Provision of technical assistance for aquifer mapping technologies for Zambia - Closure Report

1. Basic information

Title of response plan	**Provision of technical assistance for aquifer mapping technologies for Zambia.**
Technical assistance reference number	**2021000041**
Country / countries	**Zambia**
NDE organisation	**Ministry of Technology and Science**
NDE focal point	**Ms. Olga Chilambwe** **Senior Science and Research Officer, Ministry of Technology and Science**
NDE contact information	chilambwe.mwansa@mots.gov.zm
Proponent focal point and organisation	**Name**: Mr. Abel Managi Acting Assistant Director for Sanitation, Department of Water Resources Development **Organisation**: Ministry of Water Development and Sanitation **Email**: manangiabel@yahoo.co.uk **Address**: Department of Water Resources Development, Sheki-Sheki Road, Lusaka, Zambia.
Designer of the response plan	**Name**: Nadège Trocellier (Climate Technology Specialist) **Organisation**: United Nations Environment Programme **Email**: nadege.trocellier@un.org **Name**: Ms. Olga Chilambwe) Senior Science and Research Officer), **Organisation**: Ministry of Technology and Science, **Email**: chilambwe.mwansa@mots.gov.zm **Name**: Mr. Abel Managi (Acting Assistant Director for Sanitation, Department of Water Resources Development) **Organisation**: Ministry of Water Development and Sanitation, **Email**: manangiabel@yahoo.co.uk
Implementer(s) of technical assistance	**Organisation**: OneWorld Sustainable Investments (Pty) Ltd **Name**: Belynda Petrie **Email**: belynda@oneworldgroup.co.za
Beneficiaries	Government of Zambia, drillers and water users (private sector and communities)
Sector(s) addressed	Water
Technologies supported	Technology needs assessment; Water resource assessment and Water strategies
Implementation start date	01/09/2022
Implementation end date	30/09/2025
Total budget for implementation	224,990 USD and an additional 17,500 USD for the sTEM machine as a contribution from OneWorld Sustainable Investments

Description of delivered outputs and products as well as the activities undertaken to achieve them. In doing so, review the log frame of the original response plan and refer to it as appropriate	**Output 1: Preliminary assessment of the information available and selection of a specific area in Zambia to implement the Technical Assistance (TA)** Deliverables: • Kick off meeting and meeting report. • Draft preliminary assessment report with proposed sites for TA activity. **Output 2: Water balance studies of the selected area at macro level** Deliverables • Inception meeting materials. • Water balance revision – Water Balance Revision Updated Methodology (sets out the Recharge Tool and the shift towards aquifer Mapping Methodology, to replace the previously required Water Balance Studies); includes outcomes of stakeholder engagements. • Aquifer mapping _Geological Analysis Draft report for Nyimba. • Recharge tool for Zambia (Zambia recharge tool Rev03). • Workbook of available borehole data for Nyimba. **Output 3: Identify water saving technologies in different sectors and impact on ground water balance using modelling studies of the specific area** Deliverables • Report on identified water saving technologies. • Revised and updated groundwater recharge tool Rev04. • Stationary Transient Electromagnetic (sTEM) equipment for geophysical analysis procured, trained on and deployed in 2 wellfields in Nyimba district. **Output 4: Define a water management plan for both surface and groundwater to improve resilience of Zambia in time of drought** • Draft Groundwater development plan. • Draft Aquifer mapping methodology. • Capacity building workshop on water saving technologies and prioritisation, aquifer mapping methodology, and the groundwater development plan over 2 days. • Updated aquifer mapping assessment of Nyimba. • Final aquifer mapping methodology (revised with stakeholder inputs).

