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Solve Challenge: Addressing Chemical Water Quality Challenges in Groundwater in Nepal

Winnovators

Developing skills, ideas, futures

The Challenge

Design practical and scalable solutions to improve iron and manganese removal from groundwater for peri-urban water utilities in Nepal's Terai region, with a focus on NWSC Lahan, to protect health and meet national drinking water standards.

Persistent manganese contamination is posing growing public health risks, particularly for infants and children, and existing treatment approaches are not sufficient in low-resource settings.

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Summary

In Nepal’s Terai region, groundwater is the primary source of drinking water but is affected by naturally occurring (geogenic) contaminants, including arsenic, iron, nitrate and manganese. While low-cost solutions for iron removal are already available and arsenic-affected boreholes are capped, manganese remains a critical and growing challenge, particularly in low-resource settings.

At NWSC Lahan, monitoring has shown persistent and system-wide manganese contamination, with levels frequently exceeding both Nepal’s National Drinking Water Quality Standards (NDWQS 2079) and WHO guidelines. Prolonged exposure to elevated manganese poses serious health risks, especially neurological impacts in infants and children. Existing treatment and operational measures are insufficient to consistently reduce manganese to safe levels.

Summary Cont'

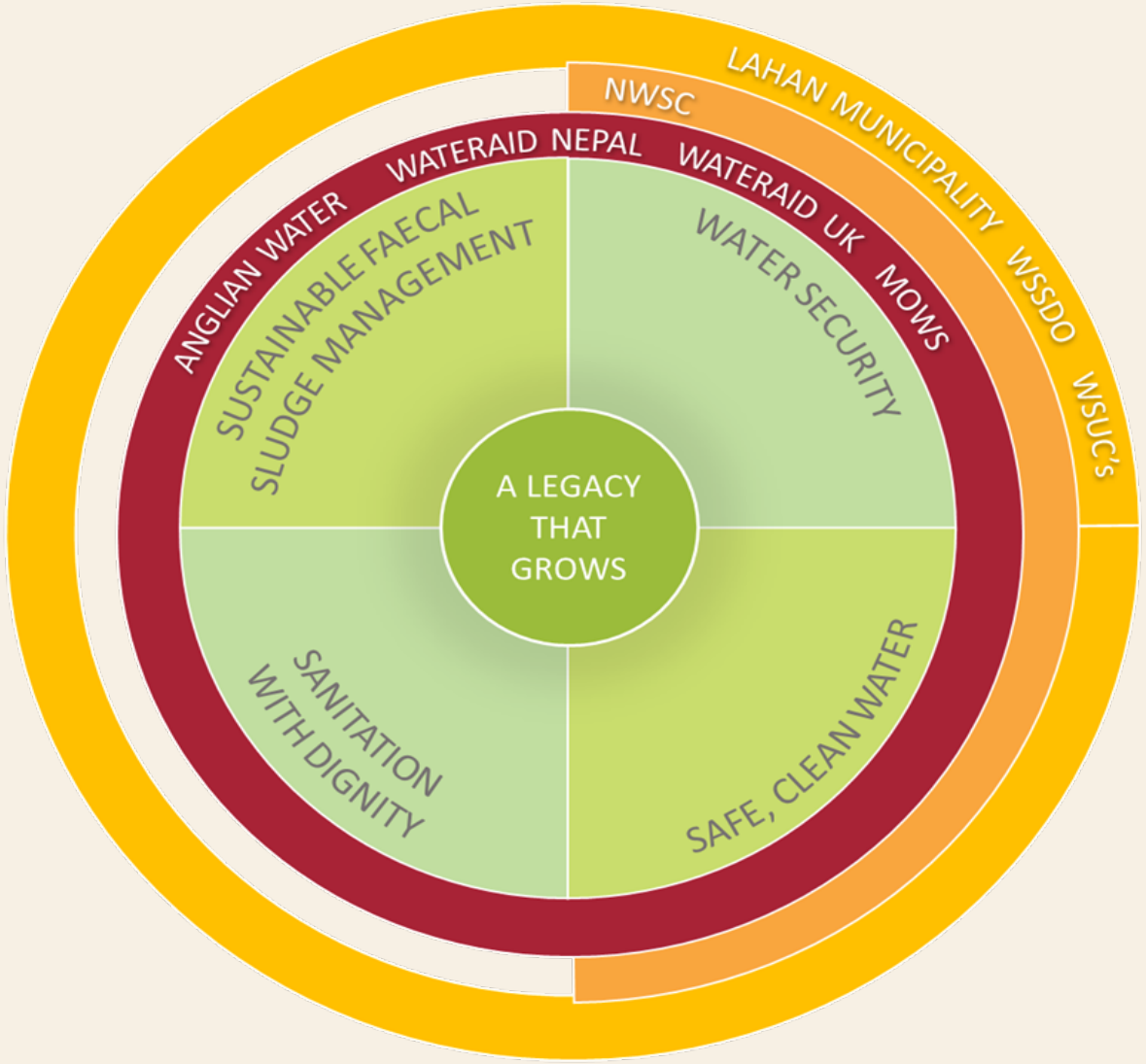
Low-cost solutions for iron removal are already available, but are facing operational challenges.

