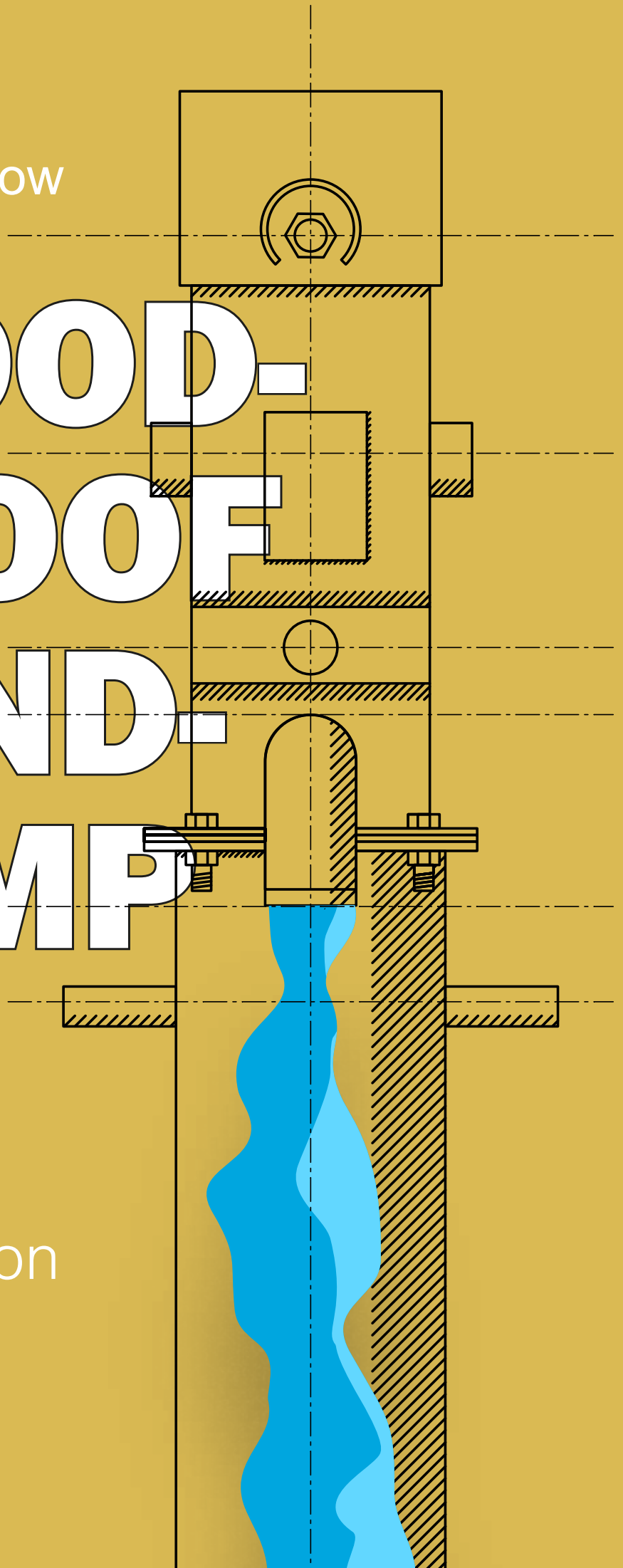




FLOOD- PROOF HAND- PUMP

Construction
Manual



FLOOD- PROOF HAND- PUMP

Construction Manual

With financial support from



Acknowledgement

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LIST OF ACRONYMS

IPCC	Intergovernmental Panel on Climate Change
UNESCO	United Nations Educational, Scientific and Cultural Organization
GIS	Geographic Information System
QGIS	Quantum Geographic Information System
DoDMA	Department of Disaster Management Affairs
MASDAP	Malawi Spatial Data Platform
WFP	World Food Programme
PVC	Polyvinyl Chloride
PPE	Personal Protective Equipment
BoQ	Bills of Quantities
OPC	Ordinary Portland Cement
SHS	Square Hollow Section

1

INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

Access to clean and safe drinking water is essential for public health and community well-being. However, in flood-prone regions such as Malawi, boreholes fitted with handpumps often face significant challenges due to recurrent cyclone-induced flooding events. Floodwaters can submerge boreholes, leading to infrastructure damage and water contamination, which compromises safe water access for affected communities. Given the increasing frequency and intensity of cyclones and extreme weather events due to climate change (IPCC, 2021), there is an urgent need to improve the resilience of water supply infrastructure (UNESCO, 2020).

This manual provides guidance on the construction of a flood-proof handpump structure to

protect boreholes from flood damage. It outlines key pre-construction considerations, a step-by-step construction guide, and post-construction activities to ensure sustainable functionality of the borehole.

1.2 IMPACT OF CYCLONE-INDUCED FLOODING ON BOREHOLES IN MALAWI

Malawi experiences frequent flooding due to seasonal heavy rainfall, cyclones, and tropical storms (Coulibaly et al., 2015; Kumambala, 2010; Ngongondo et al., 2011). These floods have devastating impacts on water supply infrastructure, particularly boreholes fitted with handpumps in flood-prone districts (WFP, 2011). Figure 1 shows map of high-risk flood districts in Malawi. The main challenges posed by flooding to boreholes include:

1.2.1 Submergence and Damage:

Floodwaters can completely submerge boreholes, rendering them inaccessible for use and damaging critical infrastructure such as handpumps, well casings, and aprons. Prolonged submersion can weaken structural components, increasing the likelihood of mechanical failure. Additionally, high water pressure and debris from floods may erode the borehole platform, making future rehabilitation efforts more difficult.

1.2.2 Water Quality Contamination:

Flooding introduces contaminants such as mud, bacteria, and chemical pollutants into boreholes, making the water unsafe for human consumption. Pathogens from human and animal waste, agricultural runoff, and other environmental pollutants can seep into boreholes, increasing the risk of waterborne diseases such as cholera and diarrhea. Boreholes with poor sealing or inadequate sanitary protection are especially vulnerable to contamination during flood events.

1.2.3 Disruption of Water Supply:

Damaged or contaminated boreholes disrupt the availability of clean water for communities, affecting drinking water, cooking,

and sanitation. Women and children, who are often responsible for water collection, are disproportionately affected, as they may have to travel long distances to find alternative water sources. This disruption can exacerbate health risks, particularly during disaster recovery periods when access to medical care may be limited.

1.2.4 Rehabilitation and Repair:

Post-flood recovery efforts typically involve assessing damage, rehabilitating boreholes, and implementing water treatment solutions. Repairs may include replacing broken components, reconstructing borehole platforms, and reinforcing protection measures. Additionally, chlorination and water quality testing are essential to ensure safe drinking water following contamination.

1.2.5 Re-Directed Humanitarian Resources:

Rebuilding water infrastructure after cyclone-induced flooding carries immense financial burdens, often trapping communities in a costly destroy-rebuild cycle. The repeated need to fix the same damaged handpumps diverts scarce humanitarian resources away from other critical needs, stretching already limited budgets. Without investment in more resilient

solutions, funds are continually absorbed by short-term repairs, undermining long-term progress and placing unsustainable pressure on aid efforts.

