

UNHCR Square Water Reservoir 10m³

D312-2016a

**Tools and Guidance for
Refugee Settings**



UNHCR
The UN Refugee Agency

UNHCR Standardized Designs for Refugee Settings

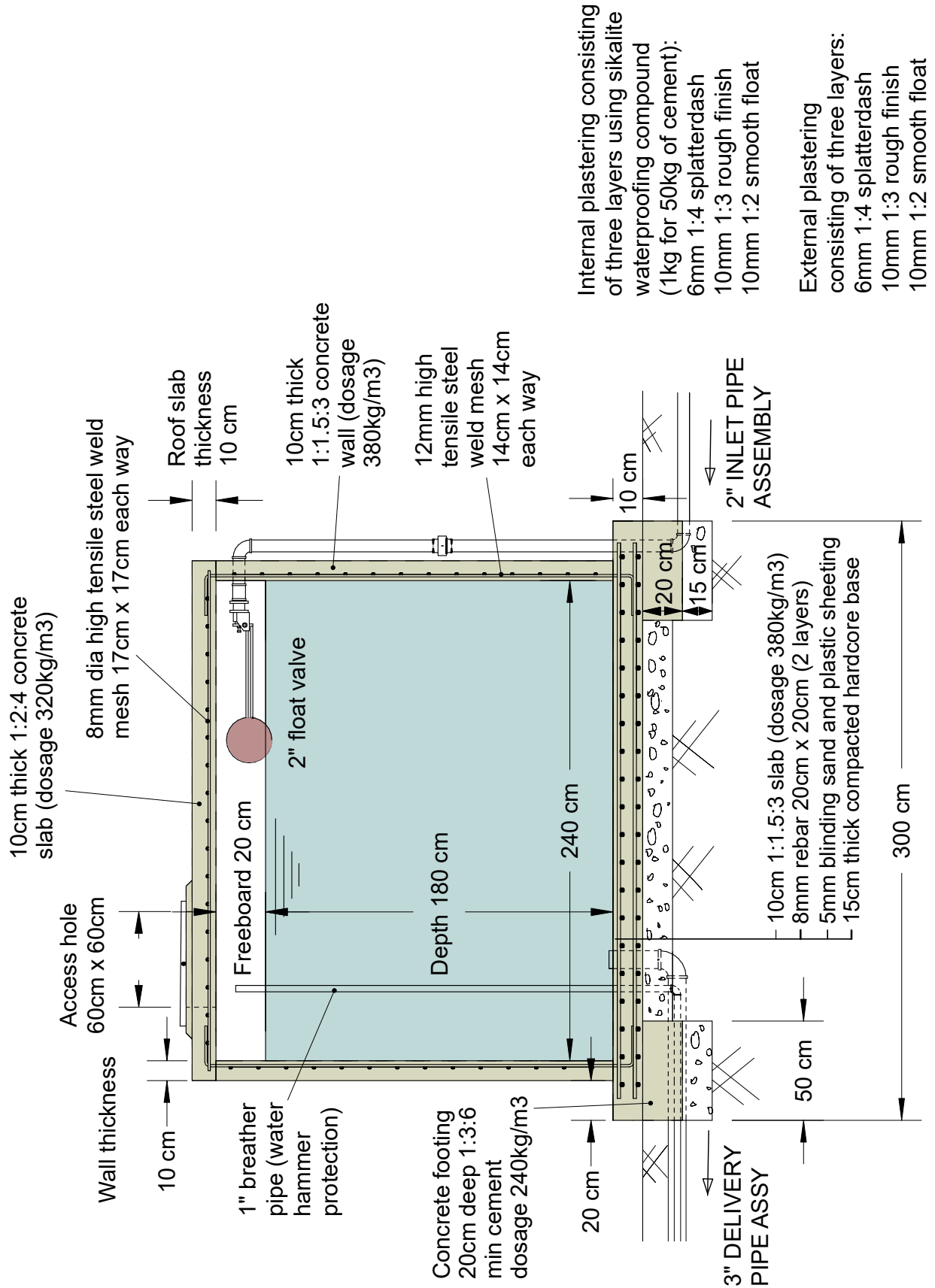
Square Reinforced Concrete Water Reservoir 10m³

FOREWORD

These square reinforced concrete water reservoir designs form part of UNHCR's series of Standardized WASH Design Guidelines for Refugee Settings which are the result of an extensive review process with WASH actors active in refugee settings. It is recognized that the Standardized WASH Designs will require continuous review and amendment in response to changes in engineering best-practice and feedback from the field. Therefore further review will be managed by a Technical Review Committee which will meet regularly to discuss issues related to the use of the design and an annual review will be reported back to the WASH community. More urgent amendments will be reported as, and when, required. Note that this reservoir is based on a design used by Water for People Guatemala.

