Clear Horizon

VALUE FOR MONEY CASE STUDY

Low-cost technology for safe drinking water

This case study assesses the Value for Money of the Safe Water Optimization Tool.

Prepared for Grand Challenges Canada

1 April 2026

CREATING HOPE IN CONFLICT: A HUMANITARIAN GRAND CHALLENGE

A PARTNERSHIP OF

UKaid from the British people

In partnership with Canada

Grand Challenges Canada® Grands Défis Canada

The Challenge

Waterborne diseases are a major risk in humanitarian settings, particularly for people displaced by conflict and disaster. Providing safe drinking water is therefore essential for preventing outbreaks. Water chlorination is widely used in emergency water, sanitation and hygiene (WASH) responses because it disinfects pathogens and provides residual protection against recontamination. However, commonly used guidance, such as chlorination targets in the Sphere Handbook, are not based on strong field evidence and do not always ensure water remains safe up to the point of consumption, where public health protection ultimately occurs.[1]

In refugee and internally displaced persons (IDP) settlements, households usually collect water from communal tap stands and transport and store it in their shelters for later use. During this post-distribution period, covering collection, transport, and storage, previously safe water can become re-contaminated. This has been linked to outbreaks of diseases such as cholera, hepatitis E, and shigellosis in refugee and IDP settlements across multiple countries. [2] To prevent this, drinking water must remain protected until the end of the household storage period. Global guidelines recommend maintaining at least 0.2 mg/L of free residual chlorine throughout this time. Achieving this requires water system operators to determine appropriate chlorination levels at the point of distribution so that sufficient protection remains at the point of consumption.[3]

The Innovation: Safe Water Optimization Tool

The Safe Water Optimization Tool (SWOT), developed by the Dahdaleh Institute for Global Health Research at York University, is a user-friendly, low-bandwidth web platform that turns routine water quality monitoring data into evidence-based, site-specific chlorination targets. By combining advanced modelling with operational guidance, the SWOT helps ensure water remains safe up to the point of consumption while balancing public health protection with user acceptability. The tool is free to use, designed for remote and resource-constrained humanitarian settings, and is supported by an online knowledge base, training, expert technical support. Funding from Grand Challenges Canada was used to pilot SWOT in Nigeria, Syria, Democratic Republic of Congo, and Gaza.

Grand Challenges Canada Funding Provided (CAD)
Seed funding \$249,982 ➔ *Transition to Scale funding* \$299,027

Value for Money Assessment

The SWOT was scored against GCC's Creating Hope in Conflict five Value for Money (VfM) criteria (see the note on methodology at the end of the case study for further information).

Economy

Good

There is good evidence that the SWOT can deliver water quality improvements at relatively low cost compared with traditional approaches. By embedding advanced, data-driven modelling into an accessible tool, the SWOT enables highly specialised water treatment engineering capabilities to be deployed directly to humanitarian field sites, without the need for costly on-site consultants. While the economic rationale is strong, there is limited direct evidence from pilots demonstrating realised cost savings attributable to the SWOT.

Efficiency

Good

There is good evidence that the SWOT delivers improved water quality outcomes at minimal additional cost per user. By embedding advanced water quality modelling into an open-source, low-cost digital tool, the SWOT makes specialist engineering analysis timely and accessible to field teams. While the evidence demonstrates strong potential for efficiency gains, these gains have not yet been quantified for the GCC-funded pilots.

Effectiveness

Good

Evidence from non GCC-funded applications demonstrates that the SWOT effectively improves residual chlorine protection and increases the likelihood that water remains safe at the point of consumption. Modelling, case studies and published evaluations show that, when applied as intended, the tool delivers substantial improvements over standard practice in protecting stored household water. This rating may increase as more evidence from implementation becomes available.

Sustainable and cost-effective

Good

By embedding the tool with country-level partners, establishing a dedicated non-profit to support scaling, and promoting sector-wide data-driven and public health-focused approaches, the SWOT combines low-cost implementation with an approach that is replicable, and demonstrates emerging evidence of enduring health benefits across humanitarian water supply systems. With more consistent evidence at scale, this rating is likely to improve.

Gender Equality and Social Inclusion

Adequate

The SWOT improves access to safe drinking water for hard-to-reach refugee and IDP populations. While women and girls are likely to benefit indirectly, the innovation does not explicitly target gender outcomes and lacks gender disaggregated evidence of impact.

