district

In case of Ponmundam and Othukungal Grama Panchayats in Malappuram district, there were no drains observed and the GP official confirmed the same. Majority of households had soak pits, and some had traps for greywater soak pits. The soak pits are covered by stone chips. Upon discussion with the local contractors, it was learnt that despite of maintaining safe distance from water sources, single pits are constructed for a maximum possible depth to avoid any disfunctions.

Sl. No	Issues identified	Severity		
		Critical	Moderate	Low
1	Unlined containment systems near open wells			
2	Lack of awareness on other containment systems			
3	Greywater management by deep soak pits			
4	Access to containment system			
5	Lack of knowledge on building greywater infrastructure among the local contractors			

By visual inspection the following issues were noticed with the severity levels indicated.

3.5 Case of Arookutty Grama Panchayat

Arookutty, a Grama Panchayat located in Cherthala taluk of Alappuzha district, was chosen as the study area to assess greywater management challenges in low lying areas. The study zone was situated near a water body within the village, where houses are not densely clustered. With a population of 23,860 (Source: Arookutty GP), Arookutty is accessible via the Cherthala-Arookutty road, surrounded by tree-lined streets. Access to these households is facilitated by narrow 2-feet roads, often crossing concrete bridges.

Observations revealed the presence of damp soil in the vicinity, characterized by dense bushes utilized for cattle grazing. Residents reported issues with rainwater accumulation around their homes, exacerbating concerns about stagnant water.

One of the most pressing concerns identified was the direct disposal of greywater from households into the nearby water body, known as St. Anthony Thodu. Greywater from the 17 households in the study area flowed untreated into St. Anthony Thodu, contributing to its significant algal bloom. Moreover, the water body received wastewater discharged from 20 prawn peeling stations registered with the Arookutty Grama Panchayat, further exacerbating pollution levels. Additionally, greywater from nearby hotels and shops was also discharged into St. Anthony Thodu, compounding the contamination issue.

Failure to address these issues not only poses environmental risks but also threatens the health and well-being of the local community. Implementation of proper wastewater treatment and conveyance systems, coupled with awareness programs and regulatory measures, is essential to mitigate pollution and safeguard the ecological balance of this area.

By visual inspection the following issues were noticed with the severity levels indicated.

Sl. No	Issues identified	Severity Levels		
		Critical	Moderate	Low
1	Lack of awareness among residents on proper waste management practices			
2	Greywater discharge in water bodies			
3	Containment of blackwater in pits near water bodies			
4	High groundwater table in the area & Eutrophication of water bodies			
5	Water borne disease incidence and mosquito problem			
6	Adequacy of fresh water supply			

3.6 Case of Aroor Grama Panchayat

Aroor Grama Panchayat, situated as an urban agglomeration within the Ernakulam district, lies approximately 15 km from the city of Ernakulam. Despite its rural administrative classification, Aroor GP presents a visually urbanized landscape, resembling that of a municipality. The total population in Aroor GP stands at around 38,000. The presence of the Puthenthodu canal alongside the households adds to the natural surroundings. Access to these households is primarily through narrow 2-feet roads, making navigation challenging for large vehicles.

Presence of unpleasant odors and signs of eutrophication in the Puthanthodu was noticed during the field inspection. A significant concern identified in the study area is the direct connection of household greywater to the Puthenthodu canal. This practice contributes to the degradation of water quality and poses environmental risks.

By visual inspection the following issues were noticed with the severity levels indicated.

Sl. No	Issues identified	Severity levels		
		Critical	Moderate	Low
1	Lack of awareness among residents on proper waste management practices			
2	Greywater and septage discharge in thodu			
3	No containment for blackwater and septage			
4	High groundwater table in the area & Eutrophication of water bodies			
5	Release of prawn peeling wastewater to thodu			
6	Odor in the thodu			
7	Adequacy of fresh water supply			

3.7 Case of Kuthiathode Grama Panchayat

Kuthiathode Grama Panchayat, located in the Alappuzha district, despite its proximity from Kochi town, the urban influence observed here is not as pronounced as in Aroor GP within the same district. The total population in Kuthiathode GP is approximately 23,669.

Within the study area of Kuthiathode Grama Panchayat, large cultivation lands and numerous prawn peeling stations contribute significantly to the local economy. Households in Kuthiathode are not closely packed.Households located near water bodies, such as Pallithode, face challenges due to their proximity to Coastal Regulation Zones (CRZ). Despite recommendations to evacuate these areas, the

population is reluctant to leave their homes, particularly during monsoon seasons when waterlogging is a common occurrence.

In Kuthiathode, greywater is directly discharged to the surrounding water bodies and low-lying areas around households. However, this discharge often includes combined wastewater, comprising both black and greywater, leading to widespread eutrophication in the surrounding areas.

3.8 Key Learnings from Case Studies

- Most LSGs have population above 5000 and the outlook of a rural area is similar to that of municipal areas.
- Most LSGs are aware of the problematic areas or places with Greywater management issues.
- Decentralized greywater management in areas with low groundwater table is possible.
- Households use open wells placed near the polluting source like single pits/water bodies.
- Recognition and ownership for undertaking a greywater management project is minimal.
- LSG President and Members are the key stakeholders who can convince the masses for taking up of greywater management projects.

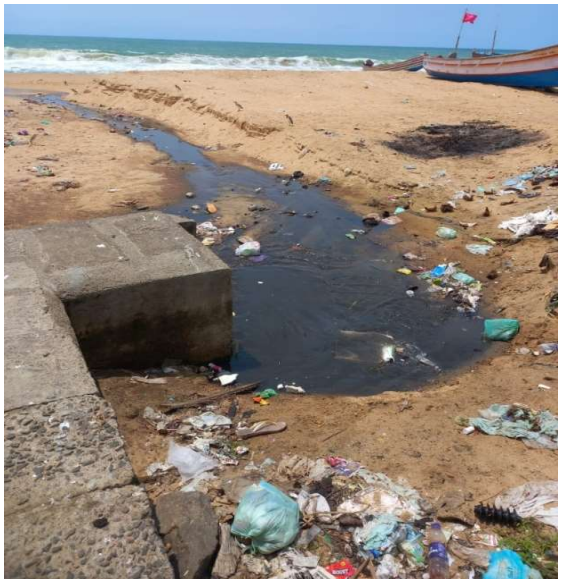
3.9 Major Challenges and Impacts in Greywater Management

Challenge	Impact
● High groundwater table, impermeable soil and proximity to water bodies making the soaking or leaching systems ineffective. ● Wastewater/Greywater discharge to waterbodies or environment.	Environmental impact ● High faecal contamination in surface and groundwater sources through greywater. ● Eutrophication of water bodies leading to damage of ecosystem. ● Groundwater pollution due to discharge of liquid waste Public health Impact ● Incidence of water borne disease through direct consumption of water from water sources. ● Mosquito nuisance in the area

