

CLIMATE RESILIENCE INCORPORATION IN WASH DESIGNS AND DRAWINGS

Sheilla Constance Apio (E4C fellow, 2023)

26th October, 2023

CLIMATE RESILIENCE INCORPORATION IN WASH DESIGNS AND DRAWINGS

UNHCR WATER SUPPLY DRAWINGS

No.	Document Name	File ID
1	Emergency Tap stand (Wooden Pallets)	D-300
2	Post Emergency Tap stand (Rectangular Concrete)	D-301
3	Post Emergency Handpump Apron (Rectangular Concrete)	D-302
4	Post Emergency Hand Dug Well Apron (Circular Concrete)	D-303
5	Post Emergency Borehole (Fractured Rock Aquifer)	D-304
6	Post Emergency Borehole (Alluvial Aquifer)	D-305
7	Emergency Raised Water Platform (Sandbags)	D-306
8	Emergency Raised Water Platform (Concrete Rings)	D-307
9	Emergency Raised Water Platform (Corrugated Steel Rings)	D-308
10	Post Emergency Elevated Tower (Reinforced Concrete)	D-309
11	Post Emergency Elevated Tower (Steel)	D-310
12	Elevated 4m Water Tower (Steel)	D-311
13	Square Water Reservoir 10m3 (Reinforced Concrete)	D-312
14	Square Water Reservoir 30m3 (Reinforced Concrete)	D-313
15	Square Water Reservoir 50m3 (Reinforced Concrete)	D-314
16	Circular Water Reservoir 10m3 (Brick and Reinforced Concrete)	D-315
17	Circular Water Reservoir 30m3 (Brick and Reinforced Concrete)	D-316
18	Circular Water Reservoir 50m3 (Brick and Reinforced Concrete)	D-317
19	Circular Water Reservoir 45m3 (Ferrocement)	D-318
20	Circular Water Reservoir 75m3 (Ferrocement)	D-319
21	Circular Water Reservoir 90m3 (Ferrocement)	D-320
22	Protection System for wells in Wadis	

PROCESS/KEY MODIFICATIONS TO WASH DESIGNS/DRAWINGS

1. ELEVATION OF INFRASTRUCTURE PLATFORMS

- a) Design platforms for water supply infrastructure such as handpumps, tap stands and water reservoir tanks to be located at or above the flood depths recorded for a specific site in order to prevent them from getting submerged during heavy downpours/flooding events.
- b) The flood depth can be determined basing on;
 - ✓ Review of existing literature (reports, maps, articles) and historical flooding scenarios and damages associated with the site. Local authorities, environmental agencies and communities can also be consulted.
 - ✓ Alternatively, a proper flood model should be developed for the site, and a flood depth determined during the design phase. Analyses should take into account long-term climate projections as this minimizes the chances resulting from future extreme weather events. Figure 1 below shows the procedure for determining flood depth for an area.

