UNHCR Post Emergency Hand Dug Well Apron

D303-2015a

Tools and Guidance for Refugee Settings

UNHCR
The UN Refugee Agency

D-303/2015a

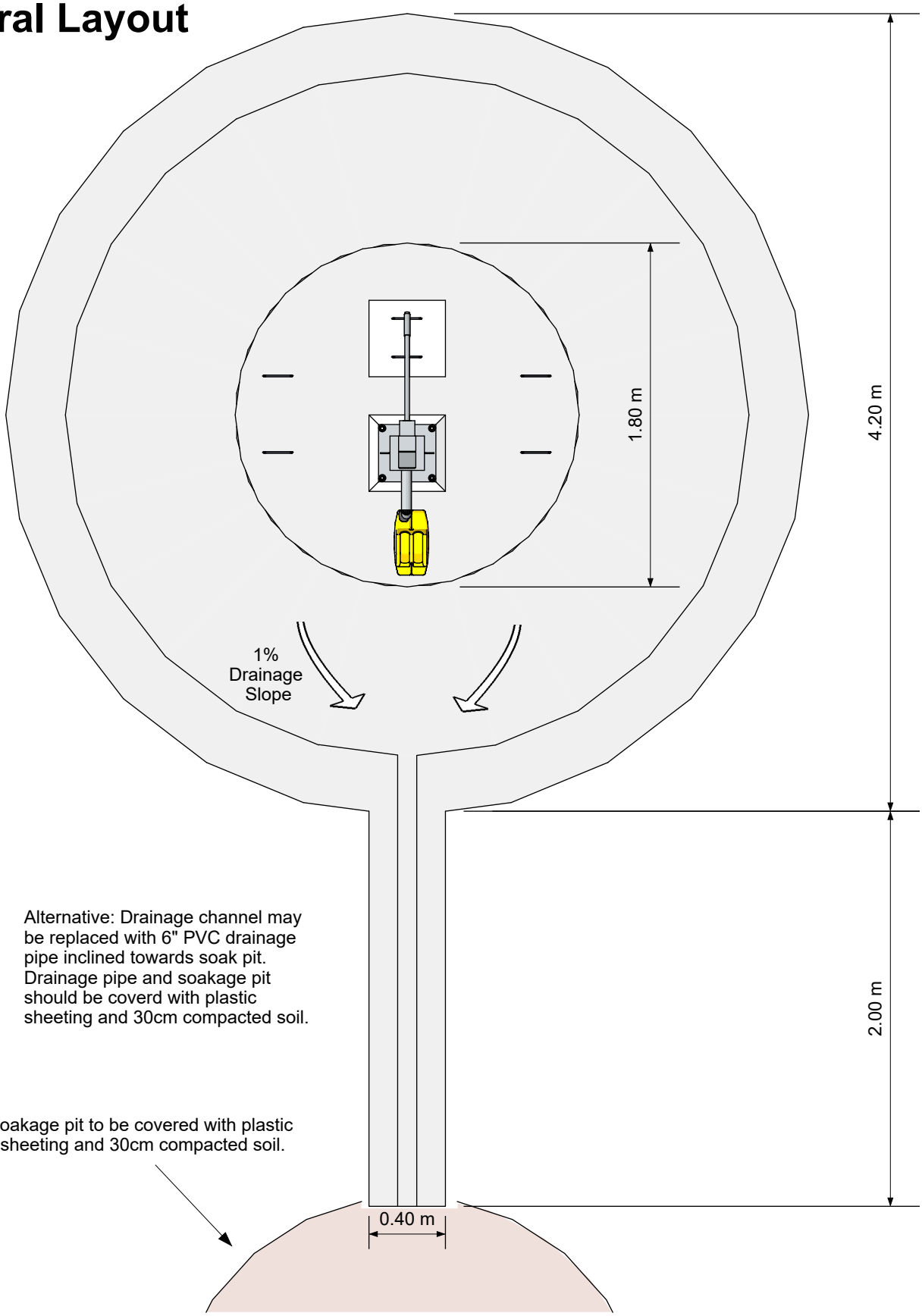
UNHCR Standardized Designs for Refugee Settings

Post Emergency Hand Dug Well Apron with Drainage

FOREWORD

These post emergency hand dug well apron 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 tapstand is based on a design shared by OXFAM GB.