Eutrophication of water bodies

Greywater stagnation near house compound

Impermeable soil holding greywater



Greywater stagnation near sea

Greywater discharge to soil

Household connecting GW to waterbody

Households connecting liquid waste to waterbody

<table>
<tr><td>Solid wastes/septage/other waste streams in the greywater</td><td>Environmental Impact
Blockage or disrupted flow of greywater causing stagnation.
Mixing of oil or septage increases and complicates the treatment requirement.
Odour nuisance created by discharge of wastewater from fish peeling station.
Oil or other effluent discharge complicates the treatment requirements.
Aesthetic impact
Blockage in flow and stagnation of wastewater damages the aesthetics of the area and affects the tourism in the area.</td></tr>
<tr><td> 
Blockage of wastewater flow by plastics</td><td> 
Presence of oil near the drainage point</td></tr>
<tr><td>Lack of drains/conveyance mechanisms for greywater/social issue surrounding conveyance systems/narrow roads/lack of space</td><td>Lack of conveyance systems creates gap in planning a community-based system and affects the sustainable treatment systems.</td></tr>
<tr><td> 
Narrow passages at Chandiroor</td><td> 
Narrow passages at Vellarada</td></tr>
</table>

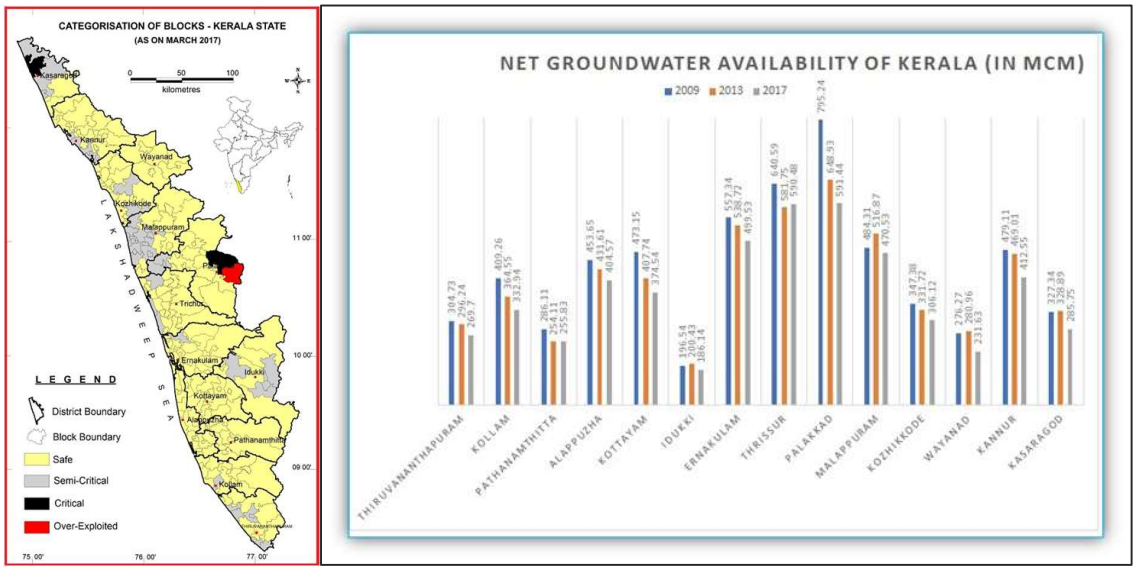
Other challenges	Impacts
Lack of ownership among LSG on GWM infrastructure or not recognizing GWM problems Lack of clarity among stakeholders on responsibilities for GWM Lack of capacity and convergence to execute Greywater Management projects	● Absence of projects undertaking on GWM or LWM ● Absence of accountability structure for Liquid Waste Management (LWM) and Greywater Management ● Substandard execution and lack of funds for conveyance of liquid waste to treatment causing unsustainable GW infrastructure

3.10 Overall Challenges

1. Mixing up of solid waste including cattle waste is a problem for greywater management.
2. There is no separate conveyance network anywhere devoid for greywater. It is difficult to plan for the conveyance network in Kerala for collecting and transporting greywater from individual houses to the decentralised treatment units due to the haphazard development of housing areas.
3. Stormwater drains are used for greywater conveyance. In some places there are no drains.
4. Existing drains are clogged due to solid deposition creating number of water stagnation points through its entire stretch.
5. LSGI engineers/officials face challenges due to a lack of clarity in overall project formulation, technology selection, and implementation of greywater management. This is primarily because they lack experience in undertaking projects related to greywater treatment in Kerala. Consequently, this lack of experience creates difficulties in effectively planning for greywater management in the state.
6. The public lacks awareness about the importance of greywater management. Many are completely unaware of the quality of water they use for their freshwater needs and how untreated greywater contributes to the contamination of freshwater resources.
7. There is a notable absence of systematic studies examining the effects of untreated greywater on water pollution and associated health issues in Kerala.
8. Understanding the context of the area is important before taking any project otherwise it may become a dead infrastructure. Example: Formulating STP project in rural areas.

4. TECHNOLOGY SELECTION FOR GREYWATER SYSTEMS

The need for grey water management is closely tied to the need for fresh potable water. Kerala's Groundwater Resource Estimation Committee Report (2017) estimates a steady decline in the net groundwater availability across the state (irrespective of water quality) from 2009 and an increasing number of semi-critical blocks in urban areas (which impose high stress on ground water resources). Most households depend on groundwater for their drinking and domestic water needs although nearly 88 percent of the total geographical area of the State is underlain by crystalline rocks with limited groundwater prospects (Kerala Ground Water Department, 2020). This untenable position drives the need for grey water management in the State.



Categorization of groundwater extraction blocks and district-wise trends of ground water availability

4.1 Greywater Management – Technologies at a Glance

I. DECENTRALISED/ HOUSEHOLD TECHNOLOGIES
   a. Household kitchen garden
   b. Household kitchen garden with root zone system
   c. Household soak pit
   d. Household leach pit
   e. Different modification to soak pits for better efficiency; including magic pit

II. SEMI-CENTRALISED/CLUSTER LEVEL TECHNOLOGIES
   a. Community leach pit
   b. Community magic/modified soak pit
   c. Community kitchen garden/plantations
   d. Community soak pit cum reed bed system
   e. DEWATS (Decentralised Wastewater Treatment System)
   f. Root Zone Treatment (RZT)
   g. Reed Beds
   h. Evapotranspiration

III. CENTRALISED TECHNOLOGIES
   a. Root Zone Treatment (RZT)
   b. DEWATS

4.2 Factors influencing Technology Selection

However, there are number of technology options for greywater treatment there are many limiting factors in selecting an apt technology for greywater management for a particular area. area. The major factors considered in the selection of technology for greywater management in Kerala Context are:

a) **Land availability:** The selection of a technology is mainly dependent on availability of land within household premises. In peripheral settlements where space is often available, decentralised facilities or cluster-based system can be implemented. Often in many Grama Panchayats, there is a lack of suitably located land of sufficient area for centralized greywater management solutions.
b) **Soil permeability:** Low permeability of soil will limit technologies that leach greywater to soils.
c) **Groundwater table:** High ground water table affects the construction as well as day-to-day working of the sanitation system.
d) **Climatic conditions:** Rainfall pattern, frequency and intensity of floods and cyclonic storms should be taken into consideration while planning for the greywater treatment infrastructure.
e) **Possibility for greywater conveyance:** Greywater treatment at cluster level will be feasible not only based on the technology selection but also on the possibility to convey the greywater from houses to the treatment location. Insufficient funding allocated to the conveyance network and ambiguity in its implementation pose significant limitations in discussions regarding the conveyance network.
f) **Affordability:** It is better to choose technologies with less capital expenditure for greywater treatment.
g) **Operational and maintenance cost:** Systems requiring high operations and maintenance cost are not desirable for financial constraints and non-availability of skilled labour.
h) **Energy requirements:** To ensure sustenance, it is necessary that technology should be selected which is less energy intensive or do not require energy or require minimum energy for its operations.
i) **Treatment efficiency:** The selected technology should meet the discharge or reuse standards requirements.
j) **Reuse opportunity:** Reuse of the treated wastewater should be considered to reduce environmental pollution and sustain the technology.