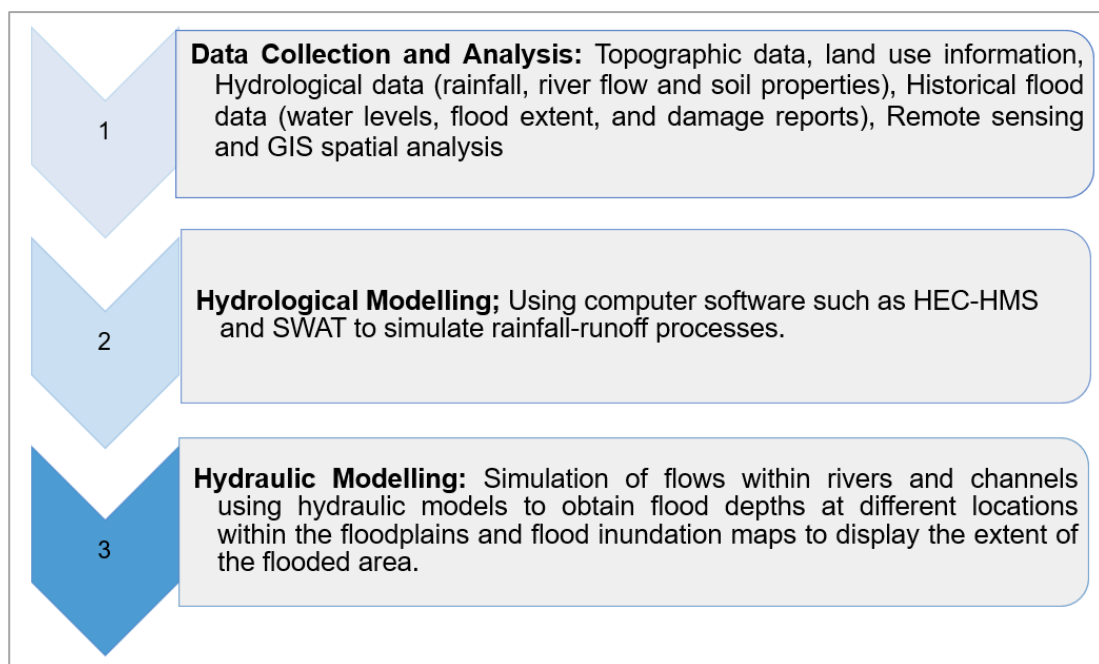


Figure 1: Procedure for determining flood depth for an area

Note:

- ✓ The depth of flooding can vary from one location to another, implying that elevations will differ for similar structures in different areas and/or refugee camps.
- ✓ Water supply infrastructure such as tap stands, reservoir tanks and handpumps located within an area of the same flood depth can have the same height above the

ground (elevation). Figure 2 below shows an elevated tower platform adopted for the protection system developed for wells located in wadis (Chad).

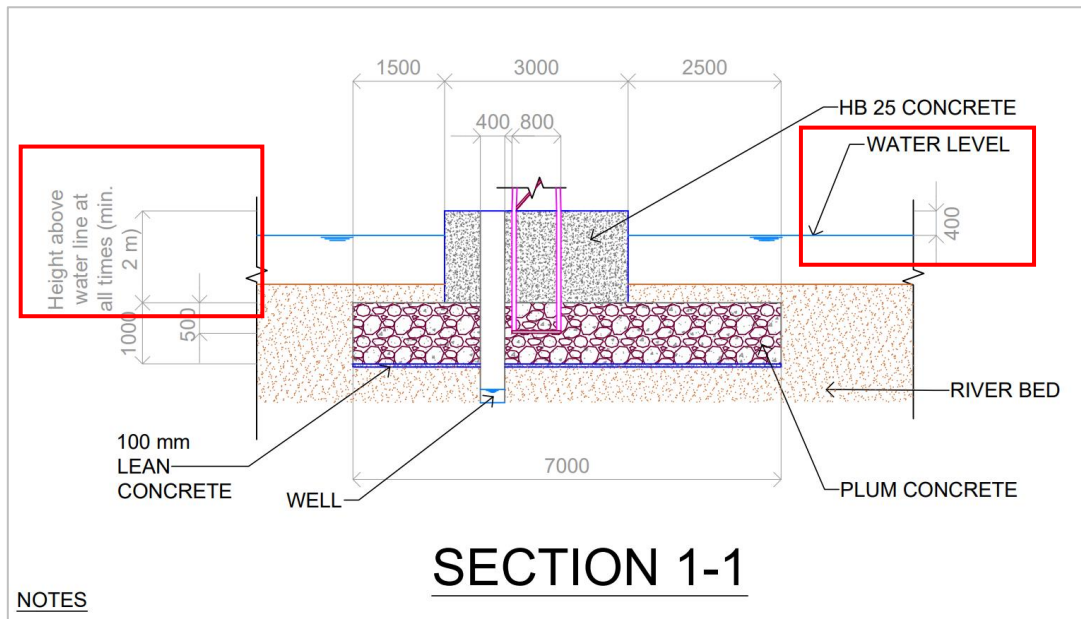


Figure 2: Tower platform elevated above flood water level (Source: *Protection structure for wells in wadis*)

2. FLOOD BARRIERS

- Design flood barriers or flood walls to be installed around the water reservoir tanks, hand dug wells, boreholes and tap stands, as a protection measure against floods.
- The design for flood barrier foundations and walls should take into account their ability to resist hydrodynamic loads, hydrostatic loads and loads from floating debris in flood waters. The figures below show the hydrostatic and hydrodynamic forces that act on barriers.