	• Final water saving technology report (revised with stakeholder inputs). • Final Groundwater development plan (revised with stakeholder inputs).
Methodologies applied to produce outputs and products	This project adopted a mixed-methods approach, combining quantitative and qualitative data collection and analysis. The methodologies applied included: • *Geospatial analysis and mapping.* • *Desk-based research and literature review.* • *Data scoping and collection through institutional engagement.* • *Knowledge documentation and technology transfer mechanisms (Structured stakeholder consultations, capacity-building workshops and field testing).* • *Participatory analysis with government stakeholders through structured participatory analysis based workshops.* • *Multi Criteria Decision Analysis of priority water savings technologies.*
Reference to knowledge resources	No specific UNFCCC Technology Executive Committee (TEC) knowledge products were used in this TA. A list of references is supplied in each of the reports developed.
Deviations	Deviation: Shift from water balance study to aquifer mapping methodology and a groundwater development plan. Timeline: August 2023 – October 2024 The inception meeting held in August 2023 highlighted Zambia's need for the project to develop a robust aquifer mapping methodology, and a groundwater development plan rather than a water balance study as originally envisaged in the project Terms of Reference. Government stakeholders articulated this need very clearly throughout the inception meetings held in Lusaka and in Nyimba. The OneWorld team further noted that this emerging priority was well aligned with trends across southern Africa for establishing quality methodologies and using these to enhance current levels of understanding of groundwater resources. OneWorld drafted a related report and submitted to CTCN for review and discussed. Agreement was reached to shift the project to these outputs. Deviation: Purchase of the sTEM equipment to collect data Data collection on groundwater resources in Nyimba District commenced in May 2023 and concluded in May 2025. The initial process involved: data mining from the

	literature and documents; identification of data required (schedule) and circulating to Govt of Zambia; submission of datasets by Govt to OneWorld; in person collection of datasets from Govt (WARMA). By mid-2023 into 2024 it was apparent that most of the data required to develop a contextualised Aquifer mapping Methodology, and a Groundwater Development Plan, was not available. OneWorld researched and explored a range of alternatives, including collaboration with a Danish university and the purchase of equipment that could aid in the data collection quest. The proposed university collaboration proved not to be feasible. The Government of Zambia, on reviewing OneWorld provided quotes for sTEM equipment for data collection and analysis, responded that they did not have available budget to make this purchase in the project timeframe. The OneWorld team then proposed to purchase the equipment under OneWorld, utilising project funds for 50% of the equipment cost, and contributing the other 50% through own funds. The rationale was twofold: i) the project would be able to be concluded with robust data enabling solid project deliverables for an aquifer Mapping methodology; an Aquifer Mapping Report for Nyimba District; and a Groundwater Development Report for Nyimba District; and ii) a sTEM machine would be available in southern Africa for groundwater data collection and analysis, through OneWorld, an established partner consultancy in the region. This deviation was approved by UNEP-CTCN and Zambian Government stakeholders. The purchase of the sTEM geophysical instrument for data collection enabled the OneWorld team to collect data in the field in March 2025.
Anticipated follow-up activities and next steps	Following the delivery of the Aquifer mapping methodology and Groundwater development plan, the following next steps have been planned and approved by the MWDS: • *Adoption and scale of the aquifer mapping methodology by the government of Zambia (Ministry of Water Development and Sanitation).* • *Adoption, implementation and upscaling of the Groundwater development plan* • *Mainstreaming of the Groundwater development plan into forthcoming District Development Plan* • *Mobilisation of finance and investments towards the above and to the implementation of the Nyimba Groundwater Development Plan*