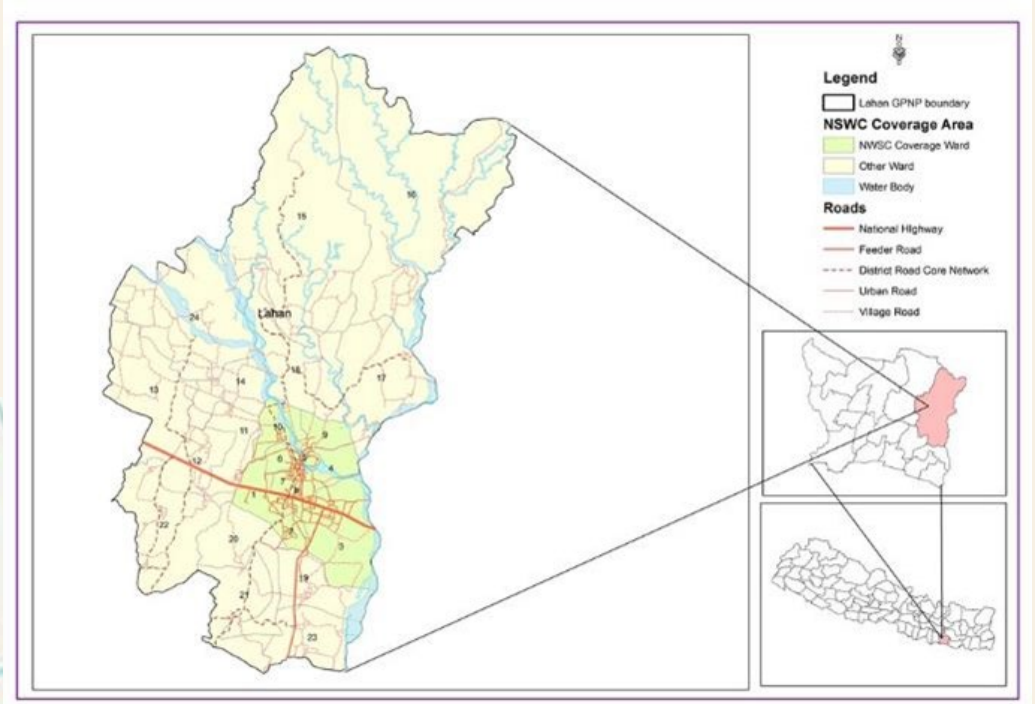
However, manganese poses a more complex challenge - although treatment methods for manganese removal exist in academic research and in utilities in high-income countries, *there is limited evidence on how to scale up and implement these in utilities in a low-income setting.*

This challenge invites teams to explore innovative, practical and locally appropriate approaches – including adapting existing research or technologies – that could be piloted, scaled, and shared with national stakeholders to strengthen water safety in Nepal.

