Water Resources Assessment and Monitoring Guide – a Citizen Science approach

Steps for rainwater tank and groundwater well assessment and monitoring

Pacific Community
Communauté du Pacifique

Importance of water resource monitoring

Water resources monitoring is necessary to:

- Understand how much fresh water is available and can be accessed for human consumption;
- Assess the water quality;
- Identify natural and human risks, and processes that can affect its usability; and,
- Determine ways to better manage and protect water resources.

Importance of communicating with owner of assets

To understand the condition of the asset and changes to water sources;

To improve communication channels and assist community councils and national agencies in understanding the changes to water sources

Goal: Promote sense of community ownership of water management

Outcome:

- Provide basic knowledge that guides owners to monitor and report any changes to their water sources;
- Help owners gain sense of ownership by engaging them in activities that meet their own needs

Activity: Key considerations when approaching asset owners

- Name of owner (tank/ well)
- Who is the owner affiliated to?
- What is the condition of the asset (repair/ replace/ good)?
- Use of water
- Nearby contamination sources

- Water collection method

Key steps for rain tank, hand dug well, and monitoring well assessment

- it is recommended that at least 2 people conduct this survey
- Capture the asset location using **KoBoCollect**
- **For wells:** measure well diameter, water level and well depth.
- **For rain tanks:** measure diameter and tank height, estimate water level.
- Measure the water salinity at the top of the water level and at the bottom of the well.
- Collect water sample for E.coli analysis (microbiological assessment)

Benefits of Citizen Science

A key element for sustainable water management is efficient monitoring, although this is particularly difficult and expensive in remote areas with limited monitoring points, and often landowners and organisations owning data are not willing to share it. Citizen science, which links water and social sciences, helps to address limited water monitoring data and data sharing. It is an approach in which professional scientists and the public (citizen scientists) collaborate in the research design, data collection and/or interpretation process. Besides providing a cost-effective method for collecting datasets over a range of spatio-temporal scales, it allows community volunteers to contribute local information and insight that can be easily overlooked by external researchers, and for participants to learn through their engagement in data acquisition.

Citizen science can also be conducted with local schoolteachers and students. This has the advantage of contributing to teaching science

and water management to local students through practical applications. It also ensures quality of data collection and motivation for participation in the monitoring projects.

- Build capacity and resources to collect, communicate, and comprehend information on the status of community water sources
- Experienced network of volunteers in decision making about climate change in their communities
- Trained first responders to water stressed situations
- Follow-up data analysis and communication
- Data quality control

Measuring Equipment Checklist

Measuring tape

Sampling container

Salinity Meter

KoBo Toolbox

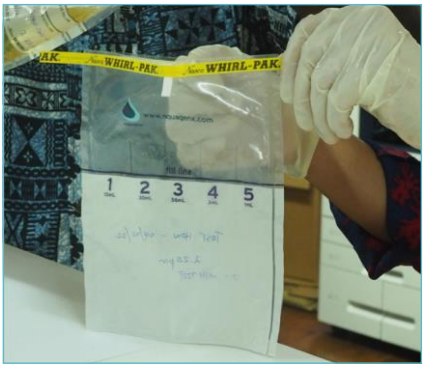
KoBo Toolbox

Sample Analysis Equipment Checklist

Stand up Bag

Glucose Reagent

Compartment Bag



Well Survey

Why: To measure the depth of the water level below ground.

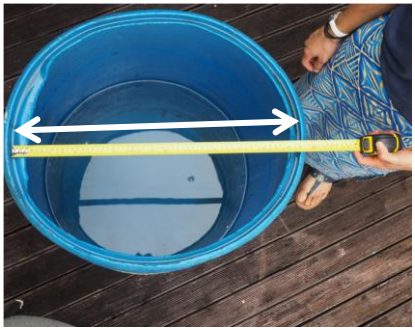
Equipment: Measuring tape

Have a general observation

Inspect the condition of the well casing, the presence or absence of a well cover, and potential contamination sources nearby

1. Diameter of the well

Make sure that you measure the two ends of the widest areas of the well

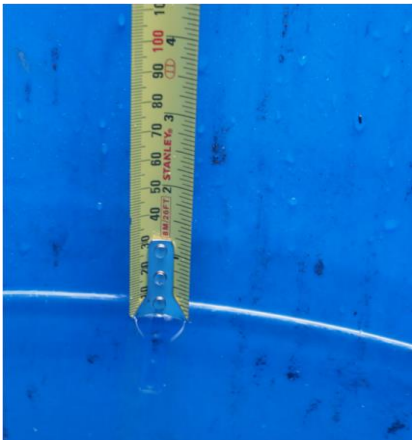


2. Casing height

Measure the height from the ground to the top of the well

3. Groundwater level

Measure the height from the water level to the top of the well



4. Total well depth

Measure the height from the bottom of the well to the top of the well

Rainwater Tank Survey

Why: To understand how much rainwater is still available in relation to current usage and demand