2. Lessons learned

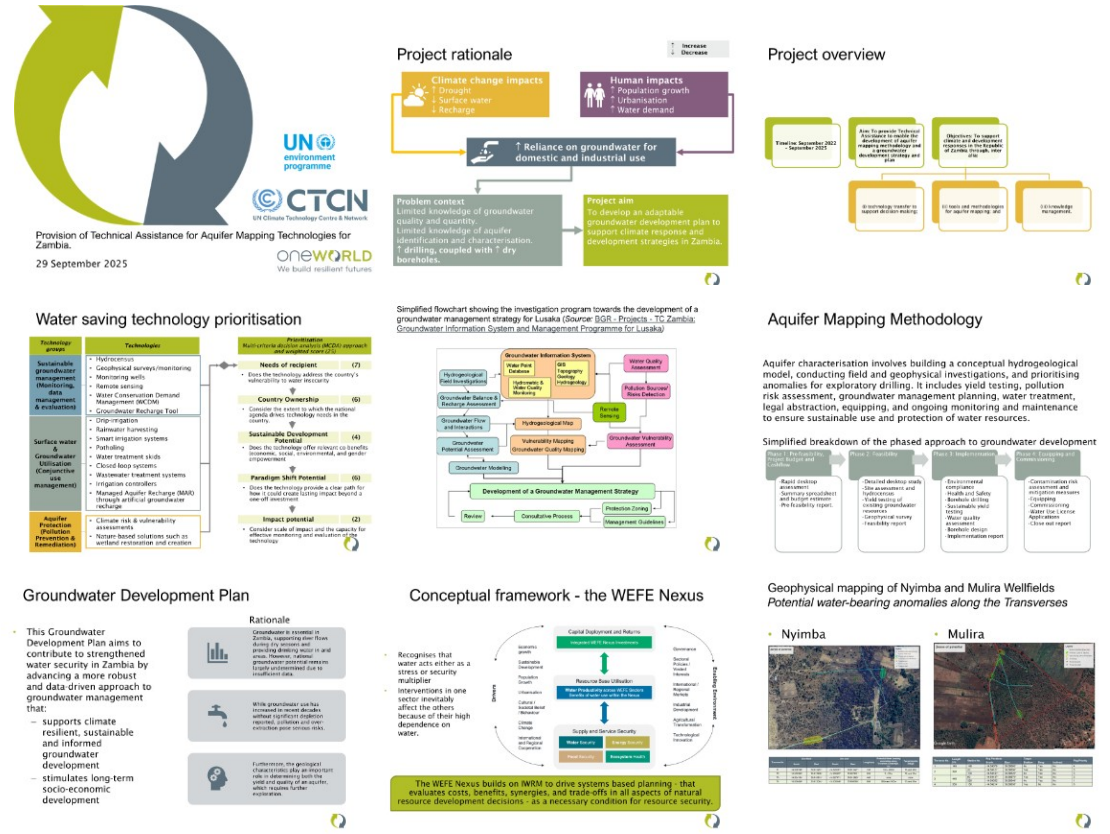
	Lessons learned	**Recommendations**

Lessons learned from the CTCN TA process	A key lesson from the provision of this TA in Nyimba District is that **infrastructure alone is not enough to guarantee sustainable water security**. Sustainable water security, particularly for groundwater, must be underpinned by **data to inform decision making; community ownership and overall institutional coordination and governance; integrated investments and capacity building**. When local role players (government and community) are actively involved in planning, monitoring, and decision-making around groundwater use, they demonstrate greater responsibility in protecting the boreholes and preventing over-abstraction. Equally, when **district authorities, local leadership and community members are engaged early** in the process, it allows for the early delegation of roles for data collection, ongoing maintenance, training and strengthened accountability of groundwater infrastructure. This means that sustainable groundwater management and development is enabled when: • **Communities understand the value of the resource and are empowered to manage it,** • **Clear governance structures exist for protection of the resource, resolving issues and financing repairs, and** • **Local institutions remain involved beyond the construction phase.**	Detailed in the Groundwater development plan, key recommendations include: • *Empowering communities through capacity building and training to be active roles player in groundwater management and development.* • *Adopting a WEFE nexus approach in groundwater planning.* • *Prioritising investment in aquifer and borehole protection.* • *Enhance data collection systems.* • *Adopt water saving technology to enhance climate resilience of communities.* • *Develop guidelines and standards for climate resilience and for infrastructure protection.*
Lessons learned related to climate technology transfer	Groundwater is a critical resource in Zambia; however,	Recommendations include