Background

- The Beacon Project is a long-term partnership between the UK water company Anglian Water and its Alliances (AWA), WaterAid Nepal, the Nepal Water Supply Corporation (NWSC), and the Ministry of Water Supply (MoWS) and Lahan municipality.
- First initiated in 2016 and then put into action in 2017, The Beacon Project aims to develop and demonstrate holistic solutions that work across communities, local governments and utilities, and ultimately contributes to Nepal's journey towards achieving the Sustainable Development Goals (SDGs).
- More info on the project and various learning briefs available here: **The Beacon Project | WaterAid**





- Largest of the 17 municipalities in Siraha District, with a population of 91,766 people across 24 wards (2011 Census)
- 35% of the population have access to an intermittent water supply
- 65% have no access to a treated water supply
- There are 51 informal, poor and Dalit settlements in the municipality with total population of 21,946 Dalit (2011 Census)

Project Location – Lahan municipality

Background Cont’

Elevated Manganese Levels in NWSC Lahan Water Supply System: A Growing Concern

- Manganese levels have exceeded NDWQS 2079 limits in the NWSC Lahan water supply system since January 2018.
- Over 50% of samples (157 of 290) tested in an ISO-certified lab showed non-compliance.
- Recent monitoring (since August 2024) indicates rising manganese levels at the source and throughout the distribution network.
- Prolonged exposure poses health risks, including neurological effects, requiring urgent action.
- Resource: *Manganese in drinking-water - Background document for development of WHO Guidelines for drinking-water quality* https://www.who.int/publications/i/item/WHO-HEP-ECH-WSH-2021.5

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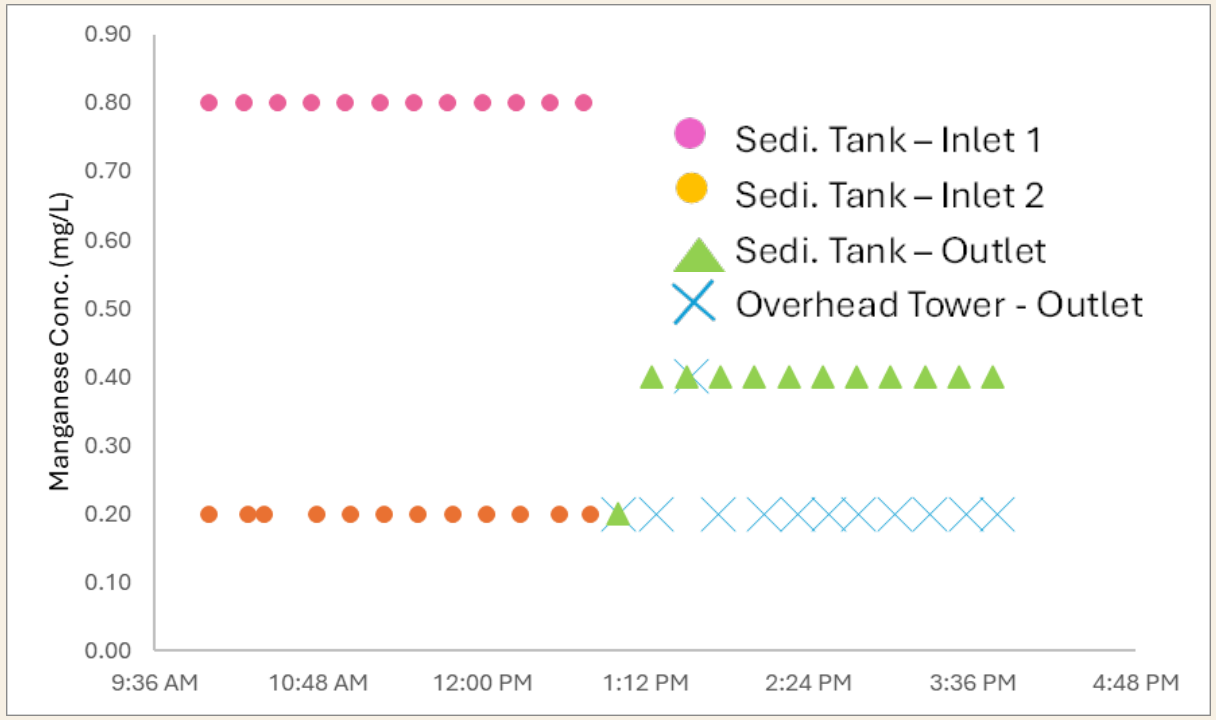
Background Cont'