Equipment: Measuring tape

Measurement of water level

- For plastic/poly tank of known height, tap the sides a few times at different height levels.
- A higher pitch thud with resonance would indicate that the tank is empty at that level. Note this can be subjective
- A lower pitch thud with no resonance would indicate that the tank is full up to that level or higher.
- Mark the level where the low pitch sound turns to a high pitch sound.
- Measure the height up to that level.

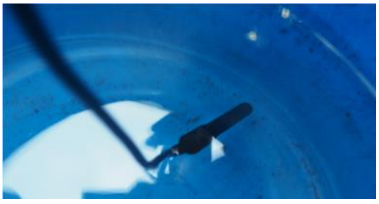
Groundwater Salinity

Why: To determine the salinity level of groundwater in relation to the drinking water standard and to understand how rainfall conditions influence groundwater salinity

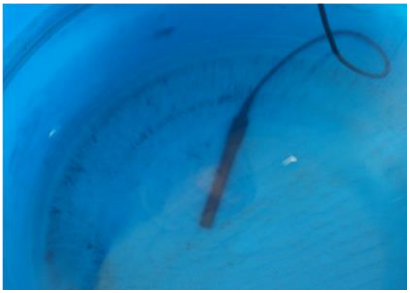
Equipment: Conductivity meter

1. **Salinity at the top of the groundwater table**
   Switch the device on

Drop the probe down the well until it is submerged just below the water level. Read the salinity level either in µS/cm or mS/cm



2. Salinity at the bottom of the well
Drop the probe down the well until it reaches the bottom. Read the salinity level either in µS/cm or mS/cm



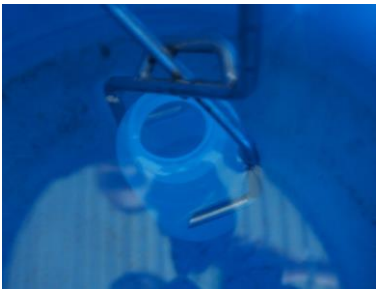
E.coli sampling and analysis for both groundwater wells and rainwater

Why: To test and count the E.coli and Total Coliform bacteria in water. To determine its safety for human consumption

Equipment: MPN method using stand up bag, glucose reagents and compartment bags

1. Wear hand gloves (if available)
2. Label stand up bag with site details and sampling time.
3. Tear open water stand up bag.
   (Avoid touching inside of the bag)

4. If sampling water from a well, use a sampling container to collect a water sample.
5. If sampling water from a rain tank, let the water run for a few seconds before sampling.



6. Transfer sample to stand up bags
7. Fill stand up bag to the marked “fill up” level.


8. Add re-agents and shake until it dissolves completely


9. Pour sample carefully into the compartment bags by filling each individual compartment up to the marked line


10. Store properly at 20-30 degree for 40-48 hours

Bottled Water

Drain Water

Tap Water

11. Read and record the Most Probable Number (MPN/100 mL) of E.coli according to the Table below.

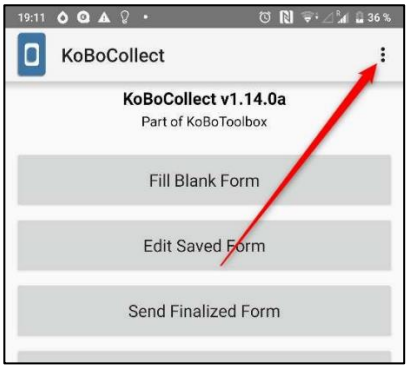
Row Number:	Compartment Number 1 10mL	2 30mL	3 56mL	4 3mL	5 1mL	MPN/100mL	Upper 95% Confidence Level/100mL	WHO Health Risk Category Based on MPN and Upper 95% Confidence Level
1						0.0	2.87	Low Risk/Safe
2						1.0	5.14	Intermediate Risk/ Probably Safe
3						1.0	4.74	
4						1.1	5.16	
5						1.2	5.64	
6						1.5	7.81	
7						2.0	6.32	
8						2.1	6.85	
9						2.1	6.64	
10						2.4	7.81	
11						2.4	8.12	
12						2.6	8.51	
13						3.2	8.38	
14						3.7	9.70	
15						3.1	11.36	Intermediate Risk/ Possibly Safe
16						3.2	11.82	
17						3.4	12.53	
18						3.9	10.43	
19						4.0	10.94	
20						4.7	22.75	
21						5.2	14.73	
22						5.4	12.93	
23						5.6	17.14	
24						5.8	16.87	
25						8.4	21.19	
26						9.1	37.04	
27						9.6	37.68	
28						13.6	83.06	High Risk/Possibly Unsafe
29						17.1	56.35	
30						32.6	145.55	High Risk/Probably Unsafe
31						48.3	351.91	
32						>100	9435.10	Unsafe