	its full potential is largely unmapped due to persistent data and capacity constraints (technical and financial). Key barriers included limited availability of data relating to groundwater. However, strong collaboration with the NDE, government of Zambia stakeholders and partners and CTCN proved to be a critical success factor, enabling the identification and assessment of Nyimba district as a pilot implementation site for this technical assistance (TA). The TA demonstrated that technologies such as the sTEM geo-profiler which proved significant to support groundwater prospecting to inform aquifer mapping, with several lessons emerging to inform future deployment. A major lesson learned is that technology transfer is most effective when embedded within a co-created process rather than delivered as a standalone technical intervention. Joint field testing and hands-on training increased confidence among local stakeholders and positioned the team to become future implementers rather than passive recipients. There is now an opportunity to scale deployment of the aquifer mapping methodology across Zambia to support the data gathering for future climate adaptation efforts.	• *Investment in data gathering and Sustainable groundwater management is critical to support the evidence based decision making and the inform policy and the development of strategic documents.* • *Adoption at scale of the aquifer mapping methodology and groundwater development plan is important to support the sustainable use, management and protection of groundwater resources in Zambia.* • *A WEFE Nexus approach to the strategic management of the groundwater resources in Zambia is recommended as it recognises that water acts either as a stress or security multiplier in the region; interventions in one sector inevitably affect the others because of their high dependence on water. When there is not enough water to meet all the multiple demands on the resource, trade-off decisions by all stakeholders concerned are needed to ensure that the overarching objectives of sustainable development are attained.*

3. Illustration of the TA and photos

For communication purposes, please provide 2-4 Power Point slides, including illustrations or charts, describing barriers, opportunities, methodology, activities, outputs and achieved results. The illustrations must be copied into the TA Closure report but must also be delivered as power point files. Also, please provide at least five high-resolution pictures in jpg format, capturing technical assistance. The pictures should illustrate how the TA has impacted the lives of the beneficiaries in particular and the communities in general.



Nyimba district sTEM geospatial analysis field testing

4. Impact Statement

The information in the table below will be used to communicate results and anticipated impacts of this technical assistance publicly. Please copy information from impact statement developed in the M&E Plan and update as relevant.

Challenge	Sustainable water resource management requires comprehensive understanding of the status of both surface and groundwater supplies. Aquifer mapping can inform management by providing an overview of the extent of groundwater resources and their locations. Effective aquifer mapping requires specialised technical skills, knowledge, and resources to be carried out and translated into informative outputs for planning and decision-making.
CTCN Assistance	To develop a robust groundwater management plan to support climate change adaptation strategies in Zambia. • Identify target area and undertake water balance /water accounting studies at macro level • Undertake aquifer mapping • Identify water saving technologies for different sectors and model potential impact on groundwater balance • Define a scalable groundwater development plan for both surface and groundwater to improve resilience of Zambia in time of drought and define an aquifer mapping methodology
Anticipated impact	• Comprehensive understanding of aquifer status in Zambia • Support of long-term decision making and water resource management • Improved water resource resilience and adaptation measures for greater overall water security • Improved knowledge, skills, and coordination of stakeholders relevant to water resource management
Co-benefits: Achieved or anticipated co-benefits from the TA	• Improved wellbeing of people directly dependent on groundwater resources • Sustainable socio-economic development through improved water resources management
Gender aspects of the TA	Gender aspects were mainstreamed through the project process with focus on how the results of the aquifer mapping would inform effective water management. This applies for all peoples but in particular women who are often responsible for household water resource acquisition and management. Gender-disaggregated tracking of participation in trainings and stakeholder workshops allowed for indicative gender representation among key stakeholders. Gender-focused participation in engagements and workshops was prioritised.
Anticipated contribution to NDC	The TA supports Prog. 1 of the adaptation measures in Zambia's NDCs "**Adaptation of strategic productive systems (agriculture, wildlife, water)**" by improving water management and facilitating the prioritisation of water-saving technologies. Alignment is present with Prog. 2 "**Adaptation of strategic infrastructure and health systems**" through sustainable natural resource management (aquifer mapping and groundwater recharge assessment, and groundwater development planning) and advancing the mainstreaming of the conjunctive use of surface and groundwater. Prog. 3 "**Enhanced capacity building, research, technology transfer and finance for adaptation**" is also supported through water technologies development and a facilitated prioritisation process, as well as capacity building workshops conducted at intervals throughput the project lifecycle.
The narrative story	While Zambia has a water abundance, the country suffers from economic water scarcity due to unpredictable rainfall because of climate change, uneven distribution of rainfall, and inadequate infrastructure. A water crisis is being experienced in the country, particularly in Zambia's drought-prone