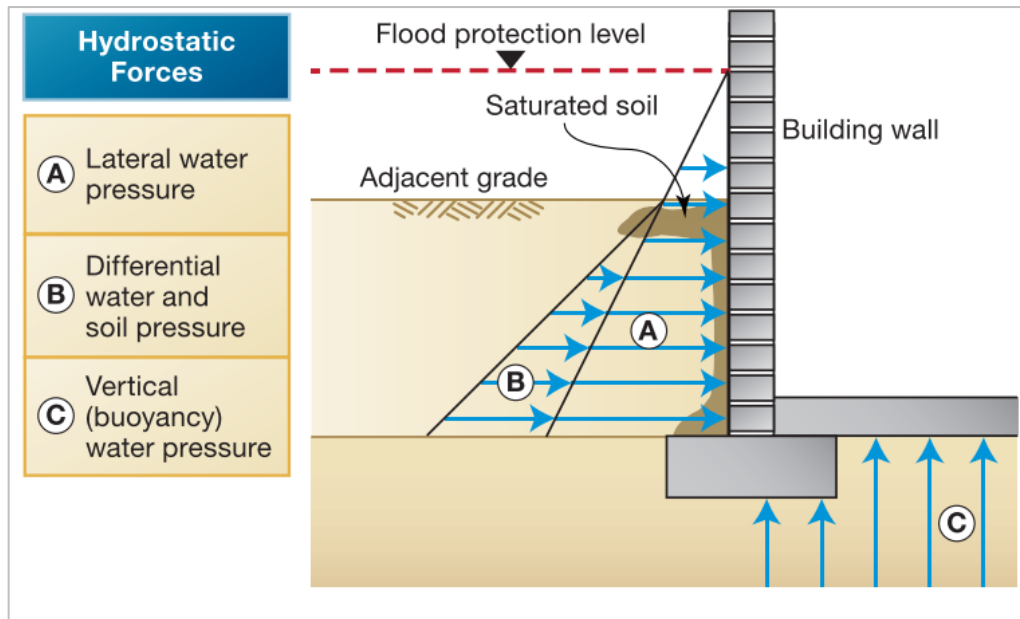


Figure 3: Hydrostatic forces (Source; [Protecting Building Utility Systems from Flood Damage](#))