Problem Identification

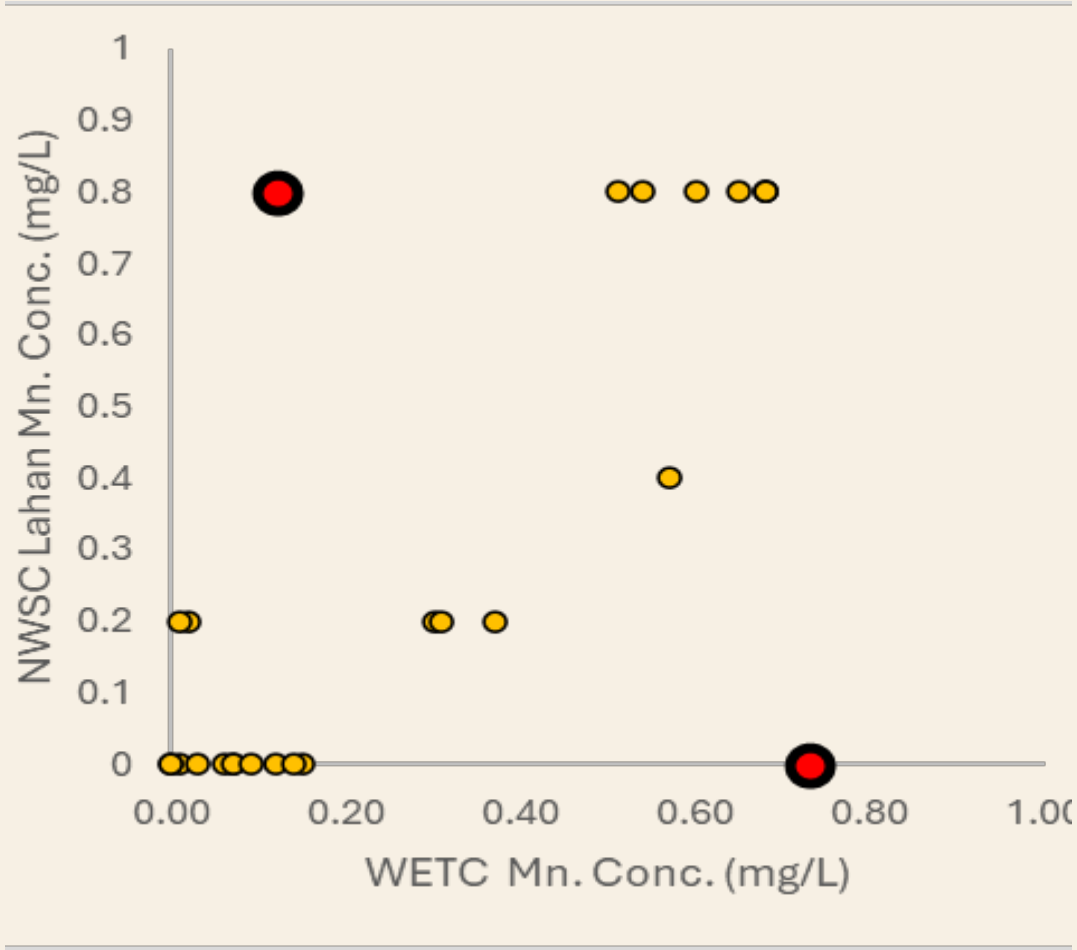
- NWSC Lahan abstracts groundwater from deep aquifers (~150 m) and is responsible for meeting NDWQS 2079 compliance.
- Manganese (Mn) is a mandatory chemical parameter under NDWQS and requires regular monitoring.
- Once considered an aesthetic issue, manganese is now recognized as a serious health risk, especially neurological impacts in infants and children.
- 157 samples exceeded the WHO provisional guideline (0.08 mg/L) by ≥5 times, indicating a public health concern.
- An enhanced sampling protocol was developed to assess manganese contamination across all service areas of NWSC Lahan (selected wards).