Economy

Good

> There is good evidence that the SWOT has the potential to reduce health care costs associated with outbreaks of waterborne diseases by protecting drinking water throughout the post-distribution period. In particular, it helps prevent pathogenic recontamination during household storage, up to the point when the final cup of water is consumed.[4]

When estimating these costs, it is important to note that waterborne illnesses are among the leading causes of infectious disease outbreaks in humanitarian response settings.[5] While there is limited evidence specifically for the SWOT, broader evidence suggests that **every dollar invested in water and sanitation returns approximately US$4.3, with an estimated gain of 1.5% of global gross domestic product (GDP) through reduced health care costs**.[6] Another more recent systematic review and meta-analysis of water treatment interventions (and chlorination programs specifically) from the National Bureau of Economic Research showed an expected 23% reduction in under-5 mortality linked to water treatment interventions. Water treatment was found to be 'one of the most cost-effective health programs available', with the authors estimating the 'cost per expected DALY [disability adjusted life-years] averted due to water treatment between USD 28 and USD 72, depending on approach'.[7]

In addition to potential savings from reduced health care expenditure, the SWOT provides a substantially lower-cost approach to developing system-specific treatment plans. In high-income settings, engineering services are typically used to monitor water systems and develop tailored treatment plans. However, this approach is not feasible in most humanitarian contexts and is cost-prohibitive in refugee camp settings. Nevertheless, it provides a useful comparator when considering the economy gains associated with achieving a similar level of water quality. Rather than requiring a specialist engineering team to conduct a dedicated water quality study, SWOT empowers existing WASH field teams to generate context-specific water treatment guidance from the data they already collect — delivering specialised engineering analysis at a fraction of the effort and cost.

At this stage, there is substantial evidence on the value of treated water and on the theoretical cost savings associated with improved water treatment delivery; however, evidence of actual, measured cost savings from the SWOT pilots remains limited. As more evidence becomes available, this rating may increase.

Efficiency

Good

> There is good evidence that the cost of the SWOT as a component of water supply provision in humanitarian and refugee settings is minimal, while the efficiency gains, in terms of improved water quality at the point of consumption, can be substantial.

Analysis of operational WASH budgets in a humanitarian context, including pooled funding proposals for humanitarian responses, benchmarked that total spending on water quality monitoring typically represents around 1–6% of total budgets for water supply projects. This estimate was consistent across different contexts, implementing agencies, and types of water systems. Across the budgets reviewed, the average water supply component was approximately US$430,000, or around US$4 per beneficiary per month. Within this context, the cost of implementing the SWOT is expected to be minimal and feasible within existing budget envelopes.[8]

The SWOT's open-source, AI-driven platform makes specialist engineering expertise accessible where it is needed most – encoding the kind of advanced modelling that would otherwise require an expensive consultant into a tool deployable at any field site. In many humanitarian and refugee settings, such expertise is not readily available in camps, and bringing in external engineers is often beyond the cost constraints of projects. As such, the SWOT offers an efficiency gain by enabling improved water-quality management at the point of consumption, which, in turn, is expected to reduce the incidence of waterborne disease.

The SWOT, however, is a smart app, and needs to be adopted as part of a broader monitoring system rather than as a standalone tool, as it is reliant on regular water quality monitoring at tap stands and the point of consumption. This was evidenced by York University's experience in northwest Syria, where regional instability led to limited monitoring capability and operational bandwidth on the part of implementing partners, which resulted in the SWOT only being adopted by one partner, and its influence across the full coordination platform (and monitoring system) was not as originally envisioned.[9] The pilot was ultimately moved to Bangladesh and Kenya.[10]

Overall, the SWOT delivers improved water quality outcomes at minimal additional cost per user. By embedding advanced water quality modelling into an open-source, low-cost digital tool, the SWOT makes specialist engineering analysis accessible to field teams without the expense or delays of deploying external technical consultants. While the evidence demonstrates strong potential for efficiency gains, the rating remains *good* rather than *excellent* due to the current reliance on supporting evidence that is not consistently drawn from GCC-funded pilot implementations.

Effectiveness

Good

There is good evidence of potential health and well-being benefits for end users of the SWOT. While formal baseline and endline data were not available from pilot locations in either the seed or transition-to-scale funding rounds, a consolidation of other evidence provides a strong foundation for the effectiveness of the SWOT.