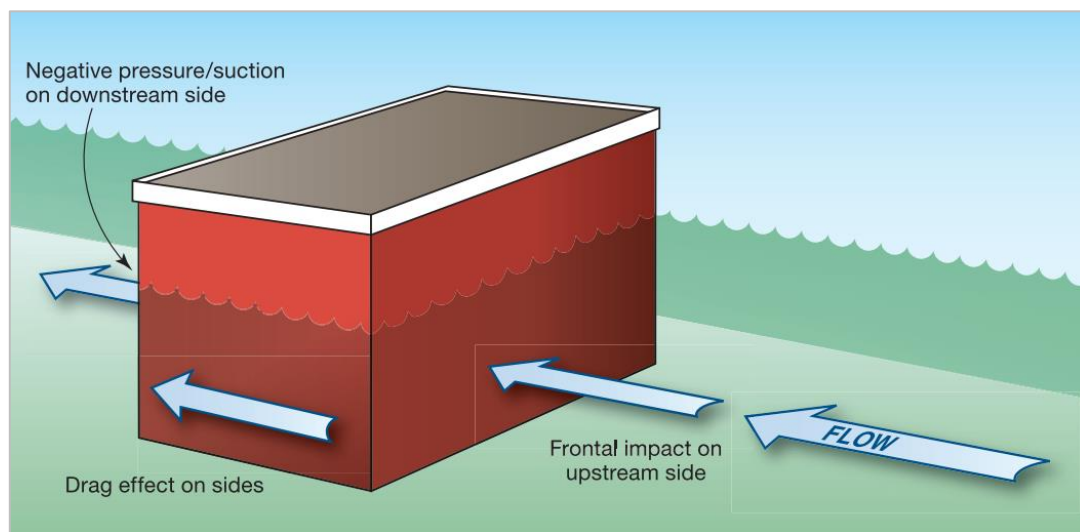


Figure 4: Hydrostatic forces (Source; [Protecting Building Utility Systems from Flood Damage](#))

- c) The height of the wall should be dependent on the depth of the flood in that area, level of protection required and the costs involved.
- d) The barrier design should incorporate drainage options for rainfall accumulated within the enclosure. This may include provision of diversion channels or trenches to direct water away from the infrastructure.

- e) For permanent barriers, materials such as concrete and masonry are recommended for use in construction.
- f) Temporary flood barriers such as sand bags can be used as emergency measures for flood protection, however, they are known to offer limited protection against floods hence cannot be fully relied upon.

3. FOUNDATION AND ANCHORAGE DETAILS

- a) When designing foundation and anchorage details for the different water supply infrastructure, take into consideration the nature of soils, site climatic conditions, associated costs, scour resistance and potential mitigation measures to enhance stability and resilience.
- b) The foundation design for structures like water tanks should take into account its ability to resist hydrodynamic loads, hydrostatic loads and loads from floating debris in flood waters.
- c) Depending on the nature of soil conditions at the site, the foundation of the infrastructure may have to be deepened to firm ground levels to provide additional strength. Soil tests and geotechnical analyses should be carried out to determine whether additional reinforcement or ground improvement is required.
- d) In regions prone to seismic activity, design the anchorage to withstand ground movement. This may involve using seismic-resistant anchors and connections.
- e) Innovative designs (foundation shapes) and application of different materials may need to be implemented to avoid scour and damage to foundation footings during flooding events. The nature of the design will greatly depend on the location of the site, availability of materials, ease of constructability by the locals and the nature of the climate-change related hazards in the area.
- f) Provide for corrosion-resistant and durable materials for anchoring systems for WASH infrastructure. Stainless steel and galvanized steel are corrosion resistant and can be used for the anchor bolts, brackets and other structural components.
- g) Proper drainage in form of channels/trenches should be provided around the WASH infrastructure in order to divert surface runoff from the footings.

4. SELECTION OF APPROPRIATE CONSTRUCTION MATERIALS

- a) Selection of appropriate construction materials should take into account durability, cost, and effectiveness of the materials in resisting the impacts of climate change. Material selection should also reflect cost effectiveness and availability of the materials

within the locality of the refugee camps. Materials that are sustainably produced or sourced should be prioritized whenever possible.

- b) An in-depth assessment of material sensitivity to different climate change impacts can be determined using the table below, prior to selecting the different options available for use.

Material	Flooding	Land- slides	Wind	Storm Surge	Sea Level Rise
Roofing					
Corrugated metal roofing	Low	High	Extreme	Extreme	N/A
Concrete roofing	Low	High	Low	Low	N/A
Piping					
Metal pipes (buried)	Low	Medium	Low	Low	Low
Plastic pipes (buried)	Low	Medium	Low	Low	Low
Metal pipes (exposed)	High	High	Medium	High	High
Plastic pipes (exposed)	High	High	Medium	High	High
Structural					
Reinforced concrete wall	Low	Medium	Low	Low	N/A
Concrete hollow block wall	Low	High	Low	Medium	N/A
Wooden walls	High	Extreme	High	Extreme	N/A
Water Storage					
Reinforced concrete water tower	Low	High	Low	Low	N/A
Structural steel water tower	Medium	High	Low	Low	N/A