1.2.6 Case Studies of Flooding Impact on Boreholes in Malawi

- 2012/2013 Floods (Karonga and other districts): Flooding damaged water pipe networks and boreholes, leading to widespread water contamination (Trócaire, 2015).
- Cyclone Freddy (March 2023): Boreholes and chlorine dispensers were submerged, significantly impacting access to clean water in Kachoka village, Zomba district as reported by Evidence Action (Oyugi, 2024).
- Cyclone Idai (2019): BASEflow's flood response in Mulanje district identified 364 boreholes affected by flooding. Rehabilitation efforts included infrastructure repair and water treatment (Nhlema et al., 2020).

1.2.7 Build Back Better: Long-Term Strategies for Flood-Proofing Boreholes

To break the costly cycle of post-disaster repairs, long-term strategies must focus on making boreholes more resilient to flooding. This includes elevating platforms above flood levels, enhancing site drainage, and conducting

borehole forensic assessments to guide smarter reconstruction. By integrating these proactive measures, communities can protect vital water sources and ensure a more sustainable, disaster-resilient supply—transforming recovery efforts into opportunities for lasting improvement.

1.3 OBJECTIVE OF THE HANDBOOK

The objective of this manual is to provide guidance for improving the resilience of handpump structures against cyclone-induced flooding in Malawi.

The manual seeks to:

- Provide step-by-step design guide for flood-proofing existing handpumps.
- Standardize construction techniques and materials for effective flood mitigation.
- Provide post-construction maintenance guidelines to ensure handpumps remain operational.

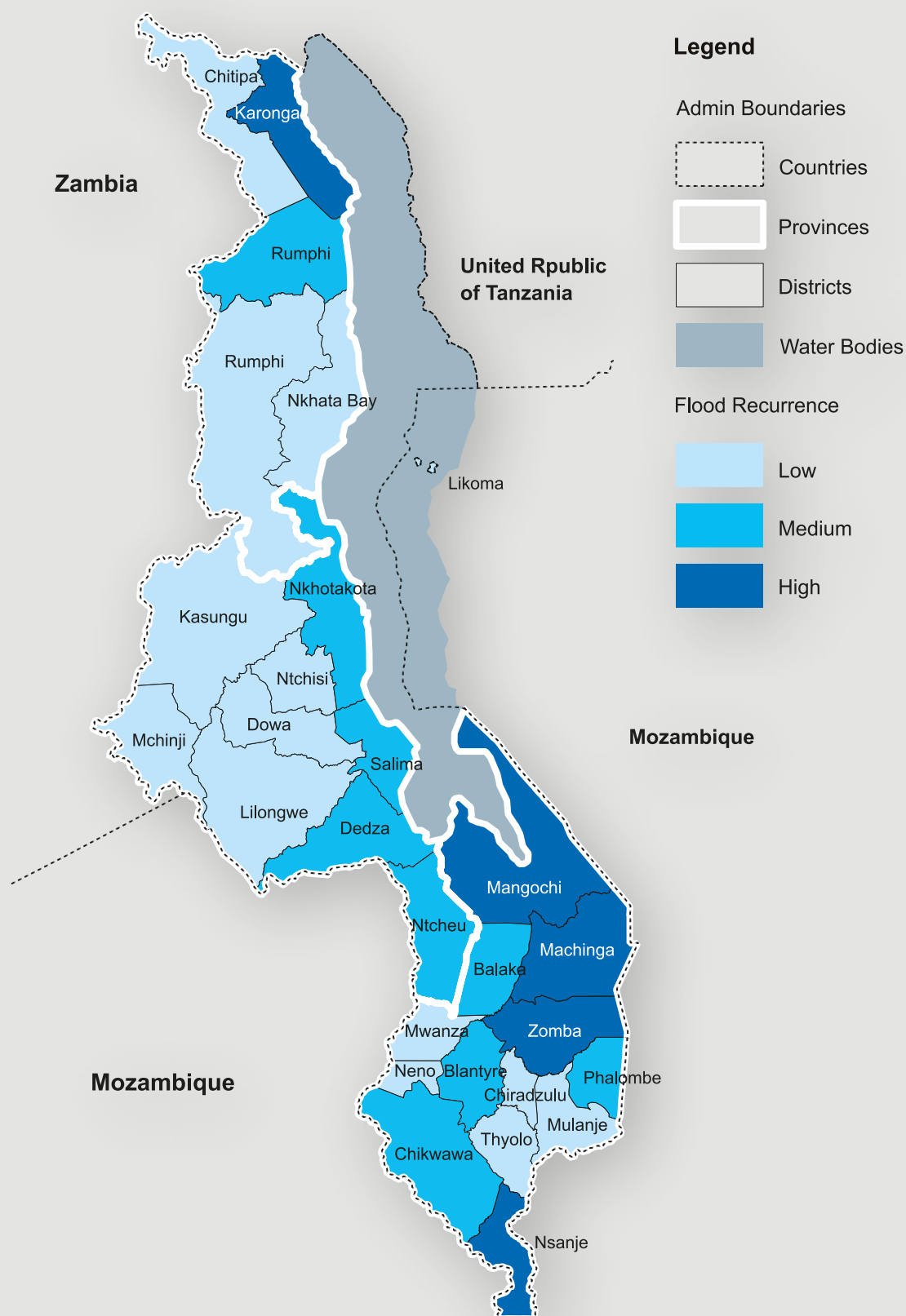


Figure 1: Map of Flood Frequency by Districts

(Sourced from: WFP 2014 Publication on Floods in Malawi)

2

PRE-CONSTRUCTION ACTIVITIES

2.1 FLOOD ZONE ANALYSIS (OFFICE DESK WORK)

Before commencing construction, a thorough assessment of the flood risk in the project area is necessary. This can be achieved using Geographic Information System (GIS) tools to analyse flood zones. This helps decide how much of the handpump structure should be elevated or protected. Table 1 describes areas that are prone to flooding in Malawi in relation to hazard level.

2.1.1 Recommended GIS Software for Flood Zone Analysis:

- QGIS (Open-source, available at <https://qgis.org>)
- ArcGIS (Commercial software, available at <https://www.esri.com>)

- Google Earth Pro (Useful for satellite imagery analysis, available at <https://www.google.com/earth/>)

2.1.2 Accessing Flood Zone Information and Shapefiles

Reliable flood hazard data is essential for selecting and designing flood-resilient borehole sites. Several online platforms offer valuable resources:

- FloodList provides accessible reports and data on recent flood events.
- Satellite monitoring tools, such as Copernicus, UNOSAT, and the International Charter 'Space and Major Disasters', offer high-resolution imagery that helps visualize flood extents during and after crises.

- National sources, including the Malawi Meteorological Service and the Digital Spatial Data Platform, supply localized data critical for understanding flood risks in specific regions.