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Sectional View



213-D

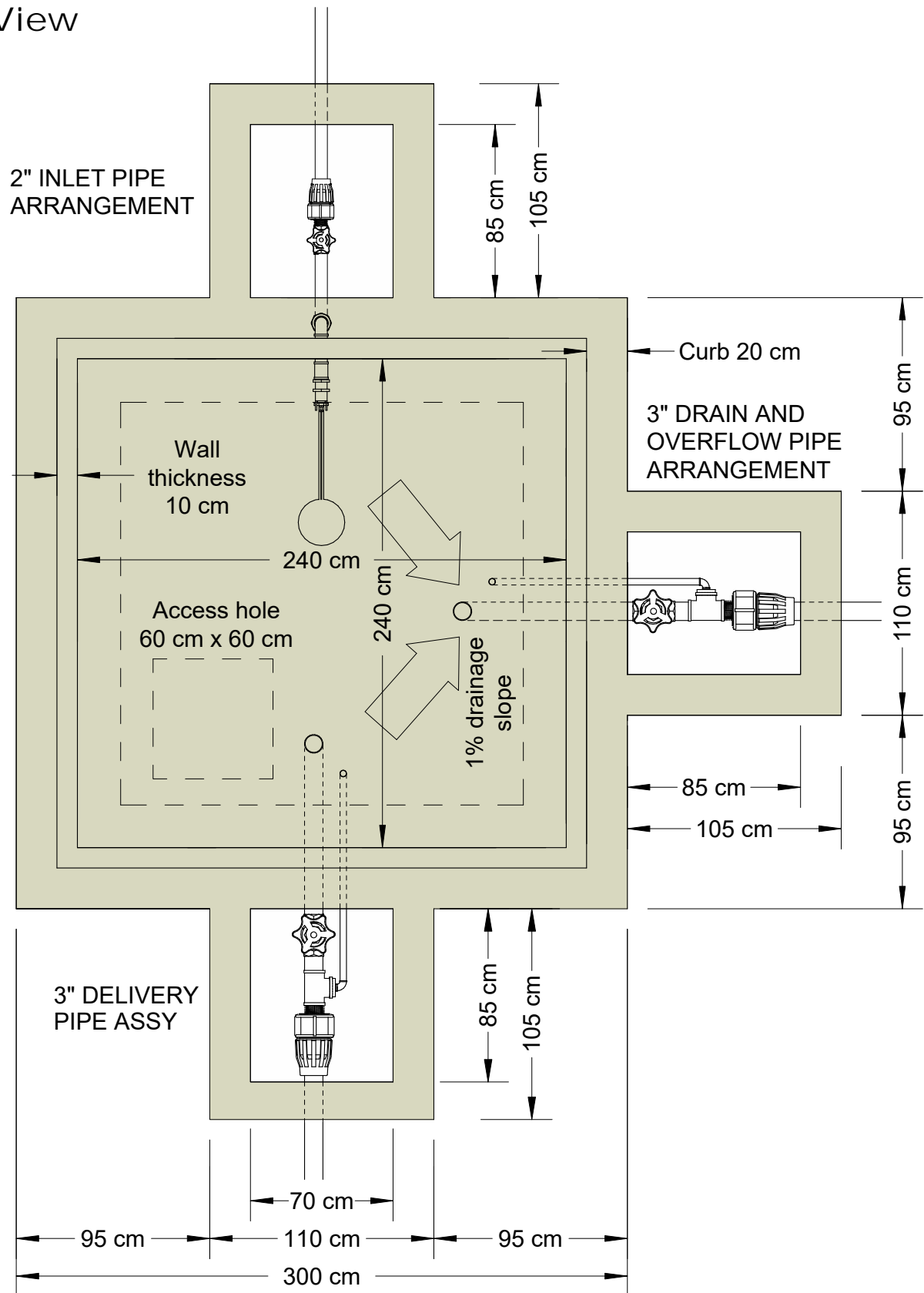
TITLE
 10m³ Square Water Reservoir
 Sectional View
 PROJECT
 Project Name, Country