Figure 5: Material sensitivity to climate change impacts (Source; [Climate-Resilient Water Infrastructure \(USAID\)](#))

- c) Materials such as reinforced concrete, Concrete blocks (Autoclaved concrete blocks – hollow and solid, concrete blocks made from sustainable mine waste such as stones, stone dust and chips) and durable or treated timber are considered to be water resistant and are recommended for use in foundation construction for infrastructure such as water tanks. Stone is also a durable material and should be adopted for foundations of water supply infrastructure.
- d) Corrosion resistant materials should be used for pipes to avoid corrosion brought about due to flooding, and drought (higher concentration of corrosive minerals in water). Materials such as HDPE pipe, stainless steel pipe, ductile iron and galvanized iron.
- e) The design should incorporate the utilization of sustainable drainage materials like permeable pavements around infrastructure such as tanks and tap stands, that are essential in managing stormwater and reducing flooding. The figure below shows a sustainable pavement used for a climate resilient infrastructure.

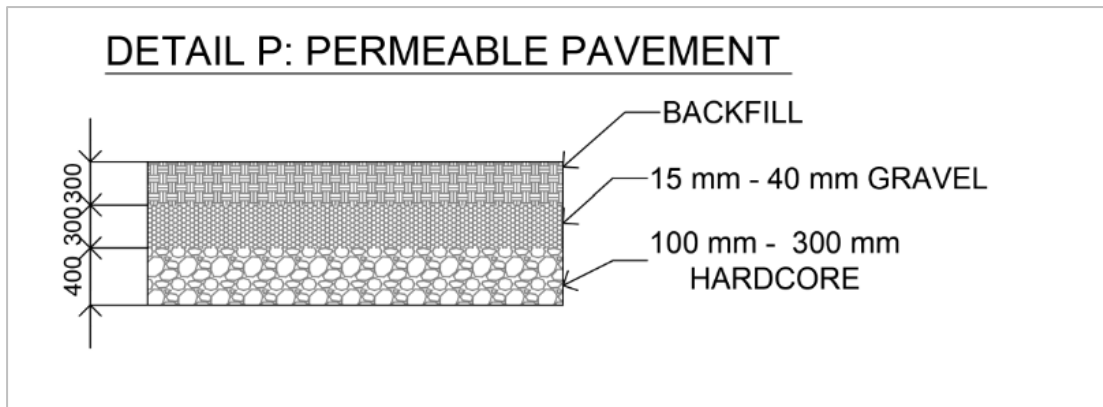


Figure 6: Sustainable Permeable Pavement

5. ELEVATING OR BURYING PIPING LINES

- a) If exposed to a considerable risk of flooding, main piping lines and their constituent parts from water supply tanks, tap stands, and wells, are vulnerable to damage from floodwaters. Therefore, to avoid this, exposed transmission/piping lines should either be elevated above flood levels and securely anchored into the ground or buried underground, if possible.
- b) Intake pipes or conduits crossing streams can be installed above the stream by means of anchoring the pipes onto a support structure or installed underground with minimum of 1.0 m cover over the top of the crown.
- c) Alternatively, exposed pipes should be embedded in concrete when raising is not possible. Relocation of transmission lines should also be done for areas that are highly at risk of climate change impacts like floods and landslides.