Using these tools during site planning and risk assessments supports informed decision-making and helps ensure borehole infrastructure is built

to withstand future flood events. Users can access shapefiles for flood-prone areas from:

- Malawi Department of Disaster Management Affairs (DoDMA)
- Humanitarian Data Exchange (<https://data.humdata.org/>)
- Malawi Data Portal (<https://spatialagent.org/Malawi/index.html>)
- Malawi Spatial Data Platform (MASDAP) (<https://www.masdap.mw/>)

■ **Table 1: Areas that are Prone to Flooding - Tables of High-Risk Areas**

Analysis of Malawian floodable areas by type and hazard level				
Type	Hazard level	Area (km ²)	Area (km ²) by type	% of area/total floodable area
Flood plain	Low	1047	5097	37.6
	Medium	1829		
	High	2222		
Dambo	Low	30	4667	34.5
	Medium	4636		
Lake borders	Low	322	1377	10.2
	Medium	450		
	High	604		
Sheet & pluvial	Low	1288	1399	10.3
	Medium	111		
Debris flows Piemont & mixed	Low	562	562	4.2
	Medium	89		
	High	151		
Alluvial fan	Medium	15	129	0.95
	High	114		
Flood plain to dambo transition	Medium	53	53	0.39
Delta & river outloet	Low		16	0.12
	Medium	9		
	High	7		
Old river channel	High	6	6	0.05
Total		13,545		100

(Sourced from: M. Garcin et al (2025) Flood hazard in Malawi, Journal of African Earth Sciences)

2.2 BOREHOLE FORENSICS (FIELD WORK)

Borehole forensics refers to the systematic assessment of the existing borehole (surface and subsurface) to determine their condition, performance, and vulnerability to environmental stresses—especially flooding. This process includes inspecting the borehole’s construction quality, depth, casing integrity, water yield, and signs of contamination or damage. It also considers the surrounding site’s exposure to flood risk. The goal is to gather evidence-based insights that inform whether a borehole can be repaired, upgraded for resilience (e.g., raised platforms, improved drainage), or requires complete reconstruction. This diagnostic approach helps ensure that rehabilitation efforts are technically sound, cost-effective, and durable under future flood conditions. For more details on the Borehole Forensics process, please visit the following Rural Water Supply Network video resource=: <https://vimeo.com/1086438253?share=copy>.

2.2.1 Key Borehole Forensics Procedures

- Identify existing infrastructure issues such as poor borehole depth, inadequate casing, or structural weaknesses.

- Conduct mWater Customized Surveys to collect borehole performance data.
- Assess well design and construction quality, checking for manually cut casings, borehole verticality, and depth sufficiency.
- Conduct pumping or yield tests, to confirm the groundwater supply is sufficient to meet existing water demand within required national standards
- Test water quality to ensure the groundwater supply meets drinking water standards.
- Evaluate Afridev pump component corrosion, particularly in areas with high electrical conductivity (salinity).

2.2.2 Pre-Construction Decision Tree

This decision tree provides a step-by-step framework to guide technicians through the pre-construction activities related to the rehabilitation, and flood-proofing of handpump-equipped boreholes in flood-prone areas. It integrates technical checks, water quality testing, and site-specific flood risk considerations to support informed decision-making. By following this structured approach, field teams can prioritize safety, sustainability, and long-term functionality in their interventions.

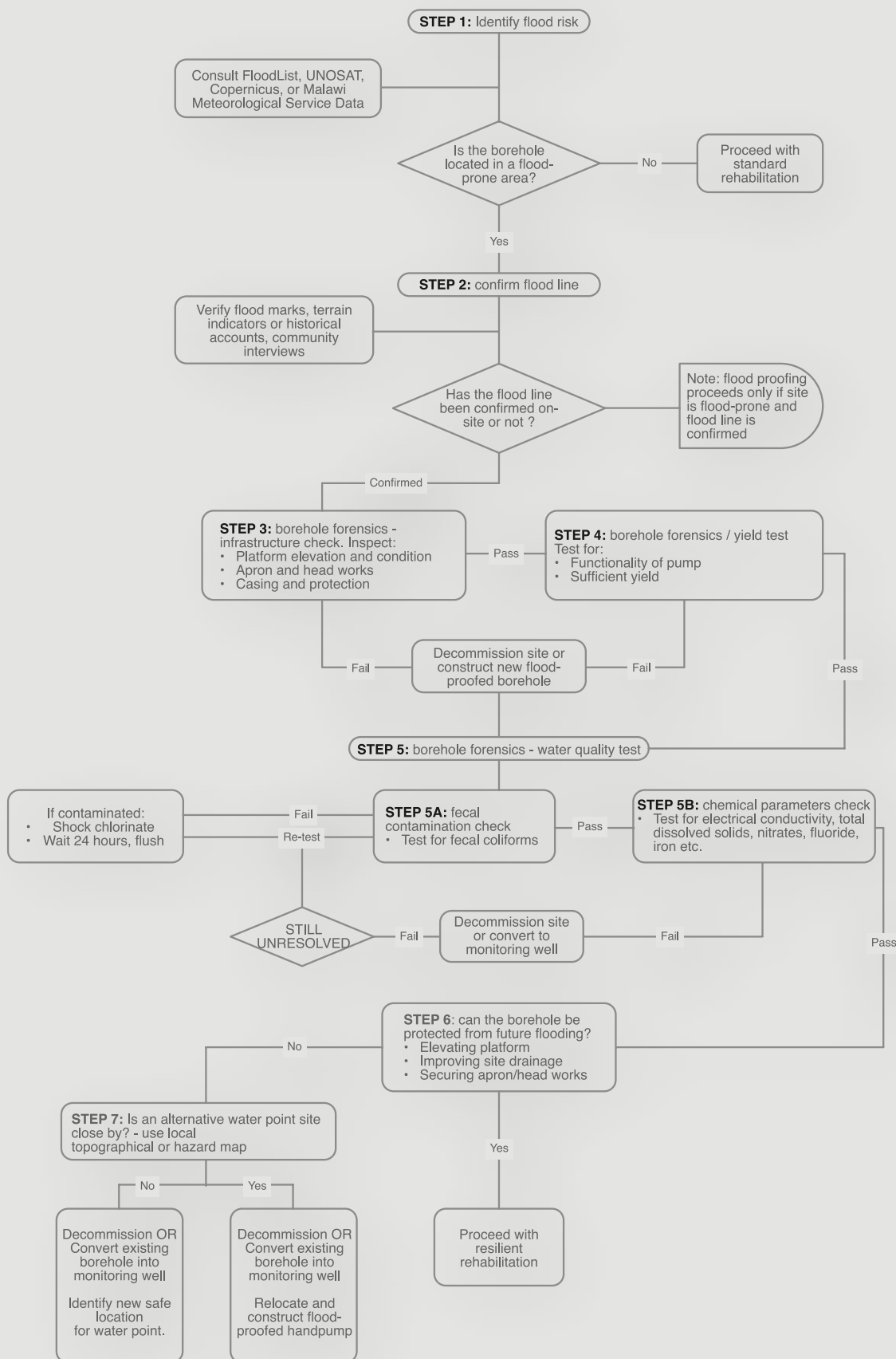


Figure 2: Pre-Construction Decision Tree for Flood-Proofing and Rehabilitation of Handpump-Equipped Boreholes in Flood Prone Areas

2.3 DESIGN MODIFICATIONS (OFFICE DESK WORK)

The following two modifications (but not limited) are made to the existing borehole if flood proofing is deemed to be needed;

- **Waterproof Sealant:** Plan where and how to apply waterproofing materials. This includes seals around the pump rod and any openings in the structure where water could enter.
- **Elevate the Pump:** If necessary, design (Refer to [Technical Drawings Section](#)) a flood-proof platform or casing to elevate the pump head to prevent damage from rising floodwaters.

