Enhancing the treatment of hospital wastewaters in Laos by improving plant operators' essential knowledge and skills and piloting advanced post-treatment systems to remove pathogens and pharmaceutical residues

Project name: HEALTH

Duration: June 2024 until May 2026

Federal Ministry
for the Environment, Climate Action,
Nature Conservation and Nuclear Safety

Project partner

- German government Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN) (program: Export Initiative Environmental Protection); principal funder
- Lao PDR, Ministry of Health, Department of Health & Hygiene Promotion (DHHP)
- Lao PDR, Public Works and Transport Training Institute (PTI)
- URBANWaters Consulting GmbH; project lead, co-funder
- aqua&waste international GmbH; international partner, co-funder

Background

A wastewater sector that ensures a controlled collection, treatment, and discharge of wastewater is just emerging in Laos. Local expertise for planning, installation, and operation of wastewater systems and the supply chain for respective equipment is limited. Laos still relies heavily on imports and external services.

Almost all provincial and central hospitals in Laos installed advanced wastewater treatment systems to protect the surrounding communities and freshwater bodies. Besides a few nature-based systems, such as DEWATS installations, all advanced biological systems are imported.

The operators are often left with operational manuals in languages different from Lao, insufficient O&M training, and inadequate knowledge of the functionality and O&M requirements of the installed systems. As a result, almost all wastewater systems provide no or only partial treatment and release or bypass hospital wastewater into the environment.

The overall objective of the HEALTH project is to contribute to practical capacity development in the Lao wastewater sector and improve the treatment efficiency of existing hospital wastewater treatment plants.

Main activities are:

1. In collaboration with the Public Working Training Institute (PTI), establishing a wastewater training centre.
2. Conducting training courses for operators, including a 4-month on-the-job follow-up coaching. Up to 12 central and provincial hospitals are targeted.
3. Installing and monitoring a pilot plant addressing the removal of pathogens and pharmaceutical residues.
4. Conducting a national conference on the needs of the wastewater sector capacity development.

Training course - Operation of wastewater treatment plants

Hosted by: **Public Works Training Institute (PTI)**

Location: PTI training centre, Vientiane

Target group: Technicians and engineers

Technologies: DEWATS, activated sludge processes & rotation disc contactors

Module 1: Wastewater basics

Basic theoretical understanding of wastewater and treatment technologies

Module 2: Sewer basics

Basic theoretical understanding and practical skills about wastewater pipes, materials, joint methods, and testing water tightness

Module 3: O&M of wastewater treatment plants

Theoretical understanding & practical skills to operate & maintain different technologies

Module 4: O&M of technical equipment

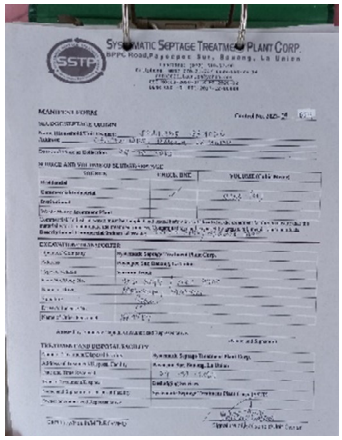
Theoretical understanding & practical skills O&M on technical equipment like pumps, valves, and sensors

Module 5: Self-monitoring wastewater treatment plants

Theoretical understanding & practical skills for effective monitoring of treatment plants and corrective actions

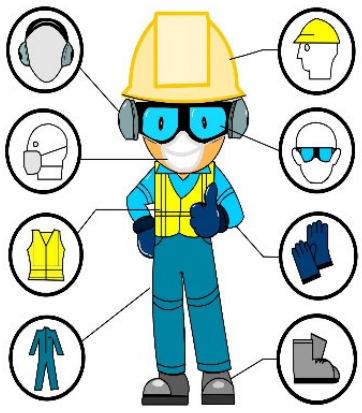
Module 6: Documentation

Theoretical understanding & practical skills to record O&M activities and the type of documents needed



Module 7: Health & safety of wastewater treatment plants

Theoretical understanding of the health and safety aspects of working in wastewater treatment plants



Pilot installation

The common practice of disinfecting hospital wastewater in Laos is the uncontrolled application of chlorine (hypochlorite). Uncontrolled means that most hospital wastewater treatment plants provide ineffective treatment and do not control the amount of chlorine added into the wastewater stream. Based on common technical standards, when applied to hospital wastewaters, the free residual chlorine concentration should not exceed 1.5-2.0 mg/l (at pH 7-8 and after 30 min). Chlorine is an oxidant that breaks many pathogens but also creates so-called Disinfection By-products (DBPs) with organic matter (measured as TOC, COD, BOD) and ammonia. DBPs such as trihalomethanes (THMs) or nitroamines (NDMA) can migrate into bodies of water used for drinking water and accumulate in aquatic life, such as fish. Most DBPs are carcinogenic to humans. Recommended is a well-treated wastewater quality of COD < 40 mg/l and TSS <10 mg/l for the application of chlorine in wastewater disinfection.[1] Many hospital wastewater treatment plants in Laos are either septic tank-based or imported advanced electro-mechanical treatment systems, and provide partial treatment with COD effluent quality >200 mg/l only due to insufficient operation and maintenance.