Impact modelling conducted by York University estimated that implementing the SWOT's operational recommendations could provide safe water access to up to 48,222 new individuals in Nigeria through the initial seed funding pilot.[11] This was further supported by a specific example from Anka IDP camp in northwest Nigeria, which demonstrated close to 100% household safe water coverage when the SWOT was used, compared to when Sphere Handbook chlorination targets were used. The SWOT tool was implemented across 5 tap stands used by over 3,500 refugees. A total of 756 samples were collected (an average of 63 per month) by a single data collector using a pool tester, with results recorded and uploaded to the SWOT web tool. The study found the SWOT-recommended chlorination target yielded 97.3% of households with sufficient residual chlorine protection of stored water supplies 6 to 12 hours after distribution, as compared to just 50% of households when using the sector-recommended Sphere Handbook water chlorination target.[12]

Through GCC's transition to scale funding in 2023, the SWOT was piloted in different locations. Through three local and international humanitarian organisations (Ihsan Relief and Development in North-West Syria, Concern Worldwide in North-East Syria, and Médecins Sans Frontières (MSF) in the Democratic Republic of Congo and Gaza), The **SWOT was deployed in 33 refugee and internally displaced persons (IDP) camps, reaching an estimated 200,926 people that were served by water systems at these sites.**[13] In addition, GCC, through a separate funding mechanism, is supporting International Medical Corps to use the SWOT in IDP camps and community settings in Yemen.[14]

While not a direct measure of the pilots funded under CHIC, published data on SWOT's use in Cox Bazar, Bangladesh, showed that households that collected water meeting the SWOT target were more likely to have sufficient protection after 15 hours compared with the status quo Sphere target (90% vs 35%, $p<0.01$), demonstrating the SWOT's efficacy. However, because the SWOT target was not fully implemented at tap stands, no overall change in household water quality (as demonstrated by free residual chlorine) was observed at endline. This finding underscores that while the SWOT is technically effective, strengthening feedback loops between monitoring and operational decision-making is essential for system operators to fully realise its water safety benefits.[15]

Evidence from mainly non GCC-funded applications demonstrates that the SWOT is technically efficacious, consistently improving residual chlorine protection and increasing the likelihood that water remains safe at the point of consumption. However, this evidence also shows that realised health and wellbeing outcomes depend on consistent system-level integration and operational use. More evidence of effectiveness from GCC-funded pilots would improve this rating.

Cost-effectiveness and sustainability at scale

Good

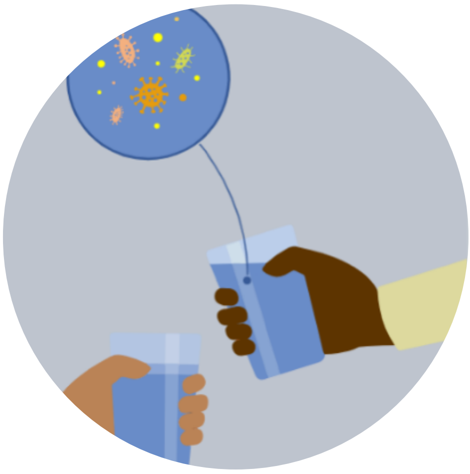
The SWOT achieves sustainable cost-effectiveness at three levels: through its partnership approach at the country level, through the establishment of a non-profit dedicated to scaling the SWOT sustainably, and through its wider advocacy efforts to centre public health and mainstream data-driven approaches in water supply programs.

The SWOT's impact is strengthened by embedding the tool within individual WASH partners at the country level. Lessons from the Syria coordination pilot have informed a 2025 scaling strategy prioritising integration in Yemen, Madagascar, Tanzania, Gaza, Sudan, and Uganda. By building partner capacity and demonstrating impact at the country level, York University aims to create a replicable model with one partner, one country at a time. At the camp level, the SWOT is easily scaled with marginal additional costs, as the tools are free, open-source, and optimise inputs, often improving water treatment quality: Cox's Bazar provides a strong example, with safe water coverage increasing from 35% to 90% of households.[16]

The creators of the SWOT have launched *Impact Water Works*, a non-profit dedicated to sustainably scaling the SWOT through grants, foundation support, and revenue from consultancies and service contracts.[17] Establishing the non-profit has also reduced overheads, as the non-profit is able to offer a much lower overhead rate compared to the university's standard overhead rate (40%). York University no longer takes a cut of consulting fees.[18] This structure ensures long-term sustainability while enabling strategic growth without relying on traditional profit-driven models.