4.3 Suggested Technologies for Kerala Context (In addition to technologies suggested by SBM-G)

In many Grama Panchayats, there is a lack of suitably located land of sufficient area for centralized greywater management solutions. Given added concerns of conveyance networks and their funding, CAPEX and OPEX costs, ground water and soil permeability variation within certain geographies, a centralized greywater solution does not seem apt for Kerala's context. Instead, opting for decentralized/semi centralized solutions can solve for many of these problems, while also being cost-effective, energy efficient, and context-based solutions. Decentralized and semi-centralized grey water management technologies are suggested herewith; they may be implemented at the household level, within institutional complexes, or alongside the conveyance network prior to discharge.

4.3.1 Kitchen Garden

The development of a kitchen garden is a good option for greywater management at the household level where adequate space is available. It not only solves the issue of greywater management, but also reduces the demand for freshwater for growing vegetables. However, this intervention can be adopted only when it is assured that greywater used for irrigation is not touched by any overflow from septic tanks. A kitchen garden should be placed near the house to avoid expenditure on pipes for carrying water. A few considerations like space availability, the quantity of greywater generated and the species of plants that can be grown, need to be considered while designing a kitchen garden at the household/community level.

The household greywater must pass through *nahani* traps for the removal of impurities. An additional provision of a silt chamber may be provided to remove grit and suspended solids, and oil and grease, particularly for greywater that is generated from kitchen water in which large oil production takes place. Oil and grease present in the greywater is deposited in the form of scum in the siltation chamber. A soak pit may be established along with a kitchen garden to divert any excess water, as well as to facilitate its disposal in the monsoon. The water should be made to travel through a filter strip covered with 300–450 mm of gravel before it reaches the kitchen garden.

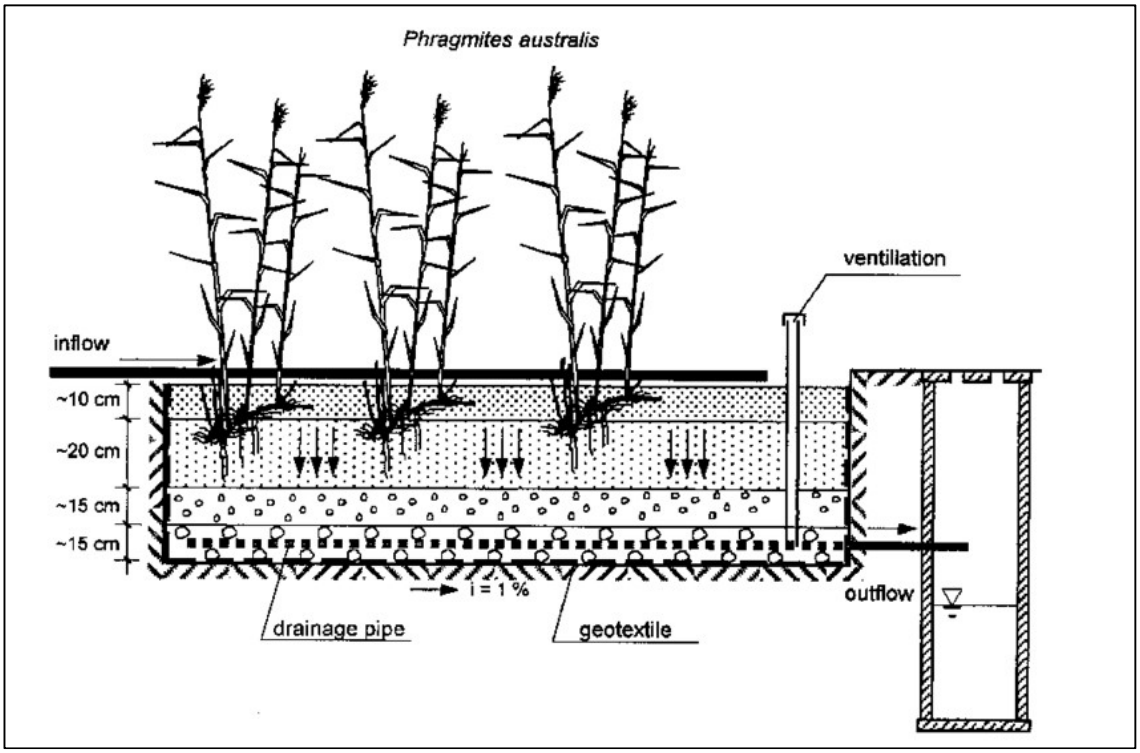
Alternative arrangements to kitchen gardens are essential during monsoon.

<table>
<tr><td>CAPACITY</td><td>150 – 250 l/day</td><td>WATER OUTPUT</td><td>N.A</td></tr>
<tr><td>AREA REQUIRED</td><td>1.5 sq. m - 2 sq. m</td><td>TERRAIN</td><td>All terrains except hard (impervious) rock; impervious soil (e.g., black cotton soil); and permanently waterlogged areas</td></tr>
<tr><td>POPULATION COVERED</td><td>1 household
(5 members)</td><td>CLIMATE</td><td>All climatic conditions; in very high rainfall zones the function of a soak pit may be affected during peak monsoon.</td></tr>
<tr><td colspan="2" rowspan="2">CAPEX*: Rs. 2000/- including washing platform and pipeline
OPEX*: Nearly nil</td><td>HOUSE TYPOLOGY</td><td>Well-suited to scattered housing; also, in houses with a limited courtyard</td></tr>
<tr><td>MAINTENANCE</td><td>Cleaning nahani trap: Once a week
Cleaning silt chamber: Once-twice a month</td></tr>
</table>

* Indicative costs only

4.3.2 Reed bed

This system works on the principles of recharge, purification, and reuse of grey water. Grey water first enters the soak pit and soaks into the soil. An overflow pipe from the soak pit leads to a reed bed (planted with water-loving plants). Excess grey water not absorbed by the soak pit automatically flows into the reed bed and is absorbed as well as purified. If the treated water comes out of the reed beds, it can be used for gardening.