General Layout



NOTES

1. Apron to be positioned centrally around hand dug well head.
2. Concrete surface to be finished with non-slip (lightly brushed) surface with 1% slope to soakage pit.
3. Soakage pit dimensions to be determined by on-site soil infiltration test (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).

D-303

TITLE

Hand Dug Well Apron

General Layout

PROJECT

Project Name, Country

DRAWN BY
B. Harvey - 11/10/15

APPROVED BY
M. Burt - 15/11/15

SCALE
1:30

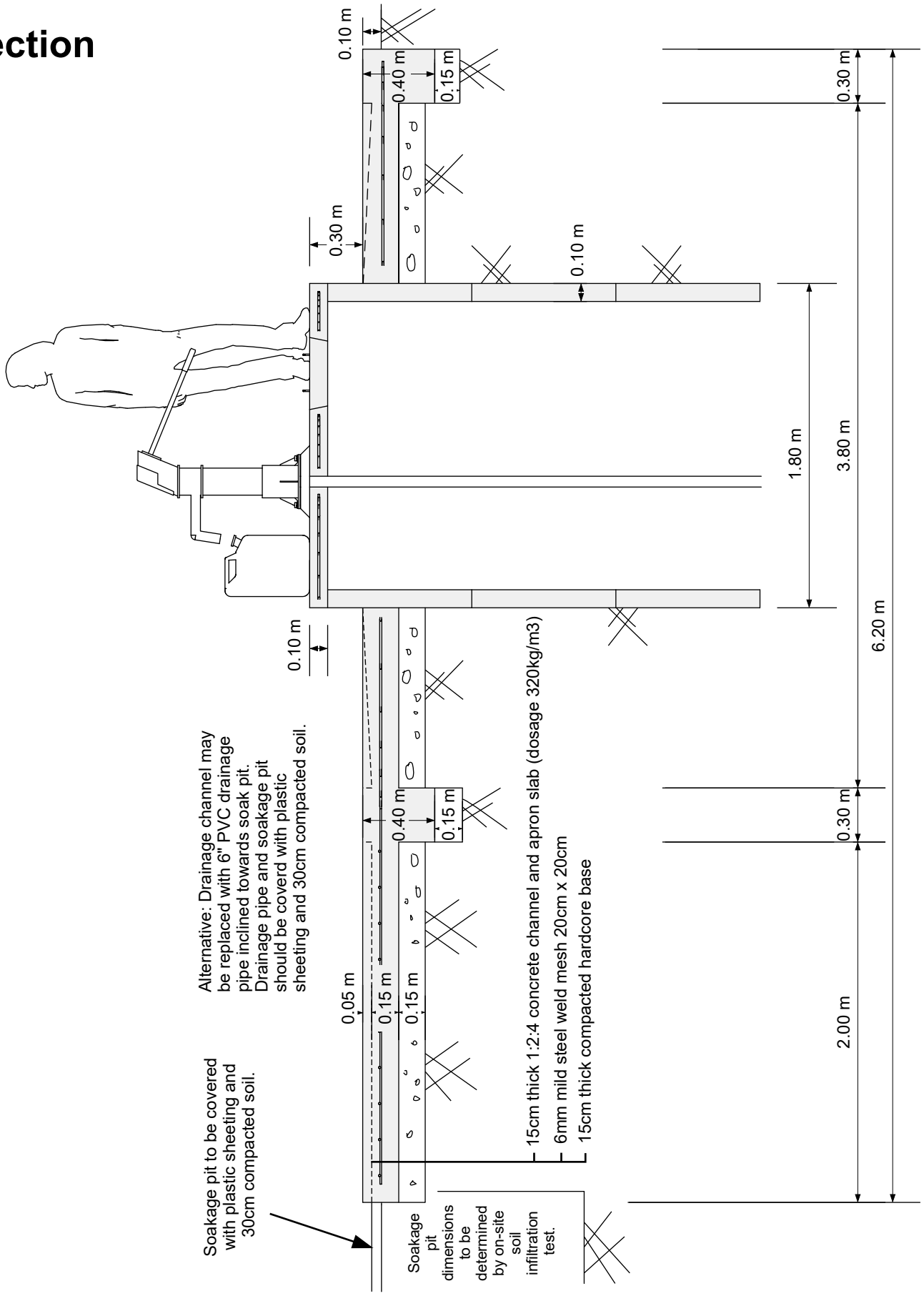
UNITS
metres

SHEET
1 of 4

DATE PUBLISHED
15/11/15

UNHCR
The UN Refugee Agency

Section



NOTES