Background Cont’

Need for a Manganese Removal Plant at NWSC Lahan

- Recent monitoring (July–September 2025) confirms persistent and widespread manganese contamination across the majority of groundwater sources supplying Lahan.
- Manganese concentrations frequently exceed both NDWQS (0.2 mg/L) and WHO provisional guidelines (0.08 mg/L), often by large margins.
- Only a few peripheral sources remain consistently within safe limits, indicating the problem is largely system-wide.
- High manganese levels enter the treatment system, with existing sedimentation and storage processes showing inconsistent and insufficient removal.



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Background Cont’

Need for a Manganese Removal Plant at NWSC Lahan

- Household tap sampling confirms consumer exposure, with repeated detection of elevated manganese levels and an increasing trend over time.
- Operational checks and laboratory cross-verification demonstrate that contamination is source-driven and stable, not due to short-term operational or sampling anomalies.
- Current treatment and operational measures are inadequate to ensure compliance with drinking water standards.
- Given the scale, persistence, and health risks particularly neurological impacts on infants and children, there is a clear and urgent need for a dedicated manganese removal plant to protect public health and meet NDWQS 2079.

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The key challenges include:

1. **Chemical parameter water quality issues**

- Manganese and Iron
- Consistency in chlorine concentration
- Quality and local availability of chemicals for treatment processes

2. **Resources and WQ treatments**

- Government policy and follow of standard on WQ
- Lack of strong surveillance unit and Implementation on Water Safety plan
- Lack of best choices of feasible technical option for WQ treatment

3. **Management, Capacity**

- Insufficient staffs
- Sustainability on WQ testing mechanism for different management model of Water service providers