Appendix

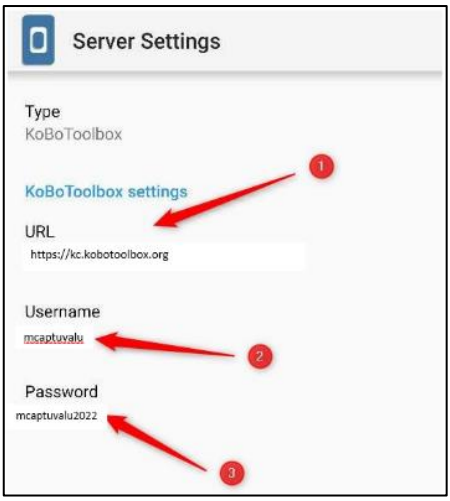
KoBo on Android

1. **Install** Kobo on your android device

2. Set your **login** credentials



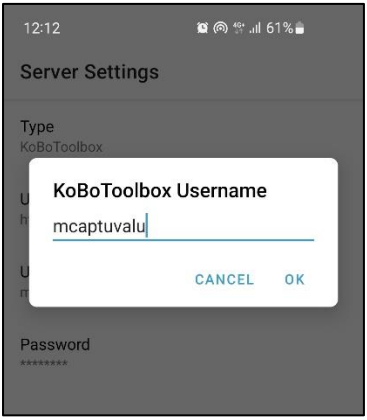
You will be asked to, set a server **URL**, put your **username**, your **password** and press OK.