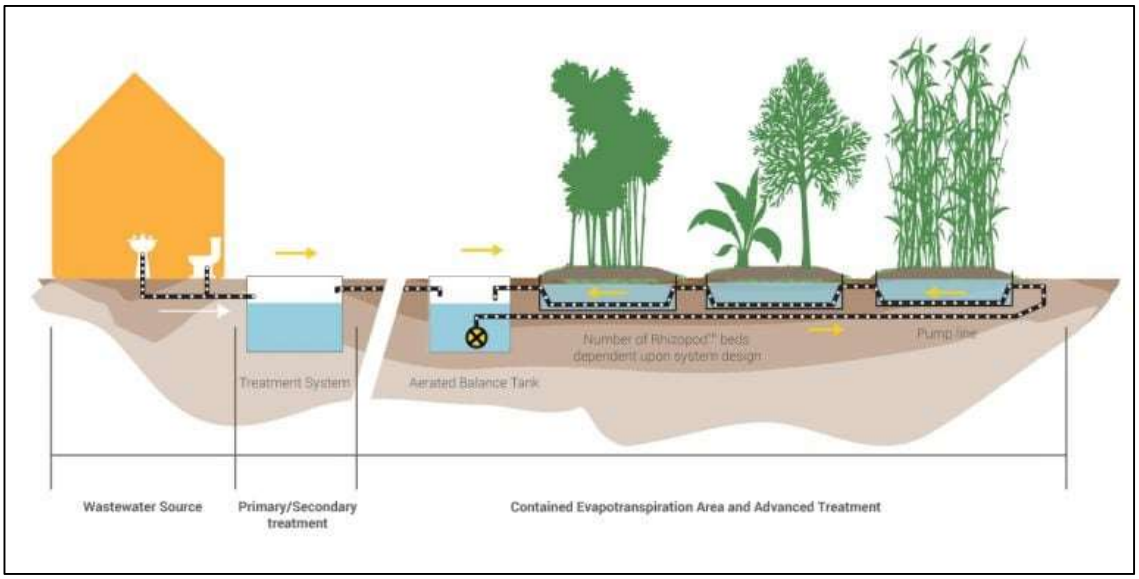
CAPACITY	500 – 1,000 l/day	WATER OUTPUT	Suitable for groundwater recharge No energy requirement
AREA REQUIRED	Varies	TERRAIN	Semi-permeable soils, coastal areas, and high-water table areas
POPULATION COVERED	Community-level solution – 30 HHs (178 individuals)	CLIMATE	All climatic conditions
CAPEX*: Rs. 8000/- OPEX*: Rs. 200-500/-		HOUSE TYPOLOGY	Well suited to dense housing dependent on common facilities for cloth and utensil washing
		MAINTENANCE	Desludging entire system: Once in 6 months

4.3.3 EVAPOTRANSPIRATION BEDS

Evapotranspiration beds are an alternative secondary treatment solution for greywater in areas with high groundwater tables, where soils prevent wastewater percolation, or where the productive reuse of wastewater flow streams is not a preferred option.

The respective wastewater effluents are discharged into sealed up receptacles where the water evaporates from the soil or transpires from the plants growing there. The dissolved organic matter is removed by bacteria and the remaining nutrients are taken up by plants. Evapotranspiration beds offer the possibility to grow biomass (e.g. bamboo) that might be useful at the household level for construction purposes, charcoal production or for composting.

While it is a low-cost option, evapotranspiration beds are predominantly suitable for hot and dry climates since the evaporation process requires time. Improper evaporation can cause the system to clog or overflow, constituting a risk to small children, generate unseemly smell, and attract insects. Proper maintenance is key for this solution.



CAPACITY	Varies	WATER OUTPUT	Nil
AREA REQUIRED	Varies	TERRAIN	In areas with high groundwater tables or where soils prevent wastewater percolation
POPULATION COVERED	Household-level solution	CLIMATE	Preferred in hot dry climates
CAPEX*: 5 LAKHS FOR 20 HOUSEHOLDS GREYWATER OPEX*: 450000 PER YEAR		HOUSE TYPOLOGY	Well-suited to scattered housing; also, in houses with a limited courtyard
		MAINTENANCE	Checks for vegetation growth, water flow and nutrient build-up. Visual inspection on a monthly basis followed by quarter-annual maintenance

**Indicative costs*

Other suggested technologies included soak pits, leach pits and magic pits. For areas with water tables below 5 metre depth, it is possible to implement all solutions as provided within the SBM manual, subject to suitable site availability and climatic restrictions.

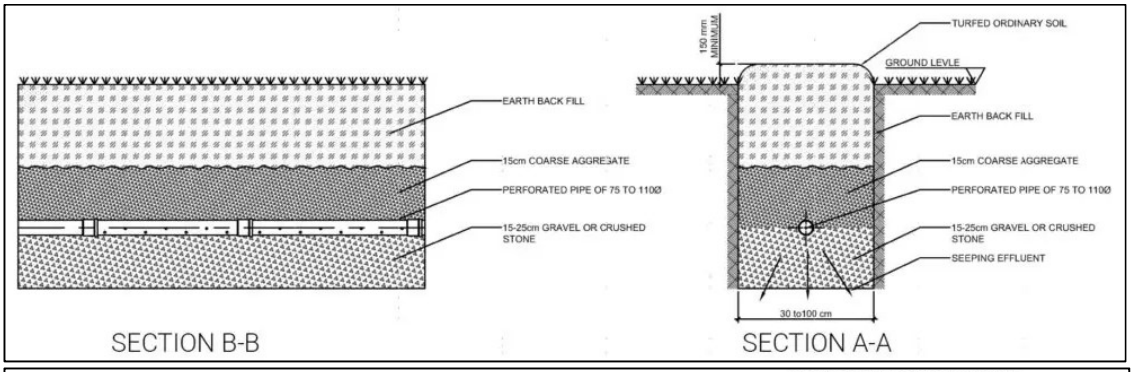
4.3.4 DISPERSION TRENCHES

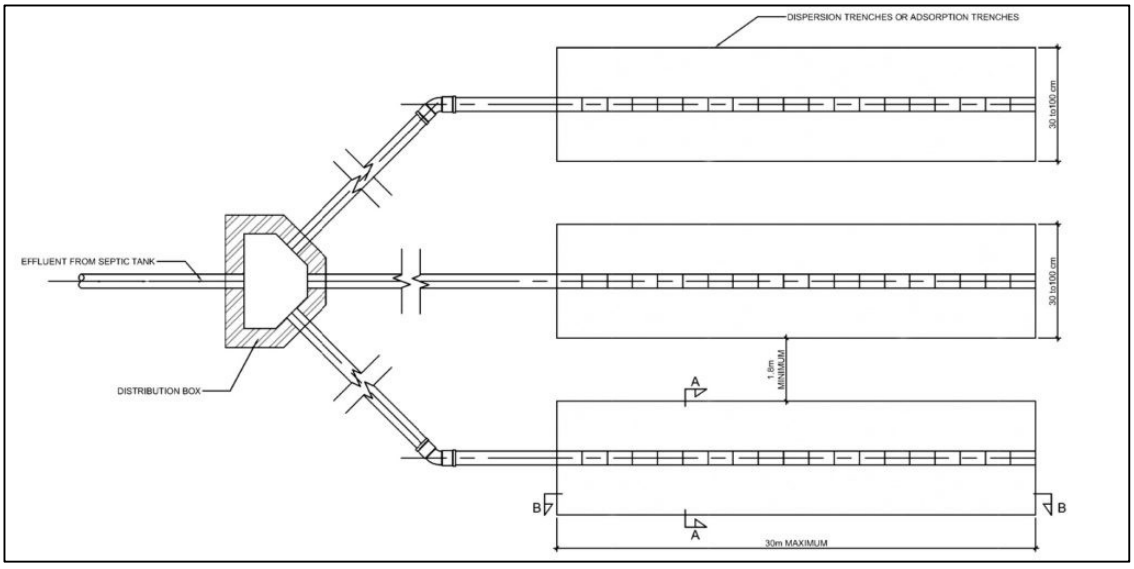
This method involves the diversion of the greywater into a masonry chamber known as a distribution box. From there, the effluent is evenly distributed through an underground network of open jointed pipes into absorption trenches called dispersion trenches. These trenches are filled with gravel and well-graded aggregate, serving as a medium for the absorption of suspended organic matter present in the effluent.