Once design modifications have been done, detailed bills of quantities for the works have to be compiled and costed based on current prices. See chapter on [Bills of Quantities](#) for a standardized BoQ for Flood Proofing borehole.

2.3.1 Afridev Handpump— Technical Description

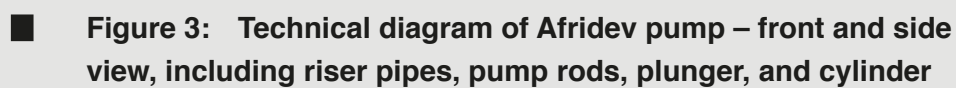
The Afridev handpump is a community water supply pump designed for deep well applications, suitable for use in rural and peri-urban areas. Developed under the UNDP-World Bank Rural Water Supply Program, it is designed for ease of maintenance and local

manufacture, making it ideal for community-based management (World Bank/UNDP, 2015).

Key Features:

- **Pump Type:** Deep well reciprocating hand pump
- **Design Depth Range:** 0–45 meters (optimal up to 35 meters)
- **Discharge:** Approx. 17–21 liters/minute at 30 m lift (Baumann & Keen, 2007)
- **Cylinder:** Brass-lined or plastic, with stainless steel or nitrile rubber components
- **Pump Stand:** Galvanized steel or cast iron, with pedestal and handle
- **Riser Main:** Ø32mm GI pipes (Class B or C), or uPVC option
- **Pump Rods:** Ø10mm stainless steel rods or galvanized steel
- **Foot Valve and Plunger:** Rubber seal valves, easily serviceable
- **Population Served:** Typically serves up to 300 people per pump (WHO, 2013)
- **Maintenance:** Designed for community-level maintenance with minimal tools (Parry-Jones et al., 2001; Ullerø, 2010).

The Afridev is known for its interchangeable parts, durability, and ease of operation, which make it one of the most widely adopted handpumps across Sub-Saharan Africa. It conforms to the standards set by RWSN (Rural Water Supply Network) for public domain handpumps (Baumann & Keen, 2007).



Flood Proof Handpump Manual | Pre-Construction Activities | More information: info@baseflowmw.org

2.4 EQUIPMENT AND MATERIALS NEEDED

2.4.1 Materials Needed

Purchase all materials listed below, ensuring that quantities match the scale of your pump and the anticipated flood level.

Table 1: Materials required for flood proofing boreholes

Item Category	Material	Specification	Remarks
1. Handpump (Existing Structure)	Pump components	Includes pump rod, handle, cylinder, etc.	Check for wear and replace faulty parts
	Existing pipe system	Compatible with the handpump model	Ensure no leaks or corrosion
2. Flood-Proofing Materials	Cement	Portland or equivalent	Ensure high-strength grade
	Sand	For concrete mix	Clean, well-graded
	Gravel or coarse aggregate	12mm size	Ensure proper gradation
	Water-resistant sealant	Marine grade	For sealing joints and critical points
	Steel reinforcement bars (Rebar)	Standard sizes	For structural stability
	Waterproofing membrane	Rubber lining or equivalent	For additional protection
	Polyvinyl chloride (PVC) pipes	For diversion or connection	Ensure correct diameter
	Gravel or crushed stone	For drainage (if applicable)	Use only where necessary

2.4.2 Tools & Equipment

During the construction of flood proofing structure, the following (but not limited to) materials will be needed to carry out the works. Ensure that all necessary equipment's and tools are on site before works begin.

Table 1: Tools and equipment's required during flood proofing of boreholes

Tool/Equipment	Purpose/Usage	Remarks
Shovel	Digging and mixing materials	Essential for groundwork
Wheelbarrow	Transporting materials	Ensure durable construction
Concrete mixer or mixing tools	Mixing concrete for construction	Manual or machine-based
Trowels	Smoothing and applying cement	Various sizes needed
Levelling tools	Ensuring even surfaces	Spirit level or laser level
Measuring tape	Accurate measurement of dimensions	Minimum 5m length
Steel cutting tools	Cutting reinforcement bars and SHS	Angle grinder or hacksaw
Wrenches and hand tools	Assembling and tightening components	Adjustable and fixed wrenches
Protective gloves, masks, and safety goggles	Ensuring worker safety	PPE for all labourers
Welding machine	To weld steel members together	Ensure it can weld to the recommended specifications

2.5 LABOUR REQUIREMENTS

Flood proofing requires different labour requirements based on the phase and complexity of the location. Ensure that all recommended and essential personnel are present on site before and during the works to ensure quality work and to standard.

Table 1: Type of labour requirements for each activity in the flood proofing construction works

Phase	Labour Type Required	Activity/Task Name
Phase 1: Pre-Construction	Engineers, Water Quality Technicians & Procurement Team	Technical design, BoQ development, procurement of required materials, water quality assessment
Phase 2: Site Preparation	Labourers	Clearing and leveling the site, material offloading and organization
Phase 3: Concrete Works & Borehole Casing	Labourers, stone masons, and welders	Excavation, foundation construction, formwork, borehole casing and support frame welding
Phase 4: Ramp & Railings Installation	Labourers, stone masons, and welders	Construction of access ramp, installation of metal railings and safety features

Phase	Labour Type Required	Activity/Task Name
Phase 5: Finishing Works & Testing	Engineers, Water Quality Technicians, labourers, stone masons & welders	Final alignment, pump installation, water quality testing, structural checks
Phase 6: Handover & Community Training	Community Mobilization Team & Project Team	System handover, user training, O&M orientation, and sensitization on water use

2.6 SAFETY AND ENVIRONMENTAL PRECAUTIONS

Proper safety and environmental precautions are essential when flood-proofing handpumps to ensure the protection of both workers and the surrounding community, as well as the long-term sustainability of the water source.

These precautions help prevent accidents during construction, minimize environmental impact, and safeguard water quality throughout the rehabilitation process. By following these guidelines, field teams can ensure that interventions are not only effective but also responsible and compliant with good practice standards and, where available, national standards. The following are the key safety and environmental precautions to be considered:

- Stabilize ground conditions before starting excavation or construction—avoid working in unstable, saturated soils.
- Use hand tools with care to prevent injury or damage to existing infrastructure.
- Mark off work zones with visible tape or signage to keep children and livestock away.