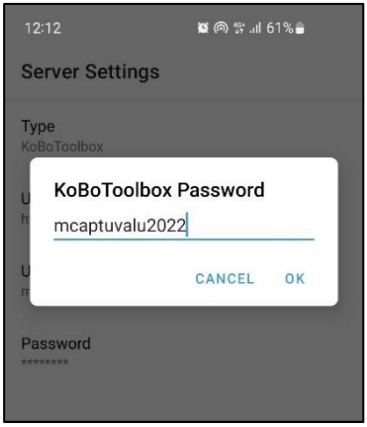


1: Set server URL https://kc.kobotoolbox.org

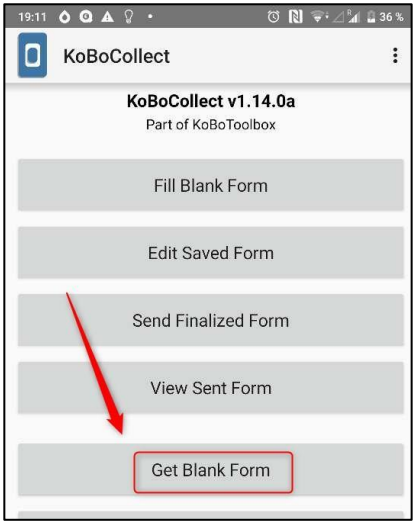
2: Set your username mcaptuvalu

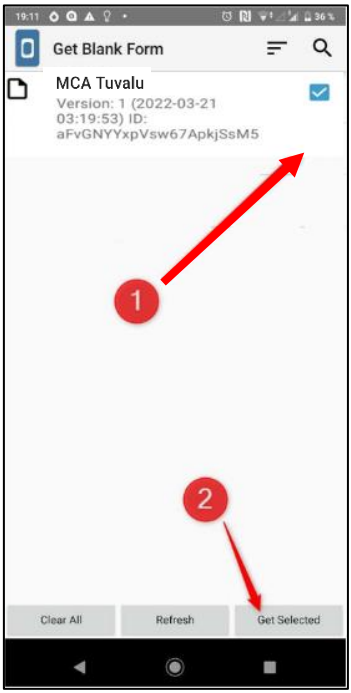
3: Set your password mcaptuvalu2022

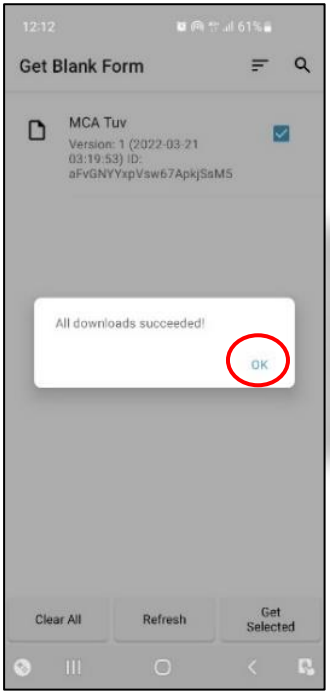




3. **Download form**





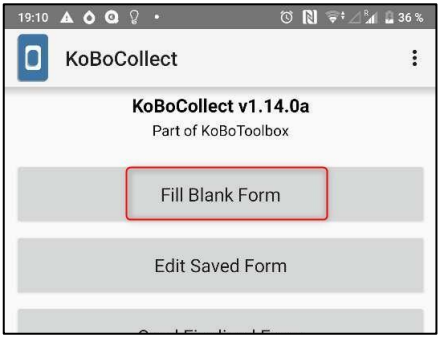


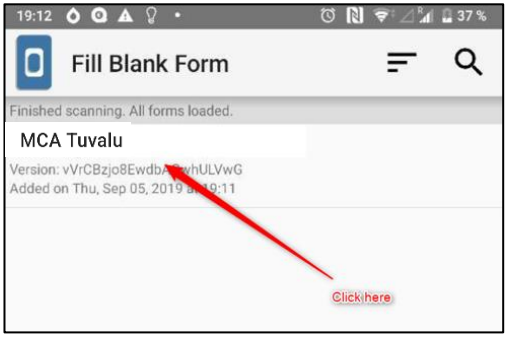
1: Select your form

2: Click, “Get selected”

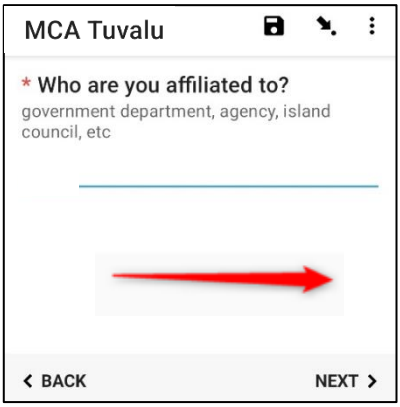
3: Press OK

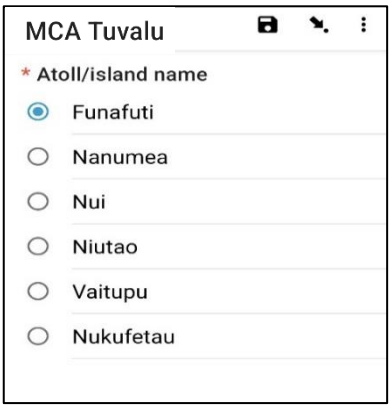
4. Click “**Fill Blank Form**” and select “**MCA Tuvalu**”

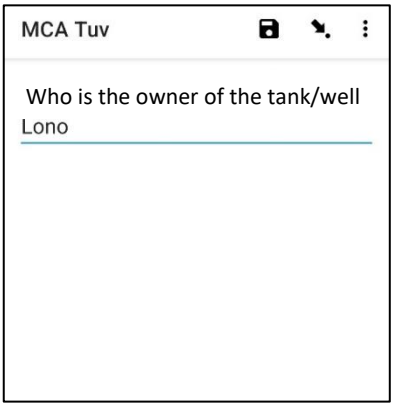


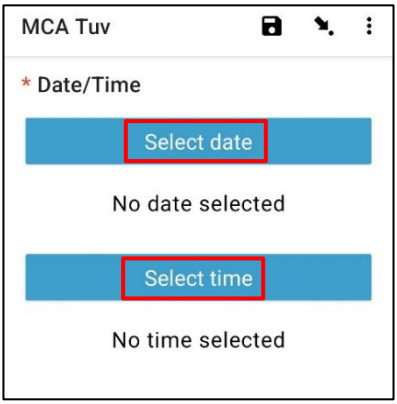


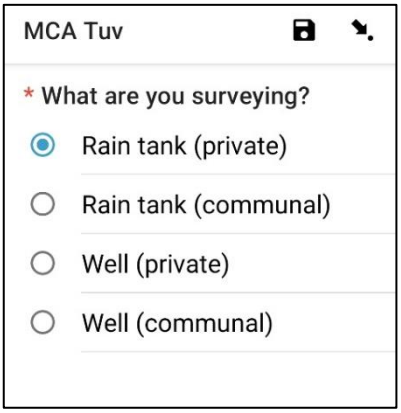
Enter “**NEXT**” to move to the next question.