	regions where droughts are becoming more frequent and intense with longer time durations due to the impacts of climate change. The socio-economic impacts become increasingly significant negative as water insecurity worsens. Aquifer mapping and effective groundwater development planning provides an opportunity to comprehensively assess groundwater in Zambia to inform suitable adaptation strategies for improved climate resilience and effective groundwater resource development. This can improve water security, bettering wellbeing and supporting sustainable socio-economic development.
Contribution to SDGs	The TA contributes to **SDG 13: Climate action** by informing priority adaptation strategies for groundwater development, and for its management. The TA also improves climate change resilience by informing sustainable water resource management. Contribution to **SDG 6: Clean water and sanitation** is significant as groundwater development and management will improve as a result of the TA. **SDG 3: Good health and well-being** will also be supported as water security improvements will benefit vulnerable populations whose health is impacted by limited access to clean water and sanitation services and to sufficient water to support consistent agricultural yields and thus food security. Lastly the TA contributes **towards SDG 11: Sustainable Cities and Communities** through groundwater development planning that enhances urban supply resilience and sustainable aquifer protection and management.

Annex 1 Technical assistance data collection

Please add quantitative and qualitative values for the indicators selected in the M&E plan and monitored throughout the technical assistance in the tables below. Indicators which have been monitored in addition to the proposed indicators below may be added at the end of table A. Non-relevant indicators should be left blank.

A. Output and outcome indicators

Indicator Please note indicators below highlighted as **anticipated**	**Quantitative value** *Numerals only; disaggregates must sum to the total*	**Qualitative description** *List the various elements corresponding to the quantitative value as well as timelines and responsible institutions*
Total number of events organized by proponents and implementing partners	8 events	• Project kick-off meetings ○ Virtual Kick-off meeting and Prelim Assessment capacity building meeting- Lusaka (12th September 2022- August 2023) • Inception meeting - Lusaka (19-20 August 2023) • Inception Nyimba field visit - Water balance studies technical session (22-23 August 2023) • Capacity building - Recharge tool presentation and training (06 May 2024) • Capacity building - sTEM and project onboarding (24 October 2024) • Water Saving Technology Prioritisation Workshop and Site visit – Pilot sTEM field testing (19 - 21 March 2025) • Capacity building workshop – Aquifer mapping and groundwater development plan (10-11 September 2025) • Project validation and close out (25 September 2025)
Number of participants in events organized by proponents and implementing partners		
a) Number of men	89 count	• Project kick-off meetings ○ Virtual Kick-off meeting (3) Prelim Assessment capacity building meeting- Lusaka (4) • Inception meeting - Lusaka (24) • Inception Nyimba field visit - Water balance studies technical session 11) • Capacity building - Recharge tool presentation and training (6)

		• Capacity building - sTEM and project onboarding (6) • Water Saving Technology Prioritisation Workshop and Site visit – Pilot sTEM field testing (11) • Capacity building workshop – Aquifer mapping and groundwater development plan (23) Project validation and close out (1)
b) Number of women	31 counts	• Project kick-off meetings ○ Virtual Kick-off meeting (2) and Prelim Assessment capacity building meeting- Lusaka (2) • Inception meeting - Lusaka (6) • Inception Nyimba field visit - Water balance studies technical session (4) • Capacity building - Recharge tool presentation and training (4) • Capacity building - sTEM and project onboarding (4) • Water Saving Technology Prioritisation Workshop and Site visit – Pilot sTEM field testing (2) • Capacity building workshop – Aquifer mapping and groundwater development plan (4) Project validation and close out (3)
Number of climate technology RD&D related events	1 demonstration of sTEM equipment – Nyimba, Zambia, March 2025 1 updated aquifer assessment report for Nyimba	sTEM facilitated data collection
Number of participants in climate technology RD&D events		
a) Number of men	11	Water Saving Technology Prioritisation Workshop and Site visit – Pilot sTEM field testing
b) Number of women	2	
Number of training organized by proponents and implementing partners		List the title of the training sessions and capacity strengthening activities
Number of participants in trainings organized by proponents and implementing partners	60	