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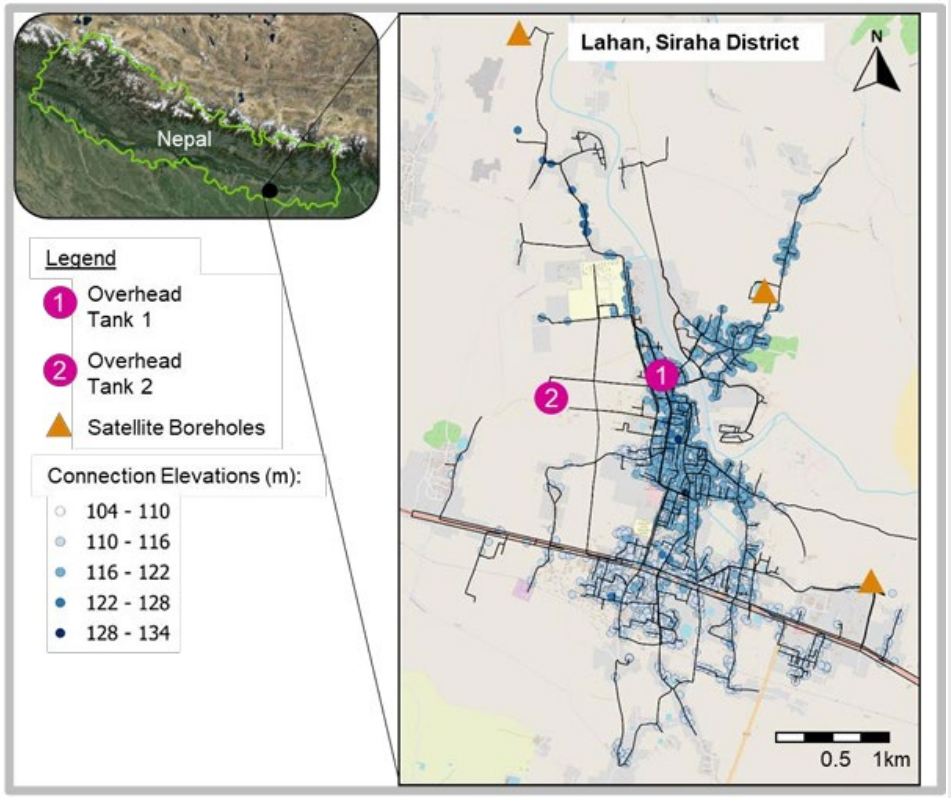
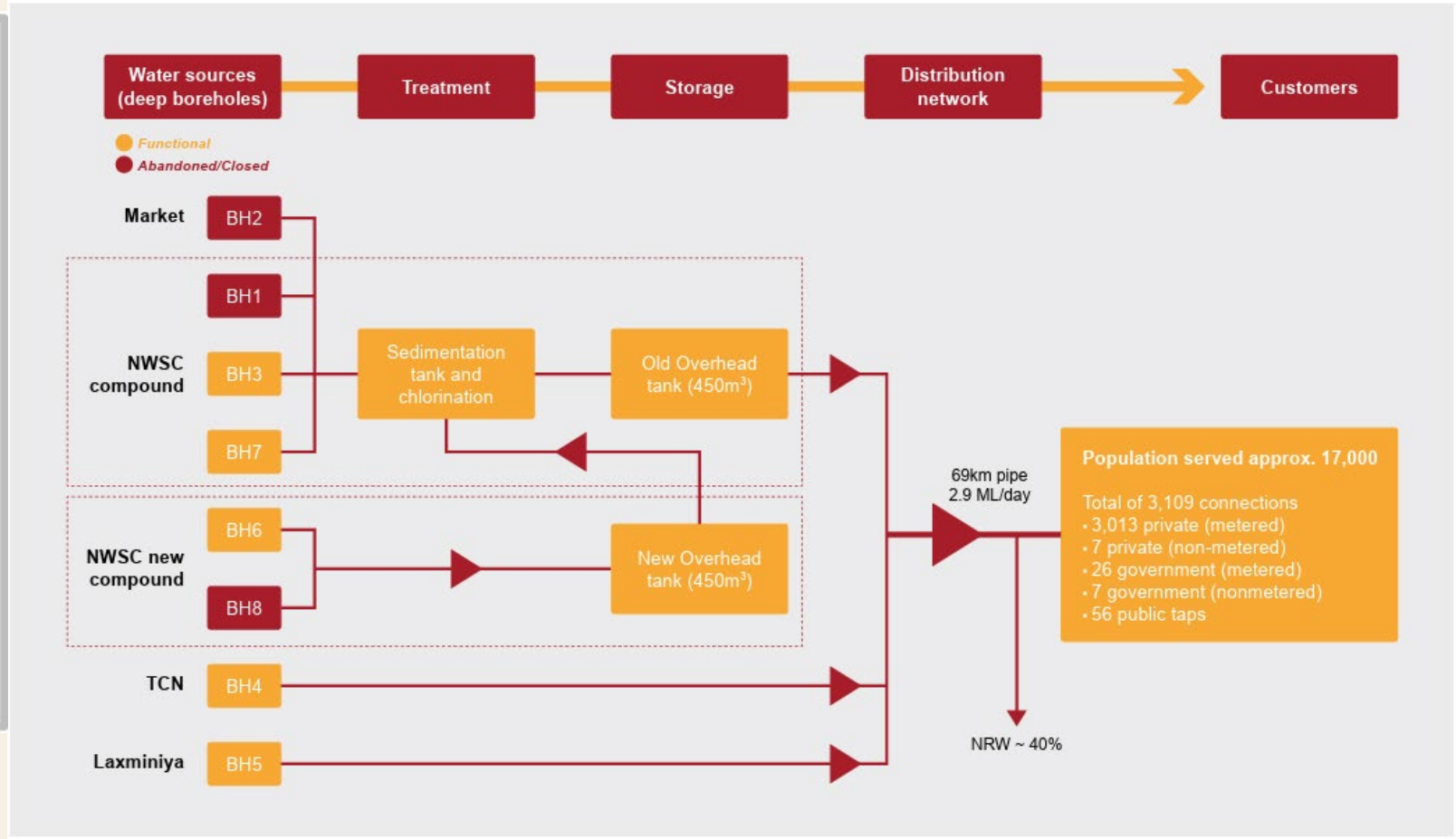
Current treatment process in Lahan