DRAWN BY
 B. Harvey - 11/10/16
 APPROVED BY
 M. Burt - 15/11/16
 SCALE
 1:30

UNITS
 metres
 SHEET
 1 of 3
 DATE PUBLISHED
 15/11/16



Plan View



NOTES

1. Ensure concrete is not over-watered = risk of cracking (no more than 1/4 height reduction during slump test).
2. Slabs to be cast in one continuous operation. All concrete works to be well rodded (preferably vibrated).
3. Ensure all concrete works are kept damp and out of direct sunlight for at least 7 days while curing.
4. Valve boxes should be sized according to inlet and outlet arrangements.

D-312

TITLE
10m³ Square Water Reservoir
Plan View and General Layout
PROJECT
Project Name, Country

DRAWN BY
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SCALE
1:40

UNITS
metres
SHEET
2 of 3
DATE PUBLISHED
15/11/16



Pipe Assembly Detail

3" DELIVERY PIPE ASSEMBLY

220cm x 1" Ø GI Pipe

30cm x 3" Ø GI Pipe

3" GI Elbow

85cm x 3" Ø GI Pipe

3" Gate Valve

3" GI Nipple

3" GI Tee

90mm Ø PE Pipe Adaptor (Male)

90mm Ø PE Pipe

3" x 1" Ø GI Reducer (M-F)

1" GI Nipple

1" GI Elbow

110cm x 1" Ø GI Pipe

1" GI Elbow

25cm x 1" Ø GI Pipe

3" DRAINAGE PIPE ASSEMBLY

DRAINAGE PIPE ASSEMBLY EXACTLY THE SAME AS DELIVERY PIPE EXCEPT VERTICAL 3" DRAIN PIPE IS 5CM SHORTER.

2" INLET PIPE ASSEMBLY

16cm x 2" Ø GI Pipe

2" GI Elbow

2" GI Socket

2" Float Valve Assembly

105cm x 2" Ø GI Pipe

2" Ø GI Union (F-F)

105cm x 2" Ø GI Pipe

2" GI Elbow

35cm x 2" Ø GI Pipe

3" Gate Valve

90mm Ø PE Pipe Adaptor (Male)

63mm Ø PE Pipe

Notes

1. Alternative valve and pipe arrangements may be used if the inlet or outlet pipe diameters are different.
2. Valves to be positioned centrally. Valve box dimensions may be increased or reduced to match valve assembly arrangements.
3. The bottom of the valve box should be kept open (i.e. filled with compacted hardcore) to allow any excess water to drain.

TITLE

10m³ Square Water Reservoir
Pipe Assembly Detail

PROJECT

Project Name, Country

DRAWN BY

B. Harvey - 11/10/16

APPROVED BY

M. Burt - 15/11/16

SCALE

1:25

UNITS

metres

SHEET

3 of 3

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15/11/16

STEP-BY-STEP ASSEMBLY DRAWINGS

Please follow the step-by-step procedure for the 30m³ water reservoir D313/2016a.

Note that the process is similar but the dimensions will be different.