a) Number of men	46	• Capacity building - Recharge tool presentation and training (6) • Capacity building - sTEM and project onboarding (6) • Water Saving Technology Prioritisation Workshop and Site visit – Pilot sTEM field testing (11) • Capacity building workshop – Aquifer mapping and groundwater development plan (23)
b) Number of women	14	• Capacity building - Recharge tool presentation and training (4) • Capacity building - sTEM and project onboarding (4) • Water Saving Technology Prioritisation Workshop and Site visit – Pilot sTEM field testing (2) • Capacity building workshop – Aquifer mapping and groundwater development plan (4)
Total number of institutions trained		
a) Governmental (national or subnational)	43	Ministry of Technology and Science Ministry of Water Development and Sanitation
b) Private sector (bank, corporation, etc.)	1	Drillers association
c) Nongovernmental (NGO, University, etc.)	2	WWF and University of Zambia
Percentage of participants reporting satisfaction with CTCN training (from CTCN training feedback form)	N/A	Satisfied= 4+ on 5-pt scale
Percentage of participants reporting increased knowledge, capacity and/or understanding as a result of CTCN training (from CTCN training feedback form)	N/A	Increased knowledge, capacity and/or understanding= 4+ on 5-pt scale
a) Percentage of men	N/A	
b) Percentage of women	N/A	
Total number of deliverables produced during the assistance (excluding mission, progress and internal reports)		
a) Number of communication	3	1 Blog piece titled - Celebrate World Environment Day with a success story from

materials, including news releases, newsletters, articles, presentations, social media postings, etc.		Zambia _ Climate Technology Centre & Network _ Published - Fri, 05_30_2025 1 AFCIA Fact Sheet (CTCN Website) 1 Webinar Presentation on WEFE Nexus
b) Number of tools and technical documents strengthened, revised or developed	9	• Aquifer mapping _Geological Analysis Draft report for Nyimba • Recharge tool for Zambia (Zambia recharge tool Rev03 and rev04) • Template workbook for data collection • Workbook of available borehole data for Nyimba • 1 Stationary Transient Electromagnetic (sTEM) equipment for geophysical analysis procured, trained on and deployed in 2 wellfields in Nyimba district • 1 Adaptation Fund Climate Innovation Accelerator (AFCIA) Fact sheet (Zambia) • Draft aquifer mapping methodology • 1 presentation on the aquifer mapping methodology • 1 updated aquifer mapping assessment of Nyimba
c) Number of other information materials strengthened, revised or created (For example training and workshop reports, Power Points, exercise docs etc.)	N/A	
Total number of policies, strategies, plans, laws, agreements or regulations supported by the assistance	1	
a) Adaptation related	1	Groundwater development plan - Recommended to support the IDP
b) Mitigation related		
c) Both adaptation- and mitigation related		
Anticipated number of policies, strategies, plans, laws, agreements or regulations proposed, adopted or implemented as a result of the TA	N/A	

a) Adaptation related		
b) Mitigation related		
c) Both adaptation- and mitigation related		
Anticipated number of technologies transferred or deployed as a result of CTCN support	1	Technology Needs Assessment
Anticipated number of collaborations facilitated or enabled as a result of technical assistance		
a) Number of South-South collaborations		
b) Number of RD&D collaborations		
c) Number of private sector collaborations		
Number of countries with strengthened National System of Innovation as a result of CTCN support		
Insert any additional indicators here		

B. Core impact indicators

Please fill in the tables for anticipated impacts of the CTCN assistance. Every technical assistance should contribute to at least one of the indicators below. For guidance on how to report on core indicators see the 'M&E Guidance Document for TA Implementers'.