The overall objective is to explore alternative post-treatment options to treat wastewater effluents with lower quality while safely addressing the removal of pathogens and pharmaceutical residues.

Under this HEALTH project, the process combinations of biological activated carbon (BAC) filters with either pure ozone or UV/ozone shall be tested in a pilot installation in the Setthathirath hospital (Vientiane/Laos), and an oxidative electrolysis process at lab scale at the municipal wastewater treatment in Reinfeld/Germany in cooperation with the Technische Hochschule Lübeck. The pilot plant will be operated and monitored over 10 months, and the collected results shall help to prepare technical design and operation guidelines for upscaling.

Technical figures of the pilot installation:

- Capacity 5 – 15 ³/d
- Pre-treated effluent from a hospital wastewater treatment plant
- Land requirement 50 m²
- Electricity < 1.5 kWh/h

[1] Metcalf & Eddy (Wastewater Engineering: Treatment and Resource Recovery), 5th Edition (2014)

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HEALTH project sheet

Activity 1&2: Establishing local wastewater training capacities

Activity 2.4: Conducting training for operators of hospital wastewater treatment plants

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www.urb-waters.com

Activity description: Laos is increasingly investing in wastewater infrastructure, although the sector remains underdeveloped in terms of local capacity to design, supply, operate, monitor, and qualify essential human resources. In cooperation with the Ministry of Public Works and Transport (MPWT) and its national Public Works Training Institute (PTI), the project is supporting the establishment of a wastewater training center in Vientiane, the capital of Lao PDR. Over an eight-month period, a dedicated training curriculum and materials were developed, both remote and on-site training-of-trainers (ToT) sessions were conducted, and practical laboratory setups were installed. From 12 to 16 May 2025, the first training course for operators of hospital wastewater treatment plants was delivered in collaboration with the Ministry of Health (MoH). To ensure participants can apply their gained knowledge at their respective treatment facilities, the project is providing both on-site and remote follow-up support over a four-month period. A second training round for new operators is scheduled for the end of 2025.

Figures: Full five days delivering seven training modules:

M1 – wastewater basics
M2 – O&M of wastewater treatment plants
M4 – O&M of technical equipment
M5 – Self-monitoring
M6 – Documentation
M7 – Health & Safety

- 14 trainees (12 operators from 12 hospitals, 2 management staff MoH) + 4 trainers
- 6 operators of activated sludge plants
- 2 operators of rotating disk contactor
- 4 operators of DEWATS plants
- 16 hours for theoretical training
- 8 hours for group work
- 11 hours for practical training
- 3 hours social event

Outcome: Most of the trainees came from professional backgrounds as plumbers or electricians and had very limited knowledge of wastewater, the functionality of their system, and basic operation and maintenance (O&M) tasks. The training enabled participants to acquire essential knowledge and skills, and to connect with a growing community of practitioners. In the pre-training assessment, participants answered only 28% of the questions correctly on average; after the training, this improved to nearly 60%. For the Ministry of Health (MoH), management staff gained a clearer understanding of the importance of adequate O&M for hospital wastewater systems and how to better support O&M management efforts.

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Activity 4: Piloting post-treatment of hospital wastewater

Activity 4.2: Piloting electrolytic process to eliminate pathogens & pharmaceutical residues

Activity objective: To explore the potential of applying an electrolytic process for the removal of pathogens and pharmaceutical active compounds (PHACs) from wastewater with a low level of pre-treatment. Conventional post-treatment disinfection methods—such as chlorination, ozonation, or UV radiation—require highly pre-treated effluent to be effective. However, many decentralized wastewater treatment plants around the world do not consistently achieve the required level of pre-treatment.

Activities description: Between January and April 2025, small-scale tests were conducted at the municipal wastewater treatment plant in Reinfeld, in collaboration with Technische Hochschule Lübeck (THL). A mobile electrolysis unit equipped with a DBB electrode for oxidative electrolysis was used to treat municipal wastewater collected after the primary settler (highly polluted). The research focused on evaluating the influence of power input, reaction time, pollution level, and conductivity on treatment efficiency and operational performance. Monitoring parameters included: COD, pH, conductivity, temperature, E. coli, and seven pharmaceutical compounds, with diclofenac serving as the key indicator. Conventional municipal wastewater treatment plants typically achieve diclofenac removal rates below 50% and therefore require advanced post-treatment processes.

Interim results: Initial results demonstrate that oxidative electrolysis can selectively eliminate key target parameters—namely pathogens and pharmaceutical active compounds (PhACs)—without requiring extensive pre-treatment. This finding highlights the potential of the process for treating hospital wastewater and for applications where effective pre-treatment cannot always be ensured. However, the current energy demand of 4,000–12,000 W per m³ is still too high for practical implementation. Further tests will be carried out to optimize both the process efficiency and energy consumption.

Parameter	Unit	Before	After	Efficiency
COD	mg/l	396 – 616	222 - 355	averg. 43%
E.coli	MPN/100 ml	26 – 51 mio.	< 15 – 3.050	>99,99%
Diclofenac	mg/l	2,6 – 5,2	< 0,02 – 0,11	>97%

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