1. Mass concrete footings 1:3:6 (min 240kg/m3 cement dosage). Slab concrete 1:2:4 (min 320kg/m3 cement dosage).
2. 15cm compacted hardcore layer to be covered with 1mm sand blinding before pouring concrete.
3. Slab reinforcement to consist of high tensile mild steel 6mm weld mesh 20cm x 20cm positioned 3cm above compacted hardcore.

D-303

TITLE
Hand Dug Well Apron
Section

PROJECT
Project Name, Country

DRAWN BY
B. Harvey - 11/10/15

APPROVED BY
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SCALE
1:30

UNITS
metres

SHEET
2 of 4

DATE PUBLISHED
15/11/15

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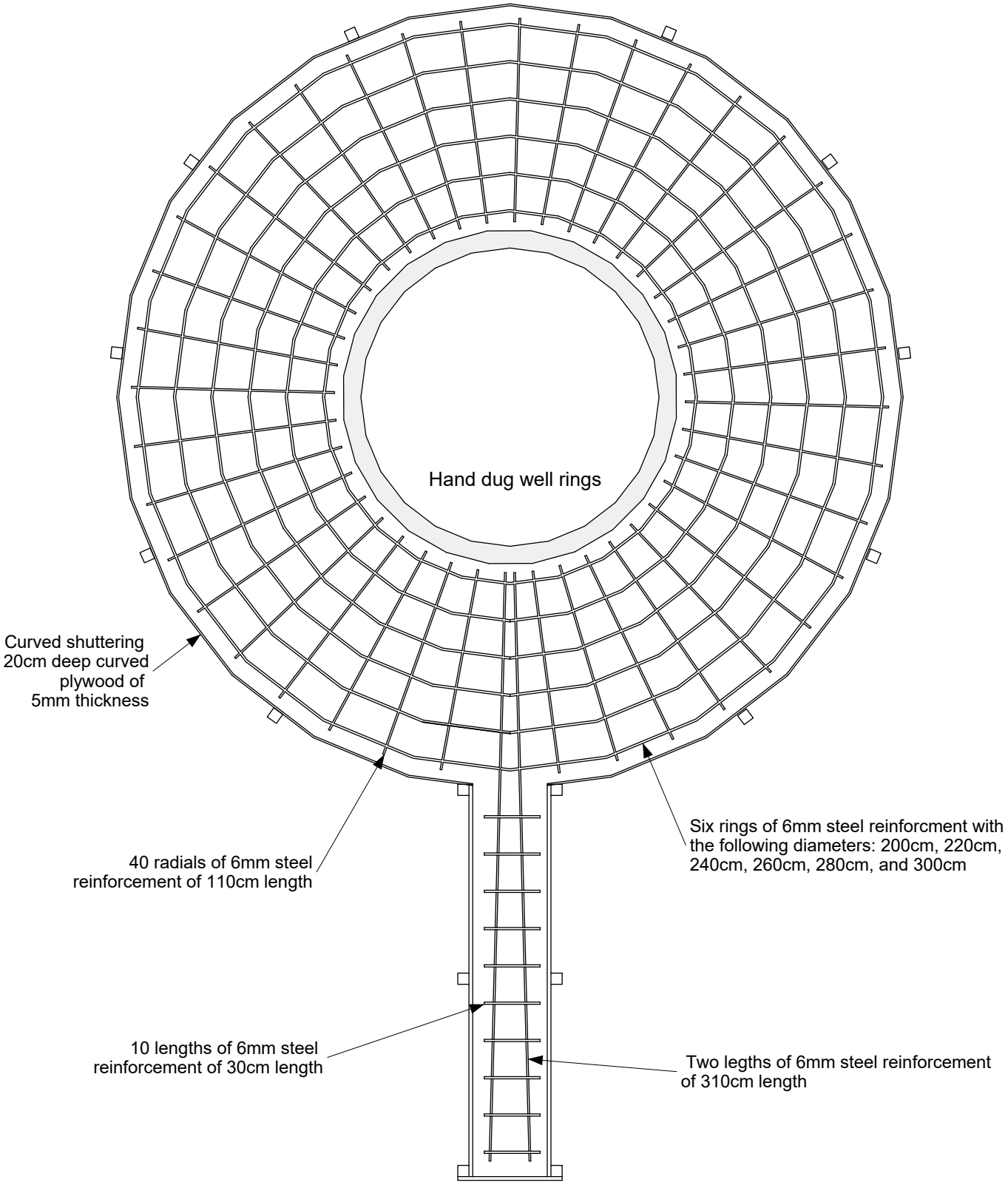
Rebar Layout