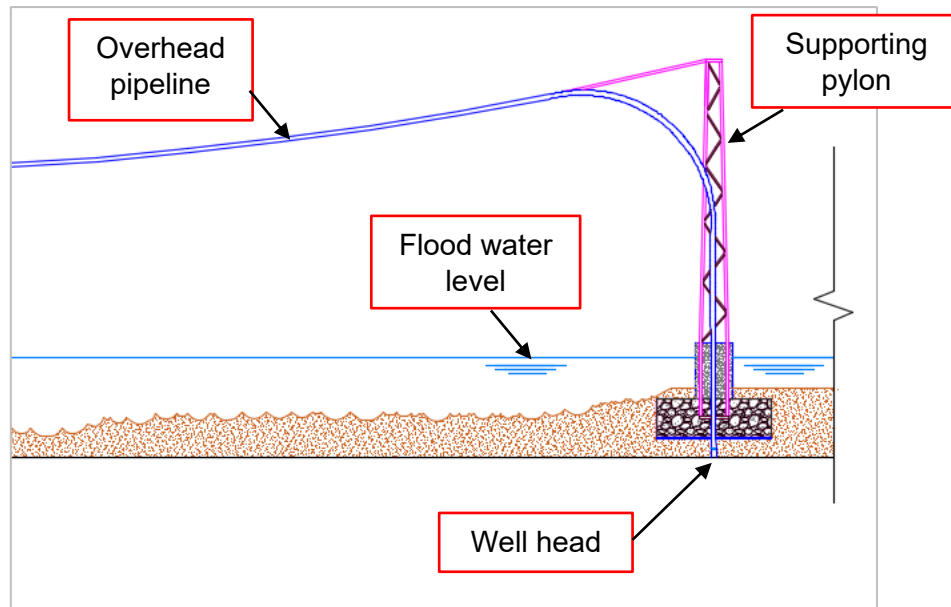


Figure 7: Elevated pipeline supported a pylon (Source: *Protection structure for wells in wadis*)

6. BLUE-GREEN INFRASTRUCTURE

- a) The design of climate-resilient water supply infrastructure should incorporate nature-based solutions such as blue-green infrastructure. Elements like permeable pavements and artificial wetlands should be incorporated in the design and construction of water supply infrastructure in order to aid in the reduction of surface runoff.
- b) Permeable pavements allow for reduced surface runoff and increased filtration of water into the soil. Artificial wetlands aid in water storage and retention, and provide an expanded area for flood waters to dissipate their energies.

7. OTHER CONSIDERATIONS FOR CLIMATE RESILIENCE

a) **Site Selection;**

- ✓ Properly site WASH infrastructure in order to reduce vulnerability to climate change impacts such as floods and drought. Hydrogeological investigations should be carried out in order to properly assess groundwater conditions for an area prior to drilling boreholes. Areas prone to flooding and earthquakes should also be avoided for siting WASH systems.

- ✓ Avoid constructing WASH facilities in sensitive ecosystems like floodplains and wetlands as this exacerbates the impacts of climate change in an area. Furthermore, design of water supply systems should incorporate drainage channels to direct flood waters away from water sources such as rivers and lakes.

b) Water Management;

- ✓ Develop a sustainable water management plan that takes into account seasonal variations in water availability, demand, and quality, including water rationing during droughts and flood response protocols.

c) Capacity Building and Community Involvement;

- ✓ Engage the refugee community in the design and maintenance processes while simultaneously providing training on how to operate, maintain, and repair the facilities. Leveraging local knowledge and community involvement will not only enhance the facility's design but also empower the community to take an active role in the ongoing maintenance of the system.

d) Monitoring and Data Collection;

- ✓ Implement a system for monitoring water usage, quality, and climate-related changes. This data can be used to make informed decisions and adapt the facility's operation as needed. Real-time monitoring of WASH infrastructure can be implemented.

REFERENCES

1. [A Practical Guide to Climate-resilient Buildings & Communities](#)
2. [Climate-Resilient Infrastructure](#) – Policy Perspectives
3. [Climate-Resilient Infrastructure Officer Handbook](#)
4. [Climate-Resilient Water Infrastructure \(USAID\)](#)
5. [Climate-Resilient Water Safety Plans](#)
6. [Engineering Design Guidelines for Rural Water Supply Systems](#) – Lowland Water, Sanitation & Hygiene Activity
7. [Integrating Climate Resilience with WASH System Strengthening](#)
8. [Protecting Building Utility Systems from Flood Damage](#) - FEMA
9. [WASH Climate-Resilient Development](#) – UNICEF