- More info: please refer to the *From Source to tap: Improving Water Supply in Lahan, Nepal* report in the Resource Library

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Technical Thoughts

- Some universities have researched manganese removal methods, but these solutions have not yet been scaled up.
- In high-income countries, manganese is removed – however, this is a costly process involving materials that might be hard to source locally.
- Through this challenge, we could review existing academic research and evaluate if any solutions are suitable for scale up and suggest practical ways to do this or suggest ways to adapt high-income country treatment processes for a low-resource setting. This is both a challenge and an opportunity to transfer technology.
- A pilot treatment is in planning stages using a locally available filter media produced by Katalox.

If an alternative solution is found through Winnovators there may be an opportunity to run another pilot to compare the results, and solutions can be shared with national stakeholders.

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What will you submit

A solution in the form of **one or more** of the following:

- 1,000-word report (excluding appendices, which should not exceed five pages)
- A3 poster/board
- 5-minute video
- 10-slide PowerPoint

Final submissions are due by Wednesday 30 September 2026.

What can you win

Best Solve – Strengthening healthcare waste management in Nepal

Best Solve – Addressing chemical water quality challenges in groundwater in Nepal

For the judging rubric, refer to the ‘Final submission instructions and information’

If your team excels in the Solve and Fund Challenges, you will win the title of:

Winnovators Overall Champion

WaterAid/ Oliver Dixon

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How WaterAid supports you

- A Resource Library hosting case studies, background documentation and submission of winning teams of previous years will be available at the Winnovators website.
- Webinars at the launch and mid-way through the program will be organised for an opportunity to meet with representatives from the Nepal team and our Program team and talk through the Solve challenges.
- Each team's work will be assessed by an expert panel. Various awards are up for grabs as teams compete with each other.

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What are the next steps

- Start thinking about the framework of your selected ‘Solve’ challenge.
  In no more than 500 words, prepare an outline and send to WaterAid at auswinnovators@wateraid.org.au. This is not part of the submission judging but is meant to help you establish a clear framework from the start and allow WaterAid to provide feedback on your initial direction and thinking.
- Check out the Submission Examples in the Resource Library on the website for ideas on the scope and format of submissions.
- Don’t forget to capture your journey! Remember to take photos during your meetings, discussions, and activities, and share them with WaterAid to document your Winnovators experience.
- Contact the Winnovators team at WaterAid with questions – we’re here to help: auswinnovators@wateraid.org.au.