Beyond operational deployment, the SWOT contributes to sector-wide improvements by recentering public health in water supply programs and promoting data-driven, evidence-based decision-making. In the global WASH sector, the SWOT is recognised as an exemplar of how analytical tools can extract lifesaving insights from large datasets and improve public health outcomes. Its adoption supports the mainstreaming of evidence-driven programming and represents a low-cost intervention relative to the significant capital expenditures typically required for water supply infrastructure.[19]

Overall, the evidence demonstrates good sustainable cost-effectiveness, supported by a scalable delivery model, low costs, reduced overheads through a dedicated nonprofit, and growing sector-wide influence. These factors indicate strong potential for sustained value over time and at scale. However, there is limited evidence to date on long-term cost-to-outcome performance, the financial durability of the non-profit model, and consistently realised cost-effectiveness across multiple countries and partners. As such, the evidence supports a good rating but does not yet reach an excellent rating.



Gender Equality and Social Inclusion

Adequate

> There is some evidence that the SWOT is designed to serve hard-to-reach and marginalised populations, including women and girls, by providing clean drinking water to all people in refugee and crisis-affected settings.

The tool does not specifically target women and girls, or other marginalised groups, although, because women and girls are often affected disproportionately by poor WASH conditions, they may benefit more than men and boys from improved water sources. Data is currently not disaggregated by gender, so it is not possible to make statements regarding gendered impacts.

The SWOT generates operational guidance for water treatment that ensures microbiological water safety and improves the acceptability of water supplies in high-risk refugee and internally displaced persons (IDP) settings. Access to safe water is a fundamental human right, yet refugees and IDPs face significant barriers in securing it. The SWOT was deployed across 33 refugee and IDP camps in three major crisis contexts – Syria, the Democratic Republic of Congo, and Gaza. Waterborne diseases in crisis settings disproportionately affect women and girls due to increased vulnerability and caregiving responsibilities. By reducing exposure and incidence of waterborne disease, the SWOT can have a particularly meaningful impact for women and girls.[20]

Because the SWOT operates at the level of community-wide water supply infrastructure, differential benefits or risks across population sub-groups (by sex, gender, age, disability, geography, ethnicity, religion, caste, or other factors) were not expected beyond those that arise from the water infrastructure itself. Nevertheless, York University worked with gender specialists to explore opportunities for more progressive, targeted interventions.[21] As a result, a gender strategy has been developed for the SWOT, and through its successor *Impact Water Works*, there are plans to improve the gender responsiveness of the SWOT, including integrating inclusive design principles in the SWOT tool interface, and incorporating gender-neutral language and diverse representation in guidance and communications materials.[22]

Overall, there is evidence that the SWOT is serving hard-to-reach populations, particularly refugees and internally displaced persons, by improving access to safe drinking water in crisis settings. However, benefits for women and girls are largely inferred rather than demonstrated, as the innovation does not explicitly target gender outcomes and lacks gender disaggregated end-user impact evidence. Although a gender strategy has been developed, it has not yet been implemented and is focused primarily on tool design and tool user experience rather than demonstrable equity outcomes for end users. Taken together, this supports an *adequate* rating, reflecting partial but not robust or targeted evidence of reach to marginalised groups.

Conclusion

> *Overall, the SWOT demonstrates good Value for Money,* achieving a 'good' rating across four of the five criteria. Emerging evidence suggests the SWOT delivers water quality improvements at low cost and enhances outcomes efficiently within existing WASH budgets when integrated into monitoring systems. Evidence from pilots shows it effectively increases safe water access and residual chlorine protection, while its country-level partnerships, non-profit scaling model, and sector-wide advocacy support replicable and sustainable benefits. As more evidence becomes available, the ratings are likely to increase.

A note on methodology

Clear Horizon used Grand Challenges Canada's Value for Money approach to develop these case studies. GCC have adapted King and OPM's Value for Investment approach for humanitarian innovation, which allows thoughtful and well-evidenced evaluative reasoning appropriate for the complexities of humanitarian innovation through the use of criteria and standards.[23]

There are five criteria, based on the 5 E's commonly used by the UK Foreign and Commonwealth Development Office, with standards for poor, adequate, good and excellent (the full rubric is available upon request). The criteria are:

- **Economy:** does the innovation generate cost savings without compromising on quality? This criterion considers what the cost of delivery the same level of products and services would be in the absence of the innovation.
- **Efficiency:** is a reduced cost per user resulting in the innovation reaching more people, or improving timeliness of service or care? This criterion considers the intersection of access, timeliness and quality.
- **Effectiveness:** does the innovation have a meaningful and measurable impact on end-user health and wellbeing outcomes?
- **Sustainable cost-effectiveness**: is there evidence of improved cost effectiveness that can be sustained at scale?
- **Gender Equality and Social Inclusion:** does the innovation serve the hardest to reach and those most affected by social exclusion, including women and girls and those with accessibility needs? This criterion looks at those within conflict-affected communities facing *additional* layers of marginalisation and exclusion.