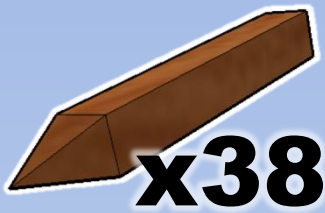


BILL OF QUANTITIES

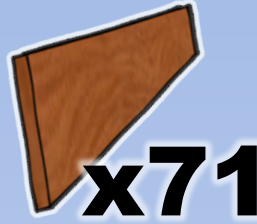
Description	QTY
Wooden Stakes (65cm x 5cm x 5cm)	46 pcs
Wooden Planks (4m x 20cm x 2.5cm)	71 pcs
Wooden Posts (4m x 5cm x 5cm)	36 pcs
Wooden Beams (4m x 5cm x 2.5cm)	5 pcs
Nails (6cm Galvanized)	3 kg
Nails (8cm Galvanized)	1 kg
High Tensile Steel Weld-Mesh Ø6mm 20cm x 20cm	17 m ²
High Tensile Steel Weld-Mesh Ø12mm 17cm x 17cm	29 m ²
High Tensile Steel Weld-Mesh Ø8mm 17cm x 17cm	8.5 m ²
Tying Wire Ø 1mm	0.5 kg
Plastic Sheeting	10 m ²
Inlet Pipe Assembly (2" Gate Valve, 2" GI Pipe x 35cm, 2" GI Elbow, 2" GI Pipe x 105cm, 2" GI Union, 2" GI Pipe x 105cm, 2" GI Elbow, 2" GI Pipe x 16cm, 2" GI Socket, 2" Float Valve)	1 pc
Outlet Pipe Assembly (3" GI Tee, 3" GI Nipple, 3" Gate Valve, 3" GI Pipe x 85cm, 3" GI Elbow, 3" GI Pipe x 105cm, 3" GI Pipe x 30cm, 3" – 1" GI Reducer (M-F), 1" GI Nipple, 2" GI Elbow, 1" GI Pipe x 110cm, 1" GI Pipe x 220cm)	1 pc
Drain Pipe Assembly (3" GI Tee, 3" GI Nipple, 3" Gate Valve, 3" GI Pipe x 85cm, 3" GI Elbow, 3" GI Pipe x 105cm, 3" GI Pipe x 25cm, 3" – 1" GI Reducer (M-F), 1" GI Nipple, 2" GI Elbow, 1" GI Pipe x 110cm, 1" GI Pipe x 220cm)	1 pc
Metallic Valve Box Covers (70cm x 70cm x 2mm)	4 pcs
Coarse Sand	4.5 m ³
Coarse Gravel (12mm – 25mm)	4.6 m ³
Cement (50kg sacks)	40 sacks
Compacted Hardcore Sub-Base	1.9 m ³

Bill of Quantities

1. Wooden Stakes (pc)
5cm x 5cm x 65cm



2. Wooden Planks (pc)
2.5cm x 20 cm x 4m



3. Wooden Posts (pc)
5cm x 5cm x 4m



4. Wooden Beams (pc)
10cm x 5 cm x 4m



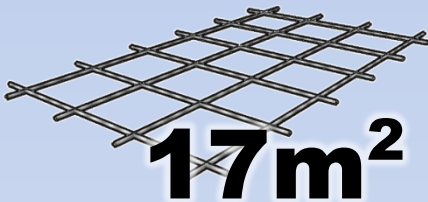
5. Nails 6cm (kg)



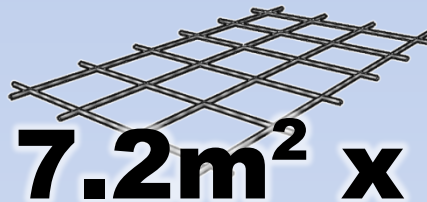
6. Nails 8cm (kg)



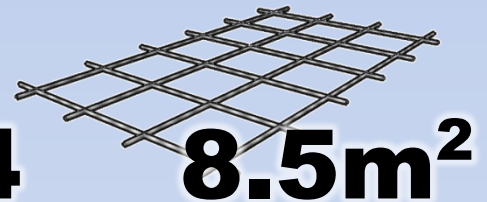
7. Steel Weld-Mesh
Ø6mm x 20cm x
20cm



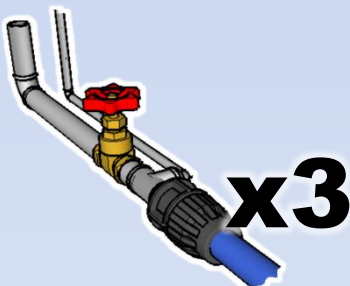
8. Steel Weld-Mesh
Ø12mm x 17cm x
17cm



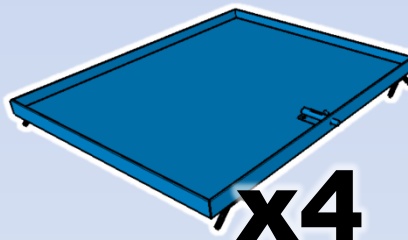
9. Steel Weld-Mesh
Ø8mm x 17cm x
17cm



10. Valve and Pipe
Assemblies (pc)



11. Metallic Covers 70cm
x 70cm x 2mm



12. Cement 50kg (sacks)



13. Sand (m3)



14. Gravel (m3)



15. Cement 50kg (sacks)



SPECIFICATIONS FOR CONSTRUCTION OF WATER SUPPLY RELATED INFRASTRUCTURE IN REFUGEE SETTINGS

300 SCOPE

300.1 These design guidelines specifically define the quality of materials and workmanship to be used when constructing water supply related infrastructure in refugee settings. A description of principles of water supply programmes in refugee settings, in addition to technical options and their advantages and disadvantages, can be found in the UNHCR WASH Manual.