2.6.2 Environmental Protection Measures

- Avoid contaminating nearby water sources with construction materials (cement, sand, debris).
- Store fuels and chemicals (e.g., for chlorination) away from borehole and drainage lines to prevent leaks.
- Minimize soil disturbance—keep excavation as shallow and targeted as possible to reduce erosion and runoff.

2.6.1 Site Safety During Construction

- Wear appropriate PPE: gloves, boots, high-visibility vests, and helmets.

2.6.3 Waste Disposal and Site Clean-Up

- Dispose of waste concrete, debris, and old materials (e.g., broken slabs or rusted pump parts) at designated disposal sites or approved landfill areas.

- Do not bury waste near the borehole, especially materials that can leach contaminants into the water table.
- Collect and remove plastic packaging, metal offcuts, and chemical containers—never burn them near the borehole site.
- If decommissioning a borehole, seal it properly using bentonite or cement grout, and ensure all surface components are removed or buried safely to prevent hazard or reuse.

2.6.4 Water Protection During Works

- Cover the borehole head during construction to prevent debris or surface water from entering.
- Avoid working during active flooding or heavy rainfall to reduce contamination risks.
- Use raised platforms and proper drainage to prevent pooling of water around the pump area.

2.6.5 Post-Construction Safety Checks

- Test water quality after completion, especially if shock chlorination was applied.
- Verify structural integrity of elevated platform, apron, and drainage channels.
- Ensure the community understands new design features and proper maintenance routines.

3

STEP-BY-STEP CONSTRUCTION PROCESS

3.1 STEP 1: PREPARE THE SITE

- **Clear the site:** Remove debris, plants, or any obstructions around the existing handpump.
- **Excavate:** Dig around the base of the handpump to assess the surrounding ground and ensure there's adequate space for the flood-proof platform or casing.
- **Drainage System:** Ensure proper drainage by excavating to create space for gravel or a perforated drainage pipe if necessary to divert water away from the pump base.



Figure 4: Site preparation works around the base of handpump - Excavation

3.2 **STEP 2: ELEVATE THE PUMP BASE: BUILD A CONCRETE PLINTH:**

- Mix concrete using the correct ratio (usually 1 part cement, 2 parts sand, and 3 parts gravel).



■ **Figure 5: Mixing of concrete on site**

- Pour the mixture around the base of the pump to form a strong foundation.



■ **Figure 6: Concrete is poured around the base of the pump**

- Reinforce the concrete with steel bars (rebar: N98 meshwire) to prevent cracking during floods.
- Level and smooth the surface to ensure the pump remains stable when in use.
- Allow the concrete to cure for 24 to 48 hours before proceeding.

3.3 **STEP 3: INSTALL WATERPROOFING: SEAL THE PUMP HEAD AND OTHER OPENINGS:**

- Apply a waterproof sealant around all joints of the pump, especially at the points where water can enter (e.g., the base of the pump rod, cylinder, etc.).
 - Use marine-grade sealant that is designed for long-term outdoor exposure.
- Use a protective cap (like concrete or clay or a rubber or PVC lining over the pump cylinder) that extends several meters below the surface to create a barrier against floodwaters.
 - This prevents surface water from entering the borehole and potentially contaminating the water source.



Figure 7: Protective cap of PVC lining over the pump cylinder extending below the surface to create a barrier against floodwaters.

3.4 **STEP 4: CONSTRUCT THE FLOOD-PROOF CASING**

- Construct a casing or box around the pump to protect the mechanical parts from floodwaters. Use strong, weather-resistant materials like concrete, metal, or PVC.
- Ensure that the casing is high enough above the maximum floodwater level identified in the initial analysis.
- Allow ventilation through small openings to prevent stagnant water inside the casing but prevent large debris from entering.



■ **Figure 8: Casing around the pump high enough above the maximum floodwater level**

3.5 **STEP 5: CONSTRUCTION OF FLOOD PROOF PLATFORM AND GUARD RAILS**

- Construct the raised concrete platform as per design specifications to elevate the pump above anticipated flood levels.



Figure 9: Construction of raised platform

- Reinforce the platform with steel bars and use waterproof concrete mix.



Figure 10: Reinforcement of the concrete platform base



■ **Figure 11: Construction and Reinforcement of second level of concrete platform base**

- Install SHS (Square Hollow Section) steel guard rails around the platform for user safety.



■ **Figure 12: Installation of guard rails**

- Weld rail components securely and ensure all joints are rust-protected.



■ **Figure 13: Welding of guard rail by certified welder**

- Construct the drainage channel and soak pit adjacent to the platform using the specified dimensions (Refer).
- Fill the soak pit with graded layers of large (200mm Ø) and small (10mm Ø) stones for effective drainage.



■ **Figure 14: Drainage channel and soak pit filled with recommended stone aggregate**

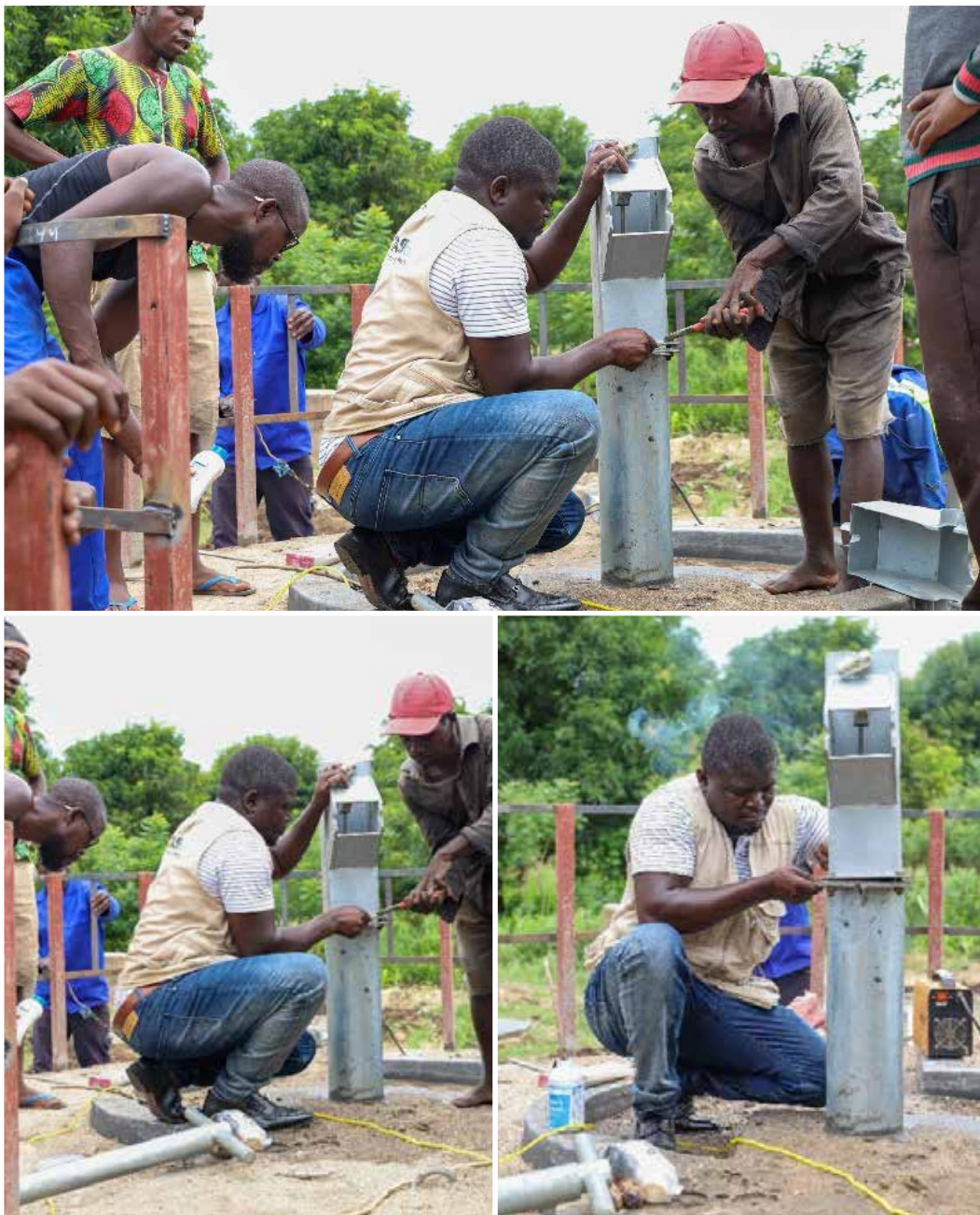
- Provide an earthen berm and stone surround to prevent erosion and maintain pit integrity.
- Apply platform finishing with a smooth concrete layer and place flat stones (300mm x 300mm) flush around the pump base to enhance durability and accessibility.