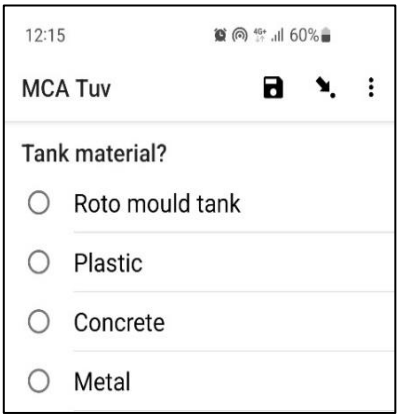


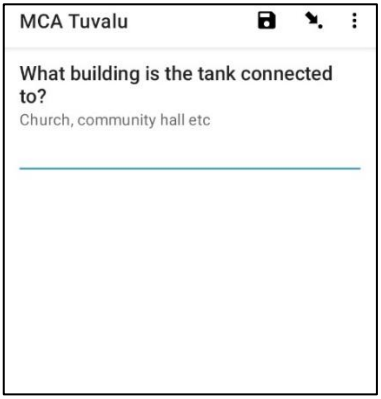


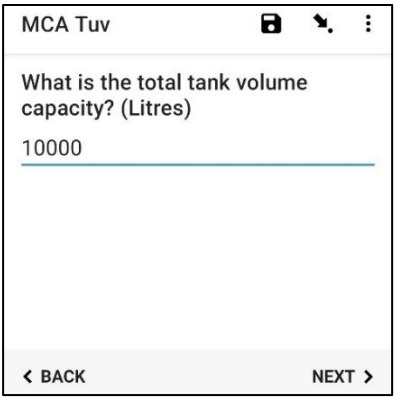

MCA Tuv
Who is the owner of the tank/well
Lono

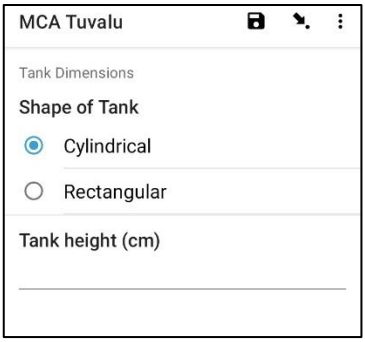

MCA Tuv
* Date/Time
Select date
No date selected
Select time
No time selected

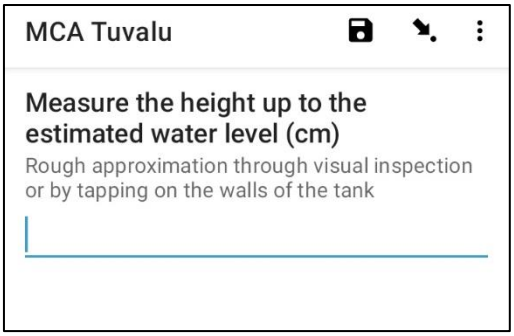

MCA Tuv
* What are you surveying?
Rain tank (private)
Rain tank (communal)
Well (private)
Well (communal)


12:15
60%
MCA Tuv
Tank material?
Roto mould tank
Plastic
Concrete
Metal


MCA Tuvalu
What building is the tank connected to?
Church, community hall etc


MCA Tuv
What is the total tank volume capacity? (Litres)
10000
BACK
NEXT



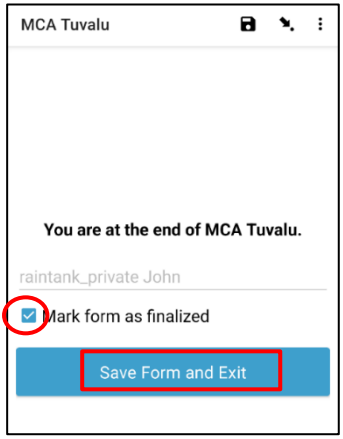


NOTE!!