Dispersion trenches shall be 0.5 to 1 m deep and 0.3 to 1 m wide excavated to a slight gradient and shall be provided with 150 to 250 mm of washed gravel or crushed stones. Open jointed pipes placed inside the trench shall be made of unglazed earthenware clay or concrete and shall have minimum internal diameter of 75mm to 10mm. Each dispersion trench should not be longer than 30 m and trenches should not be placed closer than 2.0m.

The covering for the pipes on the top should be with coarse aggregate of uniform size to a depth of approximately 150 mm. The aggregate above this level may be graded with aggregate 12 to 15 mm to prevent ingress of topsoil while the free flow of water is in a way retarded. The trench may be covered with about 300 mm of ordinary soil to form a mound and be turned over.

Dispersion trenches are not suitable for areas where fibrous roots of trees or vegetation are likely to penetrate the system and cause blockages.

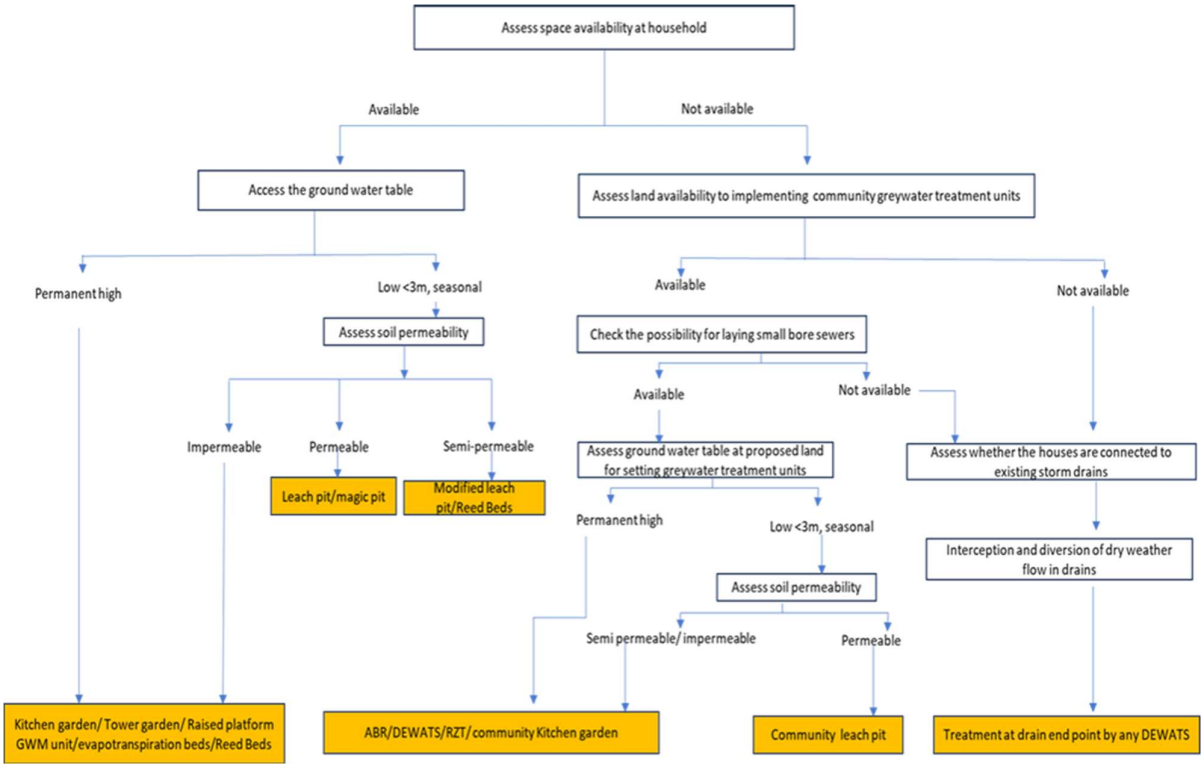




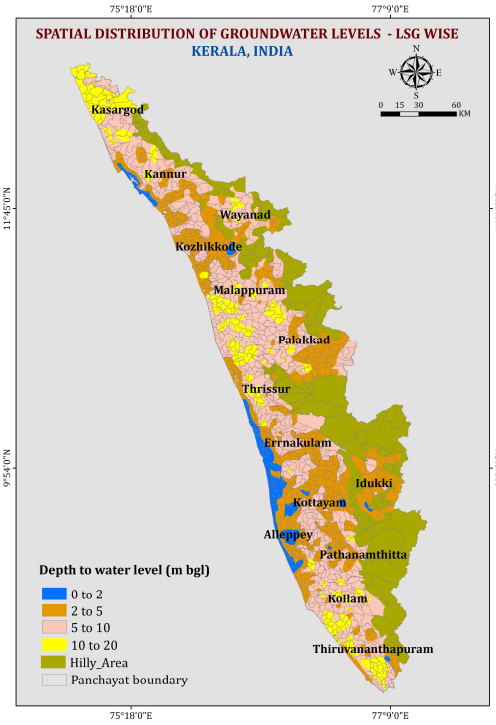
CAPACITY	Varies based on length, soil porosity (500 – 1,000 l/day)	WATER OUTPUT	Suitable for groundwater recharge No energy requirement
AREA REQUIRED	Varies (upwards of 30 sq. m)	TERRAIN	Not suitable for areas where fibrous roots of trees or vegetation are likely to penetrate the system and cause blockages
POPULATION COVERED	Community-level solution	CLIMATE	All climatic conditions

CAPEX*: ₹45,000 - ₹110,000 PER TRENCH	HOUSE TYPOLOGY	Well-suited to scattered housing
OPEX*: Rs ₹10,000 - ₹25,000 PER YEAR	MAINTENANCE	Desludging entire system: Once in 6 months

DECISION MATRIX FOR TECHNOLOGY SELECTION



4.4 Recommendations for Technology Selection



WASH Institute has created a spatial distribution map of groundwater levels and categorized LSGIs according to their susceptibility to groundwater contamination from greywater, determined by the depth of the water table. This classification will aid in pinpointing hotspots and devising greywater management projects. Indeed, susceptibility to groundwater contamination is just one criterion for identifying hotspots. Other criteria can include colony settlements, the core residential zone within the Gram Panchayat (GP), and the core commercial zone, which encompasses major restaurants and eateries. List of GPs based on water table levels is provided as Annexure to this document.