301 SITE SELECTION

301.1 A basic requirement is that the site selected for water supply related infrastructure is free from the risk of high winds, flooding, subsidence, or erosion.

302 PREVENTION OF SURFACE OR GROUNDWATER CONTAMINATION

302.1 UNHCR and WASH actors must ensure that all water supply related infrastructure including treatment systems and soakaway systems do not contaminate surface water or shallow groundwater sources. Risks are generally low and related to contamination from water treatment chemicals, water treatment by-products and sludges and contamination from wastewater.

302.2 All tapstands, or other water collection and usage points, should be equipped with adequately designed soakage systems located at least 30 metres away from groundwater sources. The bottom of any pit or soakaway must be at least 1.5m above the highest average groundwater table level. These distances should be increased for fissured rocks and limestone.

302.3 In some situations temporary groundwater contamination from on-site soakage systems may not be of immediate concern if the groundwater is non-potable. An example of this can be found in areas where groundwater is heavily saline beyond drinking water health limits of 1,500µS/cm². In all cases, local legislation should be respected.

303 SPECIFICATIONS OF COMMON CONSTRUCTION MATERIALS

303.1 Gravel used for constructing concrete footings and slabs must be clean and free from mud, dust and plant material. Rounded aggregates are preferred. If crushed stone aggregates are used then additional cement should be added (see table below). UNHCR and WASH actors must ensure that only aggregates between 12mm and 25mm are used to prevent inter granular crack propagation across load bearing concrete structures (e.g. tapstand floor slabs, water reservoir roof slabs, and columns used in reinforced concrete water towers) and to ensure an adequate covering of steel reinforcement bars.

- 303.2 Sand used for water supply related concrete works should be coarse (no fines), clean and free from mud, dust and plant material.
- 303.3 Water should be non-saline and free from organic matter.
- 303.4 Cement must be fresh (manufactured in the last three months) dry, and should be stored in a safe, dry, place at least 15cm off the ground.
- 303.5 Reinforcement bars should be free from rust and of the correct type and size for concrete construction work (typically a characteristic yield stress of at least 210 N/mm²). Steel reinforcement should be placed as per the designs (typically 7/8 of the slab or wall thickness) to ensure the bars function correctly in tension. All bars should have at least 12mm concrete covering under every bar.
- 303.6 Concrete mix strengths Mass concrete footings should be cast with a 1:3:6 concrete mixture with a minimum cement dosage of 240 kg/m³. Concrete slabs and drainage channels should be cast as single continuous structures using a 1:2:4 concrete mixture with a minimum cement dosage of 320kg/m³. Water retaining structures (reservoir walls and bases) should be cast using a waterproof 1:1.5:3 concrete mixture (note that 1:2:4 is not waterproof) with a minimum cement dosage of 380kg/m³. Additional cement should be added if hand mixing (see table below). Care should be taken to ensure that concrete mixtures are not over watered (bucket slump test should show no greater than ¼ reduction in the slump height). Cast concrete works should be immediately covered with plastic sheeting, straw, cement bags, sacking or leaves to keep the concrete moist and cool during the full curing period. All concrete should be well rodded (ideally vibrated) to remove air voids. The concrete should be cured with frequent watering at least twice daily for at least 10 days before use.

	Quantity of Cement in Kg					
Concrete Mix	Machine Mixing		Hand Mixing		Coarse Dry Sand (m ³)	Aggregate 12mm – 25mm (m ³)
	Gravel	Broken Stone	Gravel	Broken Stone		
1:1.5:3	370	390	380	400	0.42	0.84
1:2:4	290	310	300	320	0.45	0.90
1:3:6	190	210	200	220	0.46	0.92

Source: Indian Civil Engineer's Handbook (Khanna, 2001)

- 303.7 Cement plasters Interior and exterior plasters for water reservoirs should be applied as three layers as follows:
- 6mm 1:4 splatterdash
 - 10mm 1:3 rough finish
 - 10mm 1:2 smooth float

Each layer should preferably be applied when the previously layer is still 'green' (not fully cured). Each layer should be thoroughly wetted and the previously layer keyed (scratched) to ensure proper bonding. All interior plasters of water retaining structures should mixed with sikalite

waterproofing compound at a dosage of 1kg per sack (50kg) of cement. The quantities of cement and sand for a 100m² area of cement plaster can be found in the table below.