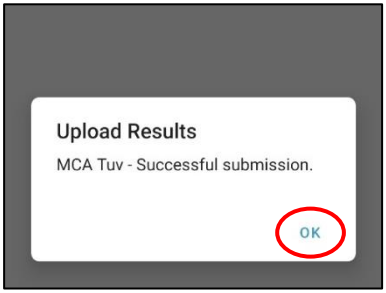
Part 1: No Water Quality Test performed:

If water samples were **"NOT"** taken.

a. The name of form is automatically saved
b. Select "Mark form as finalized"
c. Enter "Save Form and Exit"



d. Click "**Send Finalized Form**" and press "**OK**"

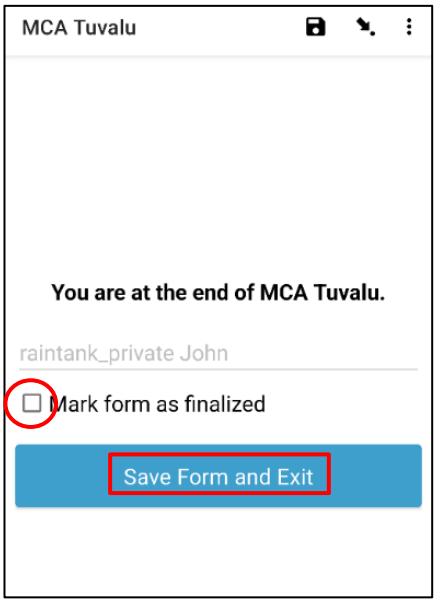


Part 2: Water Quality Test performed:

If water sample are taken.

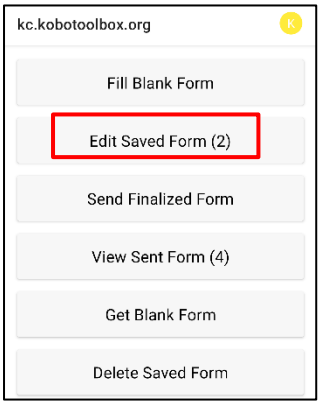
a. Under "**water quality testing,**" **ONLY** aswer the following questions:
   Sample name _____
   Date and Time _____

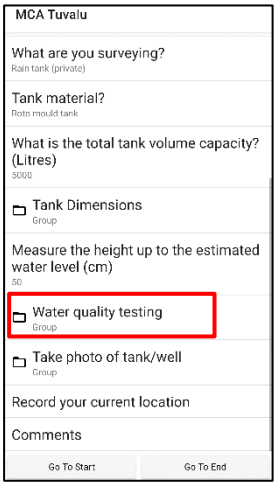
b. Click "Next" until you get to the end of form
c. The name of form is automatically saved
d. DO NOT "Mark form as finalized"
e. Enter "Save Form and Exit"



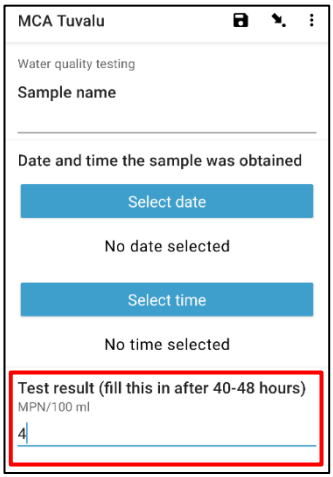
After 40-48 hours read the water quality test results and finalize form

a. Return to form
b. Click "**Edit Saved Form**"
c. Select "**Water quality testing**"

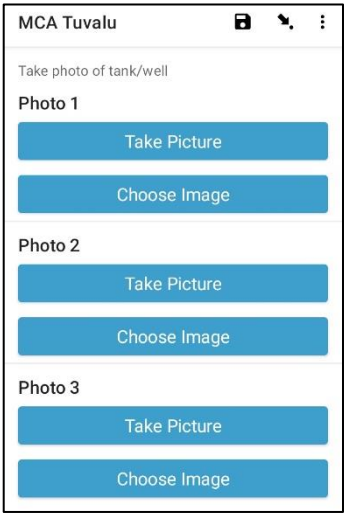


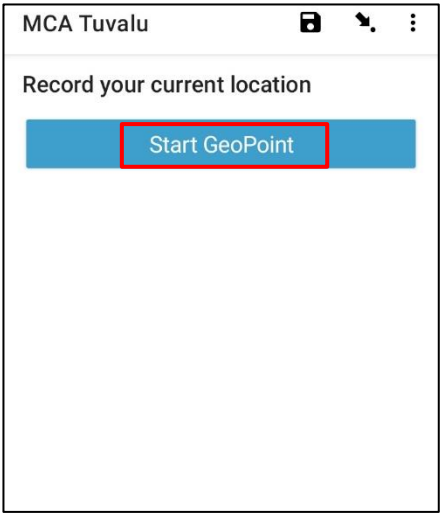


d. Enter the **MPN value** indicated from the "**E.coli testing guideline**"