Core indicator 1	**Anticipated metric tons of CO_2 equivalent (CO_2e) emissions reduced or avoided as a result of CTCN TA** *Please add your calculations in word or excel format as an Annex to this Closure Report, where applicable.*	
	Anticipated metric tons of CO_2e reduced or avoided as a result of the TA **on annual basis**	Anticipated metric tons of CO_2e reduced or avoided as a result of the TA **in total**
Quantitative value *(emissions reductions)*	*Total number (numerals only, no rounding or abbreviations)*	*Total number (numerals only, no rounding or abbreviations)*
Unit	tCO_2e	tCO_2e
GHG assessment boundary (project emissions) Identify expected post-TA activities, associated effects and assess		

boundary for quantification of GHG emission reductions		
Baseline emissions Describe baseline scenario, baseline candidates, emission factors and emissions calculated		
Methodology Explain the method or process of verifying the indicator and how data was gathered		
Assumptions Describe assumptions made during calculation and quantification of GHG reductions		

Core indicator 2	**Anticipated increased economic, health, well-being, infrastructure and built environment, and ecosystems resilience to climate change impacts as a result of technical assistance** *Please provide a **qualitative** description of the anticipated impacts on the categories below*
Infrastructure and built environment Anticipated increased infrastructure resilience (avoided/mitigated climate induced damages and strengthened physical assets)	Adoption of the aquifer mapping methodology and implementation of the groundwater development plan increases the resilience of the infrastructure and the built environment through improved planning, site selection, deployment of the appropriate equipment, coupled with efficient coordination, protection and enforcement measures. This improved approach leads to improved management, reduced over abstraction and pollution of groundwater, and the coordinated efforts of government and water users lead to reduced damages and strengthened monitoring of developed infrastructure (wellfields, boreholes, water storage and protection measures).
Ecosystems and biodiversity Anticipated increased ecosystem resilience (areas with increased resistance to climate-induced disturbances and with improved recovery rates)	Enhanced resilience of aquifer-dependent ecosystems through better groundwater management practices, improved Surface water and Groundwater Utilisation (Conjunctive use management), reducing over-extraction and pollution risks, and improving natural recharge and recovery capacity of hydrological systems. Through sustainable technologies such as Managed Aquifer Recharge , nature-based solutions and the adoption of smart irrigation technologies.
Economic Anticipated increased economic resilience (e.g. less reliance on vulnerable economic sectors or diversification of livelihood)	Livelihoods are supported through improved access to safe and reliable water resources for domestic and commercial use (agriculture and industry).

Health and wellbeing Anticipated increased health and wellbeing of target group (e.g. improved basic health, water and food security)	Improved aquifer protection and management improve the long-term sustainability and ecological health of aquifers in a given district. By reducing risks of pollution and preventing over-abstraction, aquifers are able to recharge naturally and maintain stable yields. The resulting improved access to safe, sustainable and reliable water supports good health outcomes for the surrounding communities, particularly women and children.

Core indicator 3	**Anticipated number of direct and indirect beneficiaries as a result of the TA**	
	Quantitative value	**Means of verification**
Total beneficiaries	*Total number*	
Number of adaptation beneficiaries		
Number of mitigation beneficiaries		
Number of adaptation-and mitigation beneficiaries	102,835	Population estimate for the base year 2020 - used in the preparation of Nyimba District Integrated Development Plan. *Source: Nyimba Integrated Development Plan (IDP) 2020 - 2030*

Core indicator 4	**Anticipated amount of funding/investment leveraged (USD) as a result of TA (disaggregated by public, private, national, and international sources, as well as between anticipated/confirmed funding)**			
	Quantitative value confirmed *in USD*	**Quantitative value anticipated** *in USD*	**Qualitative description** *List the institutions, timelines, and description or title of the investment*	**Methods** *Describe methods used for quantification of funds leveraged*
Total funding	*Total number in USD (numerals only, no rounding or abbreviations)*	*Total number in USD (numerals only, no rounding or abbreviations)*		
Anticipated amount of public funding mobilised from national/domestic sources				
Anticipated amount of public funding mobilised from international/ regional sources				

Anticipated amount of private funding mobilised from national/domestic sources				
Anticipated amount of private funds mobilised from international/regional sources				

Annex 2 (for internal use – to be filled in by the CTCN)

CTCN evaluation

This section will be completed by the relevant CTCN Technology Manager.

- Evaluation of the timeliness of the TA implementation as measured against the timeline included in the response plan;
- Evaluation of TA quality as defined in the response plan;
- Overall performance of the Implementers;
- Overall engagement of the NDE and Proponent;
- Lessons learned on the CTCN process and steps taken by the CTCN to improve.