1. LSGIs where the Groundwater table is only 0 to 2 meters below ground level shall be considered critical, as there is higher possibility for water pollution there.
2. Give the preference to technology which is not energy intensive and with least maintenance requirement. If sufficient space is available for opt for any configuration for nature based Decentralised Wastewater Treatment Technologies.
3. Clustering of houses should be prioritized based on the consideration of laying the conveyance network through which the greywater will be conveyed.
4. If routing the conveyance proves challenging, always explore the possibility of intercepting and diverting drains, especially if they carry dry weather flow or already convey greywater.
5. In cases where space is limited, consider placing the greywater treatment units adjacent to or below roads.

5. PROJECT FORMULATION AND ADMINISTRATIVE PROCESSES

5.1 Identification of Greywater Projects

Dedicated human resource allocation for identification of liquid waste management and greywater management projects in each block and district using a standardized procedure for site identification. Site identification shall prioritise the places with greywater management issues or demand for GWM infrastructure.

5.2 Support for tender documents

- Documentation, standard estimates, and drawings for GWM projects (simple, innovative, and contextualized solutions as given in Technology section) will be given to LSG engineers by the Block Coordinators of Suchitwa Mission to formulate the project.
- After project formulation, LSG gets approval from council and District Planning Committee.
- Post-approval the tender invitation shall be done from the LSG part.

5.3 Support in Implementation of GWM projects

After issuance of the work order, the Suchitwa Mission block coordinator have ensure the project implementation and issue time to time written letters on do's and don'ts regarding the greywater management infrastructure.

5.4 Funding sources and partnerships

Component	Cost
Conveyance systems	MGNREGS, MP LAD, MLA LAD, 15th FC funds
Community infrastructure for GWM	**SBM G fund:** Rs 660 per capita (Population of GP more than 5000) SBM KOSH funds or CSR funds or MGNREGS funds

5.5 Legal regulatory framework

There is no specific regulatory framework for greywater in Kerala.

The Kerala Irrigation and Water Conservation (Amendment) Act, 2018

The sub-section 2 of the act states that "No person shall deposit or cause to deposit rubbish or filth or excreta or any other waste materials in any distributary system or water course or allow to flow water into it or pollute it in any other way".

As per section (5), “Whoever contravenes the sub-section (4) shall on, conviction, be punished with imprisonment for a term which may extend to three years or with fine which may extend to two lakh rupees or with both.”

5.6 Roles and Responsibilities in Greywater Management Initiatives

5.6.1 Local Self Government (LSG)

LSG is the local government authority that administers and regulates all the sanitation services including liquid and solid waste management. LSG has authority over all the stakeholders in the liquid waste management. The following are the responsibilities of the LSG.

- Issuance of standard design documents and estimates for Greywater Management infrastructure in their jurisdiction.
- LSG shall develop a calendar for conducting activities for sensitization of all stakeholders on the importance of the greywater management and having kitchen gardens to use the greywater in kitchen gardens.
- Identify and formulate GWM projects in Sulekha portal and get required approvals with estimates from the LSG council and District Planning Commission for the implementation of the project.
- Administer and own the GWM infrastructure established in LSG area (all wards) by allocated needed human resources and other infrastructure.
- Ensure the conveyance of greywater to the treatment facility and engage MGNREGA for support in building the conveyance infrastructure. In case of dilapidated or damaged conveyance infrastructure, revamping or repair works must be undertaken through tender or LSG Engineering department or through MGNREGA.
- Conducting IEC relating to solid and liquid waste management practices in the LSG area for the proper functioning of the GWM infrastructure.
- Facilitate the formation of Ward level sanitation committee to formulate ward level action plan for GWM with monitoring protocols and Key Performance Indicators (KPI).
- Tendering of work to agencies for implementation of GWM interventions.
- Monitoring of GWM activities or infrastructure established in the LSG area.

5.6.2 Suchitwa Mission

Suchitwa Mission is the Technical Support Group (TSG) for Liquid and Solid waste management of the Local Self Government Department, Government of Kerala. The following are the responsibilities of the LSG.

- Provision of technical support to LSG like design, estimates and execution support if requested by the LSG.
- Vetting of DPRs or technical proposals for GWM by District Suchitwa Mission
- Provision of tender document and agreements for smooth implementation of GWM projects.
- Providing inputs by engaging with District level Technical Committee

- Assigning block level Suchitwa Mission Engineer for identification of GWM projects to support in implementation of the identified projects (Plan of Suchitwa Mission and it is not in place currently)

5.6.3 Private agency/Contractor

Private agency/Contractor will be executing the GWM infrastructure in the LSG based on the tender conditions.

- Execute and deliver the GWM infrastructure given to them in a proper and efficient manner; and,
- Abide by the conditions of the work order and LSG regulations in executing the Greywater management projects.

6. CAPACITY BUILDING AND I.E.C

Capacity building refers to the deliberate and strategic process of developing the skills, knowledge, and capabilities of individuals, organizations, and communities to enhance their ability to perform effectively, adapt to change, and achieve sustainable development goals. It encompasses a broad range of activities, including training programs, skill development initiatives, and the transfer of knowledge and technology.

The goal of capacity building is to empower individuals and entities to tackle challenges, make informed decisions, and contribute meaningfully to their respective fields. In the context of greywater management, capacity building is essential for ensuring that stakeholders possess the necessary expertise to address the complexities of sustainable water use and environmental conservation, fostering a collective ability to manage resources efficiently and responsibly.

6.1 Understanding the Importance of Capacity Building in Greywater Management

Greywater, generated from household activities such as bathing, laundry, and dishwashing, represents a significant but underutilized resource. Effective greywater management is crucial for sustainable water use and environmental conservation. This section explores the importance of capacity building in greywater management and strategies for enhancing skills and knowledge among stakeholders.

Resource Optimization:

Effective greywater management requires an understanding of treatment technologies, reuse options, and local regulations. Capacity building ensures that individuals and communities are well-informed about the potential uses of treated greywater, such as irrigation for gardens or flushing toilets, thereby optimizing this valuable resource.

Environmental Conservation:

Uncontrolled discharge of greywater poses a threat to natural water bodies, leading to pollution and ecosystem degradation. Capacity building initiatives emphasize the implementation of proper treatment methods, preventing contamination and safeguarding aquatic ecosystems.

Community Health:

Inadequate greywater management can pose health risks due to the presence of pathogens and chemicals. Capacity building fosters awareness about the importance of safe handling and treatment, reducing health hazards and promoting overall community well-being.

Sustainable Development:

Capacity building aligns with broader sustainable development goals by empowering communities to take an active role in managing their water resources. This knowledge transfer contributes to the resilience of communities in the face of water-related challenges, promoting long-term environmental and social sustainability.