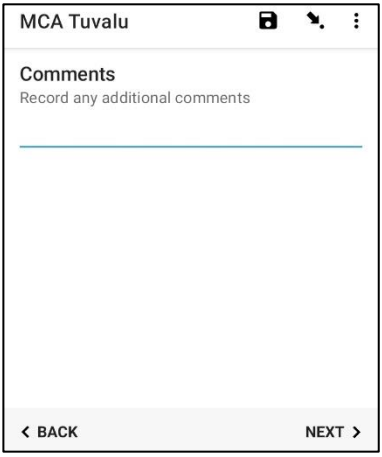


e. **After editing** the "**water quality testing**" question.
f. Select "**Next**" to continue to answer the remaining questions
g. **Take a picture** of the asset if necessary
h. Record your current **location coordinates**

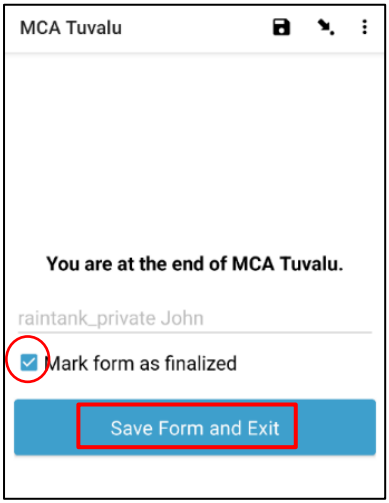


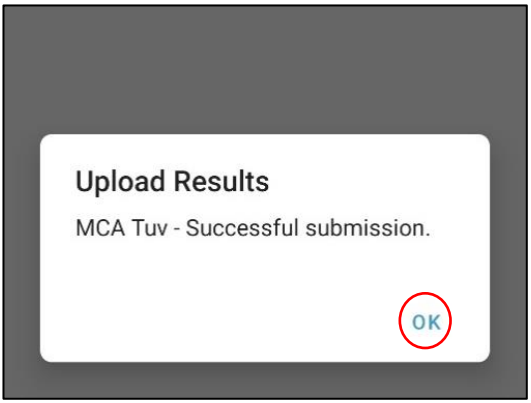


i. Include additional **comments** if necessary



j. Mark form as finalized and submit finalized form





Tuvalu KoBo Sample Questionnaire

KoBo ToolBox	
Asset ID	
What is your name?	
Who are you affiliated to? (govt. department, agency, island council, school)	
Atoll/island name	
Village name?	
Who is the owner of the tank/well?	
Date/Time	
Asset characteristics	
What are you surveying? (tank/well)	
Tank material?	
What building is the tank connected to? (Church, community hall etc)	
What is the total tank volume capacity? (Litres)	
Asset measurements	
Tank assessment	
Shape of Tank (Cylindrical/ rectangular)	
Tank height (for cylindrical tanks only) (cm)	
Tank length (for rectangular tanks only) (cm)	
Tank width (for rectangular tanks only) (cm)	
Measure the height up to the estimated water level (Rough approximation through visual inspection or by tapping on the walls of the tank) (cm)	
Well assessment	
What is the name of the well? (If any)	
Height from the ground to the top of well (measure outside the well) (cm)	
Height from the water level to the top of well (measure inside the well) (cm)	
Height from the bottom of well to the top of well (measure inside the well) (cm)	
Well diameter (cm)	

Well salinity levels	
Groundwater salinity value (indicate units)	
Water quality test E.coli	
Water quality sample name and number? (If you have taken any samples)	
Date and time the sample was obtained	
Test result (fill this in after 40-48 hours) (MPN/100 ml)	
Asset Photos	
Use the camera to take a photo of asset	
Asset location	
Record your current location coordinates	
comments	

What is Salinity?

Water salinity refers to the concentration of total dissolved salts (TDS) in water. It is usually measured in g/L or g/kg (grams of salt per litre/kilogram of water).

Salinity is an important factor in determining many aspects of the chemistry of water, such as origin, contamination and influence from seawater. Small amounts of dissolved salts in water are vital for the life of aquatic plants and animals. High levels of salinity can be harmful to humans, plants and animals, and impact water suitability for domestic use, irrigation and for animals.