■ **Figure 15: Finished platform and welded guard rail**

3.6 STEP 6: REINSTALL THE PUMP AND TESTING

- Reassemble the Pump: Once the flood-proofing measures are in place, reassemble the handpump by attaching the pump rod and other components.



■ **Figure 16: Reassembling of the pump by certified technician**

- Testing: Test the functionality of the pump by running water through it. Ensure there are no leaks or malfunctions. Pump water to verify that the mechanism works smoothly after the changes.



■ **Figure 17: Testing of the pump by certified technician**

3.7 **STEP 7: FINAL SEAL AND CLEANUP**

- **Final Waterproof Seal:** After confirming that everything is working, apply a final waterproofing layer on the base and around the joints.
- **Cleanup:** Remove any construction debris and clear the surrounding area to ensure it is safe and functional.



■ **Figure 18: Finished flood proof borehole platform**

3.8 OTHER CONSIDERATIONS:

- **Geological Design:** Boreholes need to be designed based on the specific geology of the area, and installed correctly with appropriate materials.
- **Flood Resistant Materials:** Use flood-resilient materials like metal, plastics, or hardwood for borehole components.
- **Temporary Resistance Measures:** Consider temporary measures like air brick patches, alternative sandbags, and expandable flood barriers.



■ **Figure 19: Flood proofed borehole**

4

POST-CONSTRUCTION ACTIVITIES

4.1 MONITOR AND INSPECT REGULARLY

After the pump is flood-proofed, inspect the system periodically to ensure that the waterproofing and structural modifications are holding up under normal use and during periods of flooding.

Identify a reliable community member with a working phone who can serve as a contact person for follow-up on the handpump's performance.

4.2 MAINTENANCE AND UPKEEP

Regularly check the seals and protective casing to ensure that no damage has occurred, especially after flood events.

Ensure that the drainage system remains unobstructed, allowing water to flow away from the pump base.

4.3 COMMUNITY TRAINING

User Training: Educate local users on how to maintain and operate the flood-proof handpump to ensure it remains effective during floods.

Emergency Plan: Develop a clear protocol for responding to significant flooding, including guidance on how to protect or suspend use of the handpump during extreme conditions. In the event of a flood, the designated community contact person (see Section 4.1) should be notified immediately.

5

TECHNICAL DESIGN

The following section outlines the technical design considerations for constructing a flood-proof handpump, aimed at enhancing the resilience of rural water infrastructure in flood-prone areas. This innovative design incorporates key structural adaptations that help minimize the risk of water source contamination and ensure the handpump remains operational and secure during flood events.

The design includes elevated concrete platforms, sealed pump bases, reinforced borehole casings, and secure drainage channels—each component tailored to withstand high water levels and reduce the ingress of floodwater and debris. For detailed technical drawings and engineering specifications, readers are encouraged to consult the “Appendices” section.

6

BILLS OF QUANTITIES

Here's a Bills of Quantities (BoQ) based on the technical drawings you provided. The BoQ includes materials, labor, and estimated costs necessary for constructing the Flood-Proof Handpump. If you have specific cost constraints or need adjustments based on different materials or design requirements, adjust the BoQ accordingly.

■ **Table 1: Bills of Quantities (BoQ) for Flood-Proof Handpump**

Item	Description	Unit	Quantity	Unit Rate (MWK)	Total Cost (MWK)
1. Site Preparation					
1.1	Site clearance and levelling	m ²	10		
1.2	Excavation for foundation (0.6m depth)	m ³	1.5		
Subtotal					
2. Concrete Works					
2.1	Cement (OPC)	Bags (50kg)	6		
2.2	Sand	m ³	1.5		
2.3	Gravel	m ³	1.5		
2.4	Reinforcement Mesh (A98)	m ²	2		
2.5	Hardcore filling	m ³	2		
Subtotal					
3. Borehole Casing and Structural Reinforcement					

Item	Description	Unit	Quantity	Unit Rate (MWK)	Total Cost (MWK)
3.1	Borehole casing reinforcement (steel)	m	3		
3.2	Welding for casing joints	Lump Sum	1		
3.3	Waterproofing sealant for casing	L	2		

Subtotal
4. Ramp and Railings (SHS Steel Structure)

4.1	SHS (Square Hollow Section) 50x50mm (for railing)	m	10		
4.2	SHS 30x30mm (for ramp support)	m	6		
4.3	Welding for rail installation	Lump Sum	1		

Subtotal
5. Finishing Works

5.1	Flat stone paving (300mm x 300mm)	m ²	3		
5.2	Drainage channel concrete lining	m	2		
5.3	Quality control & testing	Lump Sum	1		

Subtotal

Item	Task	Skilled Labor (Man-hours)	Unskilled Labor (Man-hours)	Rate per Hour (MWK)	Total Cost (MWK)
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6. Labor Costs

6.1	Site preparation	8	16		
6.2	Concrete mixing & pouring	12	24		
6.3	Borehole casing & reinforcement	10	20		
6.4	Installation of SHS railing	8	12		
6.5	Final finishing & quality control	6	10		

Subtotal

Total Project Cost	
Category	Cost (MWK)
Site Preparation	
Concrete Works	
Borehole Casing & Reinforcement	
Ramp & Railings	
Finishing Works	
Labor	
Grand Total	

7

WORKS SCHEDULE

Here's a Work Schedule for constructing the Flood-Proof Handpump, covering key tasks, estimated durations, and dependencies. This schedule ensures an efficient workflow, proper curing times, and quality control.