To develop the case studies, Clear Horizon conducted a document review of evidence provided by GCC and the grantee, including progress reports, final reports, and peer-reviewed journal articles. Across case studies, Clear Horizon also undertook a Key Informant Interview with the grantee or GCC grant manager. Clear Horizon then produced an evidence matrix, synthesising the evidence against the five criteria.

Following this, Clear Horizon facilitated a panel workshop with GCC staff to interrogate the evidence and reach preliminary judgements against the criteria. Clear Horizon then developed the case studies based on the provided evidence and workshop deliberations.

[1] Syed Imran Ali, Syed Saad Ali, Jean-Francois Fesselet, Evidence-based chlorination targets for household water safety in humanitarian settings: Recommendations from a multi-site study in refugee camps in South Sudan, Jordan, and Rwanda, Water Research, Volume 189, 2021, 116642, ISSN 0043-1354, https://doi.org/10.1016/j.watres.2020.116642

[2] De Santi M, Ali SI, Arnold M, Fesselet J-F, Hyvärinen AMJ, Taylor D, et al. (2022) Modelling point-of-consumption residual chlorine in humanitarian response: Can cost-sensitive learning improve probabilistic forecasts? PLOS Water 1(9): e0000040. https://doi.org/10.1371/journal.pwat.0000040

[3] De Santi M, Ali SI, Arnold M, Fesselet J-F, Hyvärinen AMJ, Taylor D, et al. (2022) Modelling point-of-consumption residual chlorine in humanitarian response: Can cost-sensitive learning improve probabilistic forecasts? PLOS Water 1(9): e0000040. https://doi.org/10.1371/journal.pwat.0000040

[44] There is strong evidence from numerous settings that household contamination compromises water safety across many context, see for example: Household water storage compromises drinking water safety in a "safely managed" system https://eartharxiv.org/repository/view/11900/; Ali, S. I., S. S. Ali, and J. Fesselet, 'Effectiveness of emergency water treatment practices in refugee camps in South Sudan,' Bulletin of the World Health Organization 93(2015): 550–558.; Steele, A.; Clarke, B.; Watkins, O. Impact of jerry can disinfection in a camp environment - experiences in an IDP camp in Northern Uganda. Journal of Water and Health 2008, 6 (4), 559–564; 8.

[5] Altare C, Kahl V, Ngwa M, Goldsmith A, Hering H, Burton A, et al. Infectious disease epidemics in refugee camps: a retrospective analysis of UNHCR data (2009–2017). J Glob Health Report. 2019; 3: e2019064.

[6] International Institute for Sustainable Development (IISD). (2014, November 19). *WHO, UN-Water report finds investing US$1 in WASH delivers US$4.3 return*. SDG Knowledge Hub. https://sdg.iisd.org/news/who-un-water-report-finds-investing-us1-in-wash-delivers-us4-3-return/

[7] Michael Kremer, Stephen P. Luby, Ricardo Maertens, Brandon Tan, and Witold Więcek, "Water Treatment And Child Mortality: A Meta-Analysis And Cost-effectiveness Analysis," NBER Working Paper 30835 (2023), https://doi.org/10.3386/w30835.

[8] WASH Market Analysis conducted by York University in 2024.

[9] York University Progress Report

[10] York University Progress Report

[11] York University Final Report

[12] Transition to Scale Lead Recommendation Report – 29 March 2023

[13] RMAF report

[14] IMC Interim Progress Report

[15] Ali SI, De Santi M, Arnold M, Khan UT, Penney TL, Ali SS, et al. Proof-of-concept evaluation at Cox's Bazar of the Safe Water Optimization Tool: water quality modelling for safe water supply in humanitarian emergencies. *BMJ Global Health*. 2025;10:e018631. https://doi.org/10.1136/bmjgh-2024-018631

[16] Ali SI, De Santi M, Arnold M, Khan UT, Penney TL, Ali SS, et al. Proof-of-concept evaluation at Cox's Bazar of the Safe Water Optimization Tool: water quality modelling for safe water supply in humanitarian emergencies. *BMJ Global Health*. 2025;10:e018631. https://doi.org/10.1136/bmjgh-2024-018631

[17] York University Final Report

[18] Interview with York University Team

[19] York University Final Report

[20] RMAF report / Final Report

[21] York University Progress Report

[22] York University Final Report

[23] King et al. (2023). Assessing Value for Money: the Oxford Policy Management Approach. Oxford: Oxford Policy Management. https://www.opml.co.uk/sites/default/files/migrated_bolt_files/opm-vfm-approach-2.pdf