Electric conductivity EC

Electric conductivity (EC) is the ability of water to conduct an electrical current, and the dissolved ions are the conductors. Salts that dissolve in water break into positively and negatively charged ions. Because dissolved ions increase salinity as well as conductivity, the two measures are related. EC is usually measured in mS/cm or µS/cm.

Depending on the context, water can be considered fresh up to 1000 or 1500 µS/cm, above which humans start to feel a change in taste, although this is not an indication for health impacts. EC of sea water is about 50 mS/cm (or 50,000 µS/cm).

Why do we measure EC?

EC can be used as a baseline for regular monitoring and, if there is a significant change in conductivity, this could be an indicator of a pollutant or seawater entering fresh water.

How do we measure EC?

EC is measured by a probe, which applies voltage between two electrodes. The drop in voltage is used to measure the resistance of the water, which is then converted to conductivity. Conductivity is reciprocal to resistance and is measured in the amount of conductance over a certain distance.

In practice, we use a TPS meter that measures EC, TDS and temperature.

pH Calibration

1. Remove the wetting cap from the pH sensor. Rinse the pH and EC/DO/ Temp sensor in distilled water and blot dry. Ensure temperature has been calibrated.

2. Place pH and EC/DO/Temp sensors into a small sample of fresh pH7 buffer, so that the bulb and reference junction are both covered.

3. Select pH Calibration.
   Menu: → Cal: → pH:

4. When the reading has stabilized,
   F1: to calibrate.

5. Rinse the pH and EC/DO/Temp sensors in distilled water and blot dry.

6. Place both sensors into a small sample of fresh pH4 buffer, so that the bulb and reference junction are both covered.

7. Select pH Calibration.
   Menu: → Cal: → pH:

8. When the reading has stabilised,
   F1: to calibrate

Temperature Calibration

1. Place the Electrical Conductivity **(EC)**, Dissolved Oxygen **(DO)** or Temperature sensor into a beaker of room temperature water, alongside an accurate thermometer. Stir the sensor and the thermometer gently to ensure an even temperature throughout the beaker.

2. Select Temp Calibration.
   Menu: → Cal: → Temp:

3. When the reading has stabilized, press the Up / Down keys to adjust the temperature.

4. **F1:** to calibrate.

Conductivity Calibration

1. Rinse the Conductivity sensor in distilled water. Shake off as much water as possible. Blot the outside of the sensor dry. Do not blot the sensor plates. Ensure temperature has been calibrated.

2. Zero Calibration Leave the sensor dry and in the air. Select Conductivity Calibration.
   Menu: → Cal: → Cond:

3. When the reading has stabilized,
   F1: to calibrate.

4. **Standard Calibration** Place the sensor into a sample of fresh Conductivity standard so that it is immersed at least above the vent hole. Select Conductivity Calibration.
   Menu: → Cal: → Cond:

5. When the reading has stabilized, F**1:** to calibrate.

Care, Cleaning and Maintenance of Conductivity Sensors

The conductivity section of the sensor supplied with your WP-81 consists of two platinum wires that are plated with a layer of "platinum-black". This is quite a soft layer and is required for stable, accurate measurements. You can help to maintain the platinum-black layer by following these simple rules:

1. **NEVER** touch or rub the sensor wires with your fingers, cloth etc.
2. Avoid using the sensor in solutions that contain a high concentration of suspended solids, such as sand or soil, which can abrade the sensor wires. Filter these types of solutions first, if possible.
3. Avoid concentrated acids. If you must measure acids, remove the sensor immediately after taking the measurement and rinse well with distilled water.

Conductivity sensors can be stored dry. Ensure that the sensor is stored in a covered container, to avoid dust and dirt build-up.

Cleaning of Conductivity of Sensors.

Platinised platinum Conductivity sensors can only be cleaned by rinsing in a suitable solvent. **DO NOT** wipe the sensor wires, as this will remove the platinum-black layer.

1. Rinsing in distilled water will remove most build-ups of material on the sensor wires.
2. Films of oils or fats on the sensor wires can usually be removed by rinsing the sensor in methylated spirits.
3. Stubborn contamination can be removed by soaking the sensor in a solution of 1 part Concentrated HCl and 10 parts distilled water. The sensor should not be soaked for more than approximately 5 minutes, otherwise the platinum-black layer may start to dissolve.
4. If all of these methods fail, then the last resort is to physically scrub the sensor wires, which will remove the contaminant and the layer of platinum-black. Use only a cloth or nylon scouring pad. **DO NOT USE STEEL WOOL**. The sensor will then need to be cleaned in HCl, as per step 3 and replatinised.