Table 1: Work Schedule For Flood-Proof Handpump Construction

Work Schedule for Flood-Proof Handpump Construction				
Total Duration: 21 Days (3 Weeks)				
Task No.	Activity	Duration (Days)	Labor Required	Dependencies
Phase 1: Pre-Construction				
1.1	Site assessment & flood zone analysis	2	Engineers	None
1.2	Borehole forensics & suitability tests	2	Engineers & Water Quality Technicians	1.1
1.3	Procurement of materials & equipment	3	Procurement Team	1.1, 1.2
Phase 2: Site Preparation				
2.1	Site clearance and leveling	1	4 labourers	1.3
2.2	Excavation for foundation (0.6m depth)	1	4 labourers	2.1
Phase 3: Concrete Works & Borehole Casing				
3.1	Mixing & pouring concrete foundation	2	6 labourers, 2 masons	2.2

Work Schedule for Flood-Proof Handpump Construction				
Total Duration: 21 Days (3 Weeks)				
Task No.	Activity	Duration (Days)	Labor Required	Dependencies
3.2	Borehole casing reinforcement installation	1	2 welders, 4 labourers	3.1
3.3	Waterproofing & curing of foundation	3	2 masons	3.2
Phase 4: Ramp & Railings Installation				
4.1	Fabrication of SHS (Square Hollow Section) railing	2	2 welders	3.3
4.2	Installation of SHS railing	1	2 welders, 4 labourers	4.1
4.3	Ramp construction with compacted gravel & concrete	2	4 labourers, 2 masons	4.2
Phase 5: Finishing Works & Testing				
5.1	Installation of flat stone paving	1	2 masons, 4 labourers	4.3
5.2	Drainage channel construction & finishing	1	2 masons, 4 labourers	5.1
5.3	Quality control, final inspections & water testing	2	Engineers & Water Quality Technicians	5.2
Phase 6: Handover & Community Training				
6.1	Community engagement & training on pump usage	1	Community Mobilization Team	5.3
6.2	Final handover & commissioning	1	Project Team	6.1