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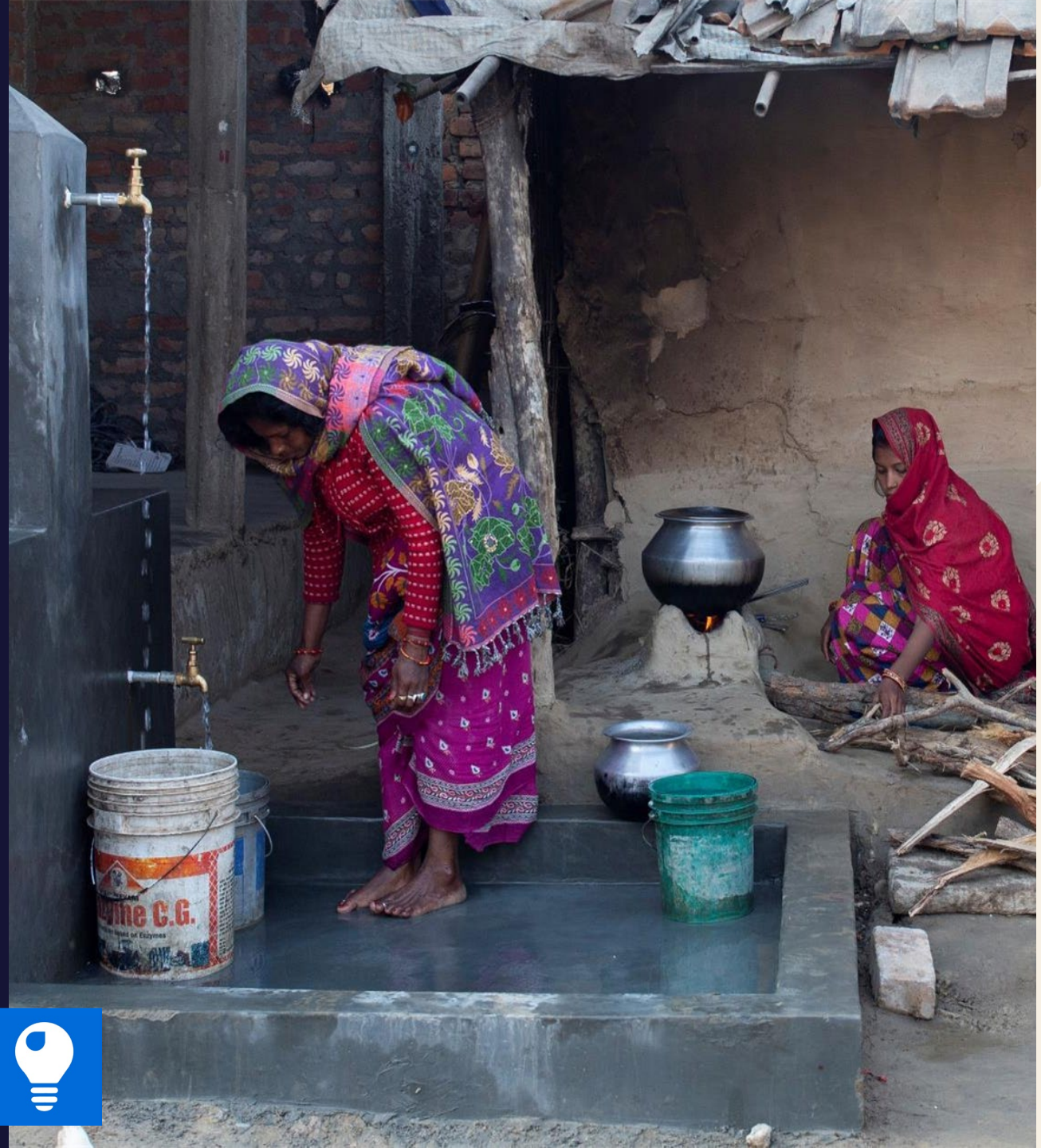

Thank you

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