6.2 Strategies for Capacity Building:

Effective capacity-building strategies include comprehensive training programs, community workshops, technology transfer initiatives, and collaborative partnerships. These strategies ensure that stakeholders acquire practical skills, stay abreast of innovative technologies, and participate actively in sustainable greywater initiatives.

Case Studies: Highlighting successful capacity-building initiatives provides valuable insights. Case studies of communities that have implemented effective greywater management practices following capacity-building interventions showcase the tangible benefits and lessons learned from such endeavours.

Policy Implications: Capacity building should be complemented by supportive policies that encourage and regulate sustainable greywater management. Collaboration with government bodies is essential to integrate capacity-building outcomes into broader water management strategies.

Challenges and Opportunities: Recognizing the challenges, such as financial constraints and resistance to change, is crucial. Identifying opportunities, such as leveraging technological advancements and fostering community-driven solutions, helps chart a realistic path forward.

6.3 Strategies for Enhancing Skills and Knowledge among Stakeholders

Capacity building is an interactive process that, at least, five basic phases to complete the programming cycle. Although the timing and length of each phase will vary from one case to another, this five-step process cycle fosters a common frame of reference for a programmatic response to capacity development in water management.

Process flow or sequence of activities (from phase 1 to phase 5) as diagrammatic expression shall be needed.

Phase 1 – Stakeholders engagement

The identification of key players sets in motion the process. These may vary a lot depending on the case, especially since we have already seen that water management may be relevant in very diverse scenarios. The reason why the engagement of key actors is the first step of the cycle is the need for their support and vision. Stakeholders must be consulted to guarantee the self-sustainment and internal drive of the process.

Phase 2 – Assessment of capacity assets and needs

Once all interested stakeholders are aware and engaged, the first thing to do is to carry out an assessment of the existing needs at the different levels of the community. At this point the State's or local institution's wishes must be placed in the centre of attention, following the demand-oriented approach.

Since the context is extremely decisive, there is no 'one size fits them all' approach. However, a tool to facilitate this previous assessment has proved to be the formulation of these three questions: 'capacity why?', 'capacity for whom?' and 'capacity for what?' Through this method, the cycle is adapted to the specific area situation.

Phase 3 – Formulation of a Capacity Development Programme

The formulation of capacity development plans must be adapted not only to the actors involved in the implementation, but also to the target population that will benefit from the programme. Investments in capacity development have tended to focus mainly on training without addressing other necessary and complementary actions such as strengthening infrastructure, data collection, alliances and collaboration with minority groups and civil society organizations, etc.

It can be concluded that it is necessary to maintain a holistic and integrated approach that considers all key elements. When using the term 'holistic approach', what is meant is for the programme to foresee the desired results as an interconnected goal, made up of many specific targets that reflect all previously assessed needs.

Phase 4 – Implementation of a Capacity Development Response

A capacity development response must be composed by four main fundamental elements: institutional agreements, leadership, knowledge, and responsibility. If the previous steps have been taken properly, all these four pillars will be present during the fourth phase of the project cycle, namely: the implementation of a capacity development response, or, in other words, monitoring the suitable performance of the project.

For a successful implementation of a capacity development response, local ownership and sustainability of the project must be guaranteed. Local stakeholders and decision makers must continue working in the field of awareness-raising among those responsible for the protection and management of water resources, to produce safe food and for public health with a long-term perspective on sustainable development.

Phase 5 – Evaluation of results

The implementation of a capacity development response monitors the transformation of inputs into outputs. Evaluation, however, focuses on the analysis of those outputs, in other words, it studies the results. In this way, the fifth phase assesses whether outputs contribute to capacity development and, if so, what their impact is.

The information obtained is used for accountability purposes, performance management and further learning. The lack of relevant data or the existence of low-quality information in the field of water management is an obstacle that should not be underestimated. It hinders the possibilities of designing a good follow-up system. Subjective and objective sources may be used, as well as both, quantitative and qualitative information.

The fifth and last phase of the cycle should be oriented towards the establishment of a more systematic and results-based mechanism, whose outputs could be submitted for decision-making processes, budget design and government planning. The challenge, though, remains being capable of creating an evaluation framework that is comprehensive enough to gather all key factors without becoming too unmanageable.

6.4 Best Practices shared by Experts in Capacity Building Initiatives:

- Localized Solutions: Experts emphasize the need for tailoring capacity-building initiatives to the specific needs and contexts of communities, considering factors such as geography, climate, and socio-economic conditions.
- Hands-On Training: Best practices include incorporating hands-on training sessions to provide practical skills in greywater management, ensuring participants can implement what they learn.
- Multi-Stakeholder Involvement: Successful initiatives involve the active participation of diverse stakeholders, including government bodies, local communities, NGOs, and the private sector.
- Continuous Monitoring and Evaluation: Experts stress the importance of ongoing monitoring and evaluation to assess the effectiveness of capacity-building efforts and make necessary adjustments.

6.5 Information, Education, Communication, and Social Behaviour Change Communication in Greywater Management

- IEC for Awareness: Utilize Information, Education, and Communication (IEC) strategies to raise awareness about the benefits of greywater management, emphasizing its role in sustainable water use.
- SBCC for Behaviour Change: Implement Social and Behaviour Change Communication (SBCC) campaigns to influence attitudes and practices related to greywater management, encouraging responsible water use.
- Community Engagement: Involve communities in designing IEC/SBCC campaigns, ensuring messages are culturally sensitive and resonate with local values.
- Media Outreach: Utilize various media channels, including social media, radio, and television, to disseminate information and promote positive behavioural changes regarding greywater management.

7. PILOTING OF GWM

7.1 Piloting Strategy for Greywater Management (GWM) in Kerala

Addressing the burgeoning challenges of water management, particularly in regions like Kerala, necessitates innovative and sustainable solutions. Greywater Management (GWM) emerges as a crucial avenue, offering opportunities to mitigate water scarcity and environmental degradation. In this context, the piloting of GWM projects becomes imperative, serving as a testing ground to identify, understand, and address the complexities inherent in implementation. This comprehensive piloting strategy delineates a systematic approach towards GWM, encompassing the identification of pilot Gram Panchayats, rigorous need assessments, strategic planning, phased implementation, robust monitoring, capacity building, and knowledge dissemination. By leveraging these steps, stakeholders can pave the way for effective greywater management practices, fostering water security and environmental sustainability in Kerala and beyond.

1. Identification of Pilot Gram Panchayat:
   Select a Gram Panchayat with prominent GWM challenges and visible impacts post-implementation. Choose one per District or Block based on factors like population, land availability, hotspots, and demand areas. Scrutinize selections with a team comprising District and Block Level officials.

2. Need Assessment and Planning:
   Conduct a comprehensive need assessment through SHGs, CRPs, or field-level volunteers. Evaluate household, institutional, and community-level needs. Develop a plan outlining required GWM activities and map funding sources including SBM (G), 15th FC, MGNREGS, and others.

3. Identification of Suitable Technologies:
   Select appropriate greywater treatment and reuse technologies considering cost-effectiveness, scalability, ease of maintenance, and compatibility with local infrastructure. Ensure compatibility with existing conveyance mechanisms.