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APPENDICES

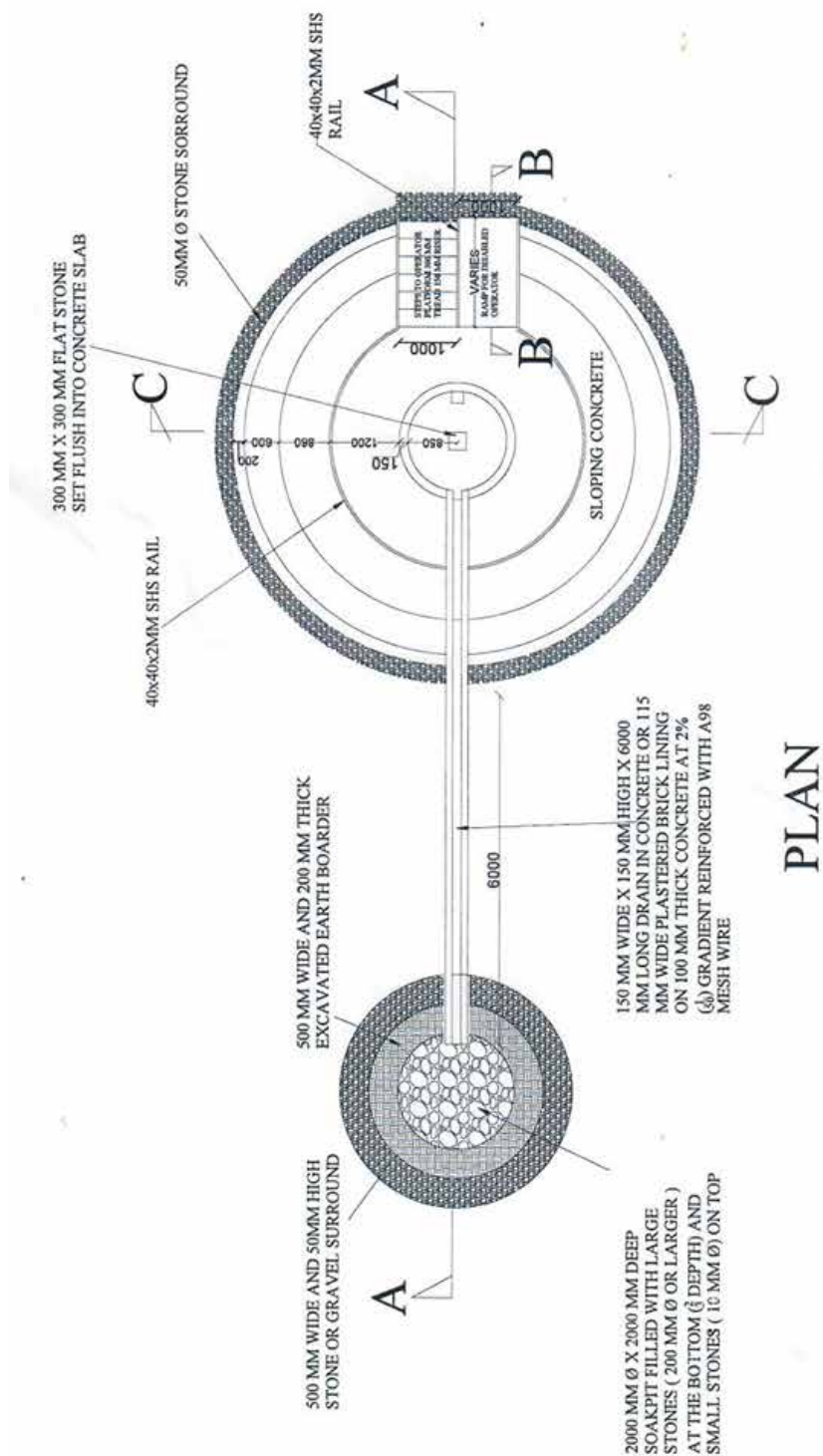


Figure 20: Plan View

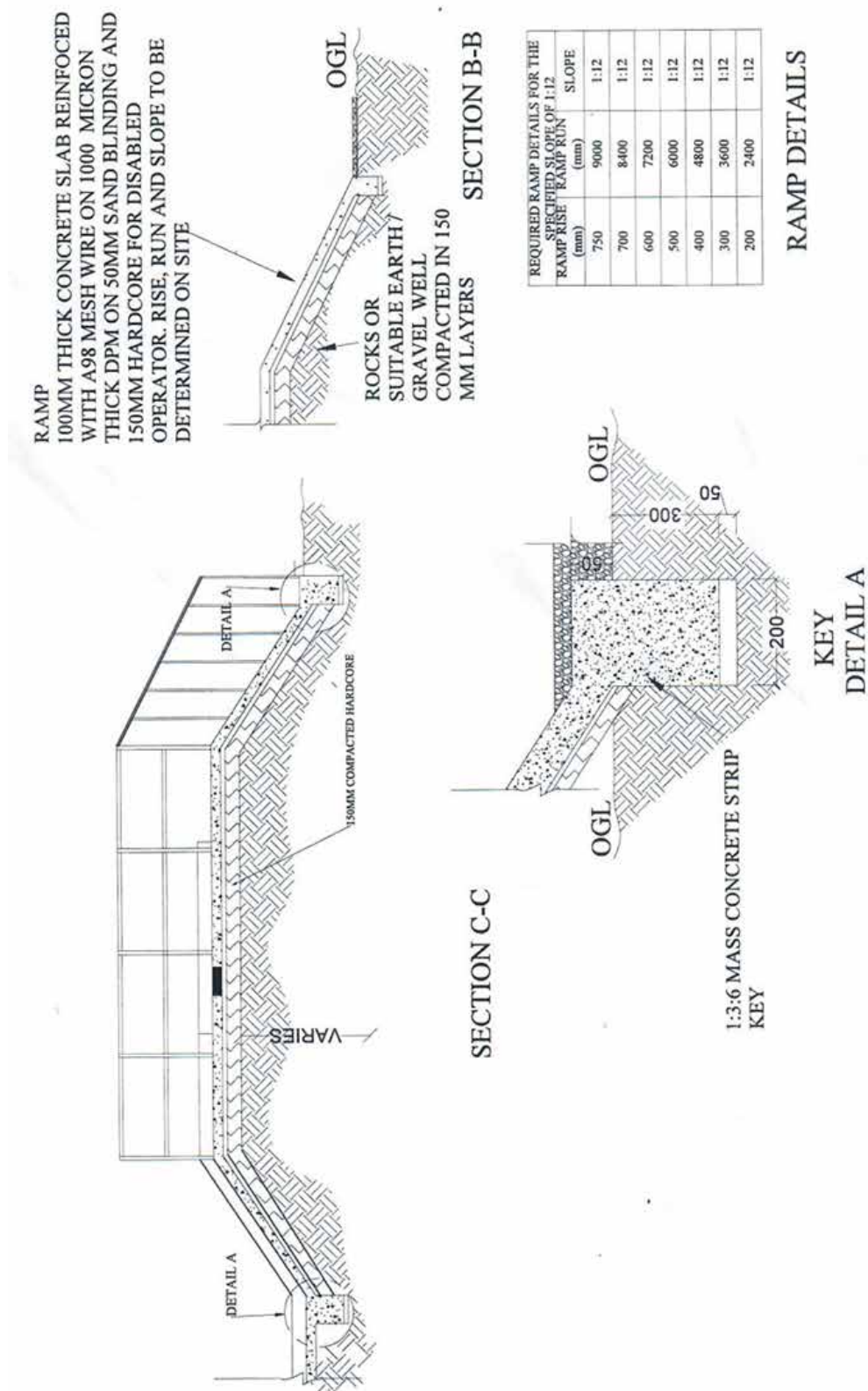


Figure 22: Ramp and Rail Details

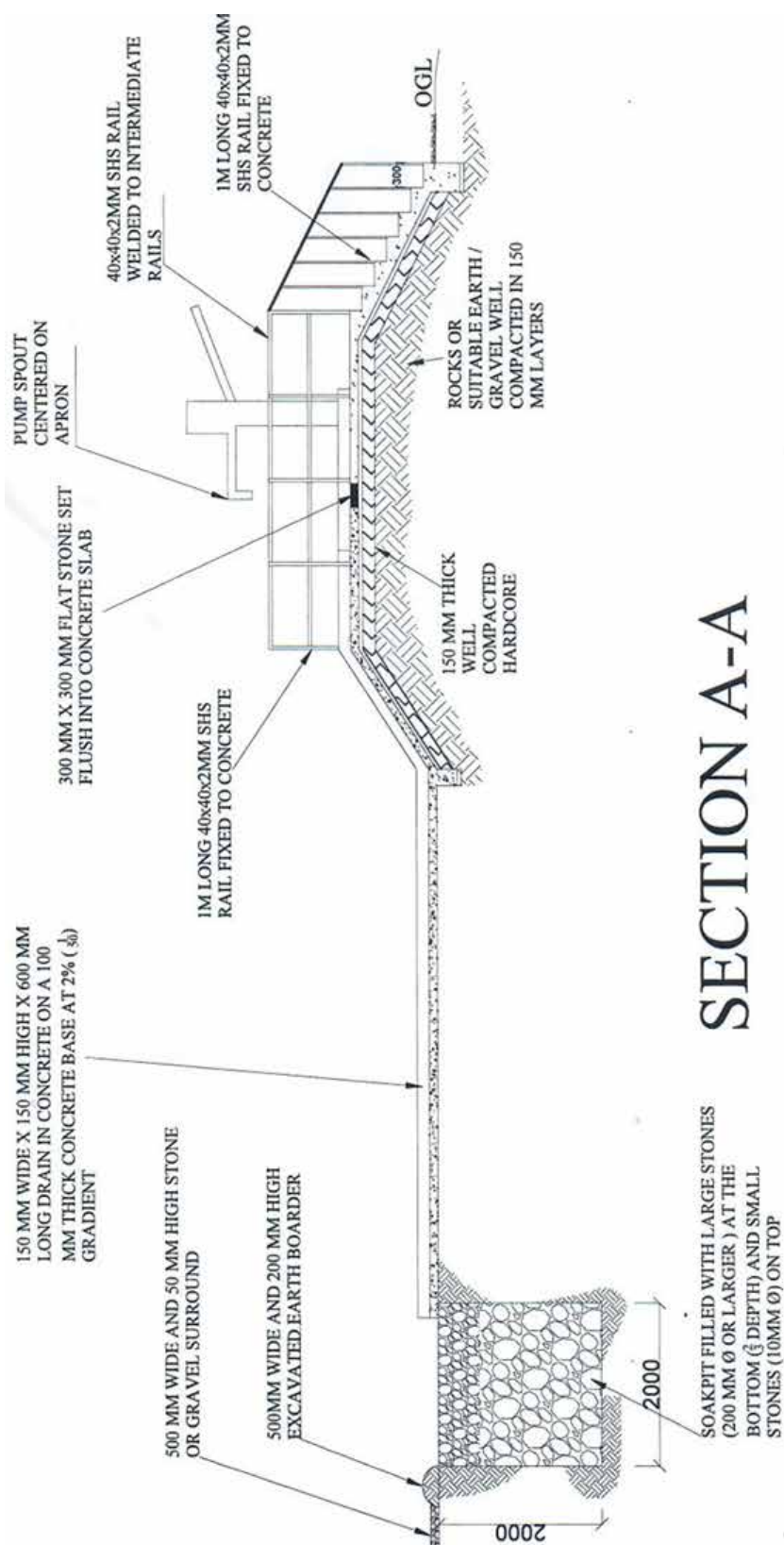


Figure 21: Section Views