	100m ² 6mm thick		100m ² 12mm thick	
	Cement (kg)	Sand (m3)	Cement (kg)	Sand (m3)
1:4 splatterdash	274	0.766	- - -	- - -
1:3 rough finish	- - -	- - -	734	1.541
1:2 smooth float	- - -	- - -	979	1.371

Source: Indian Civil Engineer's Handbook (Khanna, 2001)

304 SOAKAGE PIT SIZING BASED ON SOIL INFILTRATION RATES

- 304.1 The sizing of soakage pits, trenches and drain fields is dependent upon local site soil infiltration rates, the number of users and the quantity of waste water that is expected to be generated per person. Soakage pit dimensions should be determined by on-site soil infiltration tests (see Appendix 20 of Engineering in Emergencies. Alternatively refer to the table of typical soil infiltration rates on page 213 of the UNHCR WASH Manual). Soakage pits for wastewater from showers or septic tanks are likely to be much bigger than those for wastage from tapstands (see table below). In some cases communal shower blocks and septic tank installations may require drain fields rather than soakage pits.

	Clean Water (litres/m2/day)	Wastewater (Sewage and Sullage) (litres/m2/day)
Sand	720 – 2,400	33 - 50
Sandy Loam	480 – 720	24
Silt Loam	240 - 480	18
Clay Loam	120 - 240	8
Clay	24 - 120	Unsuitable

Source: Engineering in Emergencies (RedR, 2010)

305 SLOPES FOR WATER COLLECTION POINTS AND DRAINAGE CHANNELS

- 305.1 All water collection surfaces and drainage channels should be inclined to ensure that there is no standing water at water points. In general a slope of 1% should be sufficient to ensure that the water is gradually evacuated towards soakage pits.

306 SURFACE FINISHES AT PUBLIC WATER COLLECTION POINTS

- 306.1 All concrete surfaces at water collection points should be given a non-slip finish (the surfaces should be lightly brushed with a yard brush before the surface has cured) to ensure safe access by all users including the elderly, pregnant women, disabled users and small children. The surface should be sufficient to facilitate cleaning while also preventing slipping.

UNHCR STANDARD DESIGNS FOR WATER SUPPLY

The following technical designs for water supply are available from UNHCR.

D-300/2015a	Emergency Tapstand (Wooden Pallets) with Drainage
D-301/2015a	Post Emergency Tapstand Design (Rectangular Concrete)
D-302/2015a	Post Emergency Handpump Apron Design (Rectangular Concrete)
D-303/2015a	Post Emergency Hand Dug Well Apron Design (Circular Concrete)
D-304/2015a	Borehole Design (Fractured Rock)
D-305/2015a	Borehole Design (Alluvial Aquifer)
D-306/2015a	Emergency Raised Water Platform (Sandbags)
D-307/2015a	Emergency Raised Water Platform (Concrete Rings)
D-308/2015a	Emergency Raised Water Platform (Corrugated Steel Rings)
D-309/2015a	Elevated 6m Water Tower with 20m ³ , 25m ³ , 50m ³ 60m ³ and 75m ³ Water Reservoir (Reinforced Concrete)
D-310/2015a	Elevated Water Tower 15m high with 109m ³ Reservoir (Steel)
D-311/2015a	Post Emergency Elevated Water Tower 4m (Steel)
D-312/2015a	Square Water Reservoir 10m ³ (Reinforced Concrete)
D-313/2015a	Square Water Reservoir 30m ³ (Reinforced Concrete)
D-314/2015a	Square Water Reservoir 50m ³ (Reinforced Concrete)
D-315/2015a	Circular Water Reservoir 10m ³ (Reinforced Concrete)
D-316/2015a	Circular Water Reservoir 30m ³ (Reinforced Concrete)
D-317/2015a	Circular Water Reservoir 50m ³ (Reinforced Concrete)
D-318/2015a	Circular Water Reservoir 45m ³ (Ferrocement)
D-319/2015a	Circular Water Reservoir 75m ³ (Ferrocement)
D-320/2015a	Circular Water Reservoir 90m ³ (Ferrocement)

These designs may be found at <http://wash.unhcr.org/wash-technical-designs/>.

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