4. Phased Implementation Strategy:
   Adopt a phased implementation approach to mitigate errors. Consider project timelines, resource availability, and regulatory requirements. Collaborate with local partners for effective coordination and communication.

5. Monitoring and Evaluation:
   Establish robust monitoring and evaluation mechanisms to assess project performance, impact, and sustainability. Monitor key indicators such as water quality, treatment efficiency, system reliability, and user satisfaction. Incorporate stakeholder feedback and lessons learned into project implementation.

6. Capacity Building:
   Conduct training and capacity-building activities for local communities, water professionals, and policymakers. Provide technical support to ensure successful operation and maintenance of greywater treatment and reuse systems.

7. Knowledge Sharing and Replication:
   Disseminate findings, best practices, and lessons learned through workshops, seminars, publications, and online platforms. Facilitate knowledge exchange and replication of successful pilot projects within Kerala and beyond.

8. Impact and Future Replication:
   By implementing greywater pilot projects, stakeholders can demonstrate the feasibility and benefits of sustainable GWM practices. This initiative will catalyze broader adoption, contributing to water security and environmental sustainability in Kerala.

This refined plan provides a structured approach for piloting GWM projects in Kerala, emphasizing thorough assessment, strategic implementation, and widespread dissemination of knowledge for sustainable impact.

8. RECOMMENDATIONS AND WAY FORWARD

The following recommendations shall be taken for taking up of Greywater management projects:

1. Sanitation Situation Assessments

- Conduct comprehensive sanitation situation assessments across Local Self Governments (LSGs) in Kerala to gain insights into existing greywater management practices and challenges.
- Utilize innovative tools such as Shit-Flow Diagrams or similar visualizations to effectively communicate the context and identify priority areas for intervention.
- Engage competent organizations to ensure accurate data collection and analysis, enabling the design of context-specific greywater management solutions.

2.Technical Support Consultants (TSC)

- Facilitate the engagement of Technical Support Consultants (TSC) by inviting expressions of interest from qualified third-party engineers.
- Establish a committee under Suchitwa Mission to evaluate and select TSCs based on their expertise, experience, and alignment with project objectives.
- Provide ongoing oversight and support to TSCs throughout project implementation to ensure quality and adherence to guidelines.

3. Creation of Knowledge Portal and Dissemination of Knowledge

- Develop a dynamic knowledge portal dedicated to greywater management, serving as a central hub for resources, guidelines, and best practices.
- Implement a proactive communication strategy, including regular newsletters and targeted mailings, to disseminate information and interventions on greywater management to all LSGs.
- Designate accountable personnel within state offices to oversee knowledge dissemination efforts, ensuring timely delivery and feedback mechanisms for continuous improvement.

4. Engagement of Transaction Advisory Support

- Assess the need for transaction advisory support to optimize operation and maintenance strategies for greywater management projects.
- Collaborate with expert advisors to develop tailored approaches for sustainable project management, including financial planning, procurement, and risk mitigation.
- Provide ongoing monitoring and evaluation to assess the effectiveness of transaction advisory support and make necessary adjustments as needed.

5. Creation of Pool of Capacitated Professionals

- Conduct structured capacity building programs for civil engineers and contractors to enhance their skills and knowledge in greywater management.
- Define clear criteria for selecting participants, ensuring alignment with project objectives and the needs of local communities.

- Offer hands-on training and mentorship opportunities led by experienced professionals in the sector, providing guidance and support for implementing greywater management projects at the LSG level.

- Foster a collaborative learning environment to encourage knowledge sharing and continuous improvement among capacitated professionals, ultimately building a sustainable workforce for ongoing greywater management initiatives.

These recommendations aim to provide a comprehensive framework for advancing greywater management projects in Kerala, leveraging technical expertise, knowledge dissemination, and capacity building to achieve lasting impact and sustainable water resource management.

Acknowledgement

We are grateful to our contributors who gave their valuable time and insights regarding the greywater management implementation in Kerala.

1. Sri. Sandeep K.G, Chief Engineer, LSGD
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3. Sri. P.C. Mohanty, WaterAid, Odisha
4. Sri. A. S. Mazumdar, Sri. V. Pareekh (Technical Consultants – SBM(G), West Bengal),
5. Sri. Andrews Jacob (Senior Program Manager, CDD India)
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7. Dr.K.B. Radhakrishnan (Professor, Sree Chitra Thirunaal College of Engineering, Trivandrum)
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9. Officials from Kerala Water Authority
10. Officials from Kerala Rural Water and Sanitation Authority
11. Officials from MGNREGS

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Agenda

State-Level Consultative Workshop on Grey Water Management Projects

Date: 28 Dec 2023 **Venue: Hotel SP Grand Days, Thiruvananthapuram**

Time	Session	Resource Person
09:30 – 10:00	Registration	
10:00 – 10:05	Welcome	Smt. Ganga RS. LWM Director i/c Suchitwa Mission
10:05 – 10.15	Presidential Address	Sri. T M Muhammed Ja, Executive Director i/c, Suchitwa Mission
10.15-10.30	Inaugural Remarks	Smt. Sarada Muraleedharan IAS, Addt. Chief Secretary, Planning and Economic Affairs and Waste Management
10:30-10:40	Opening Remarks	Dr. Arumugam Kalimuthu, Executive Director, WASH Institute
10:40-10:50	Introductory Remarks	Sri. Sandeep KG, Chief Engineer, LSGD
10:50- 11:15	Context Setting & Agenda	Smt. Resmi PS. LWM Expert, Suchitwa Mission Sri Akhilesh Ramesh, WASH Institute
Tea break (11:15 – 11:30)		
11:30 – 11:50	Understanding Grey water management and approaches	Sri Praveen Nagaraja, Project Director WASH Institute
11:50– 12:20	Case Study Presentations	Smt. Swarna, WASH Institute Sri Sheik Muhammed Shibl, WASH Institute
12:20 – 13:00	Mapping the Challenges in GWM & Group Discussion	Sri Praveen Nagaraja, Project Director WASH Institute
13.00-13.20	Expert Presentation -1	Sri. Purna Chandra Mohanty, Technical Specialist, Water Aid
Lunch Break (13.20 – 14.20)		
14:20-14.40	Expert Presentation -2	Sri. Ardhendu Sekhar Mazumder & Sri. Vinayak Pareek

Time	Session	Resource Person
		Technical Consultants, SBM (G)Department of Panchayat and Rural Development, West Bengal
14.40 – 15:00	Expert Presentation -3	Sri. Andrews Jacob, Senior Program Manager, CDD India
15:00-15:20	Expert Presentation -4 (online)	Sri. Krishna Chaitanya Rao Director, WASH Advisory, WASH Institute
Tea break (15:20 – 15:40)		
15:40- 16:30	Group Activity and Discussion on the GWM Model for Kerala	Sri Praveen Nagaraja, Project Director, WASH Institute
16:30- 17:00	Concluding Remarks & Way Forward	Smt. Resmi PS, LWM Expert Dr. Arumugam Kalimuthu, ED, WASH Institute Sri. T M Muhammed Ja, Executive Director i/c, Suchitwa Mission

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