NOTES

1. Slab reinforcement to consist of high tensile mild steel of 6mm diameter spaced every 20cm x 20cm.
2. Reinforcement to be positioned 3cm above compacted hardcore.

D-303

TITLE

Hand Dug Well Apron

Rebar Layout

PROJECT

Project Name, Country

DRAWN BY
B. Harvey - 11/10/15

APPROVED BY
M. Burt - 15/11/15

SCALE
1:30

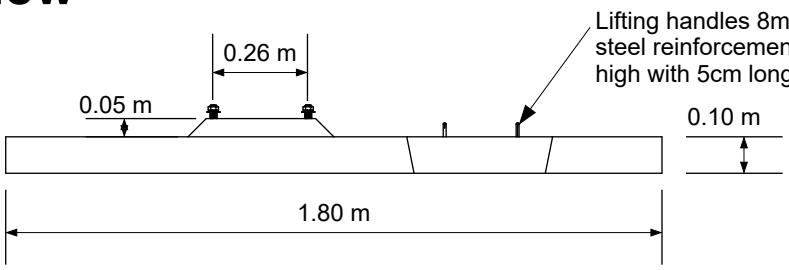
UNITS
metres

SHEET
3 of 4

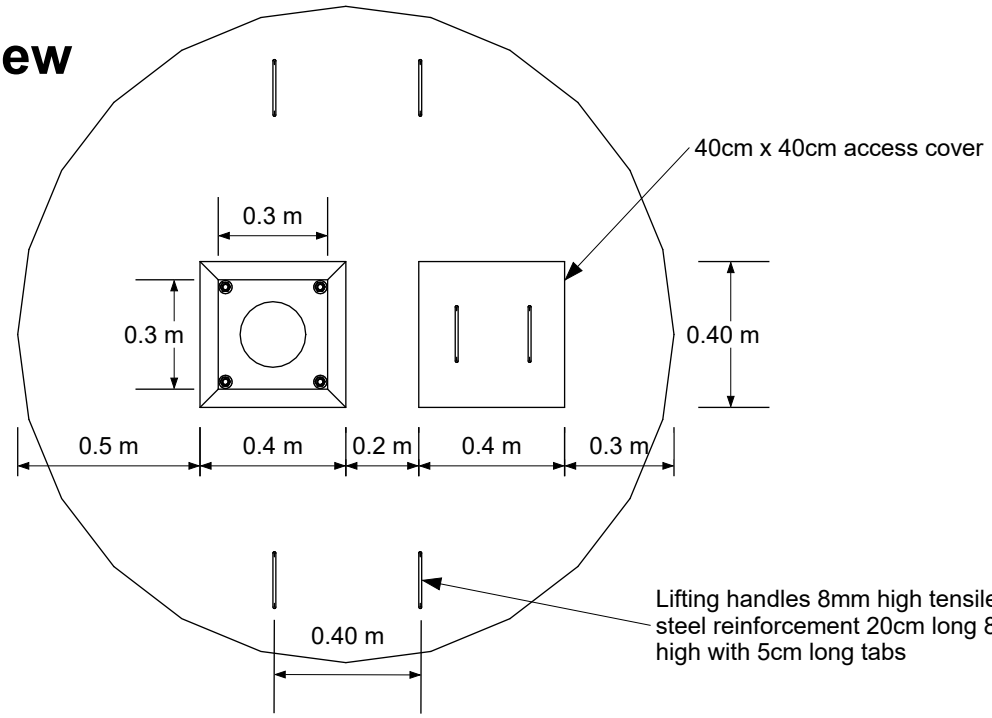
DATE PUBLISHED
15/11/15

UNHCR
The UN Refugee Agency

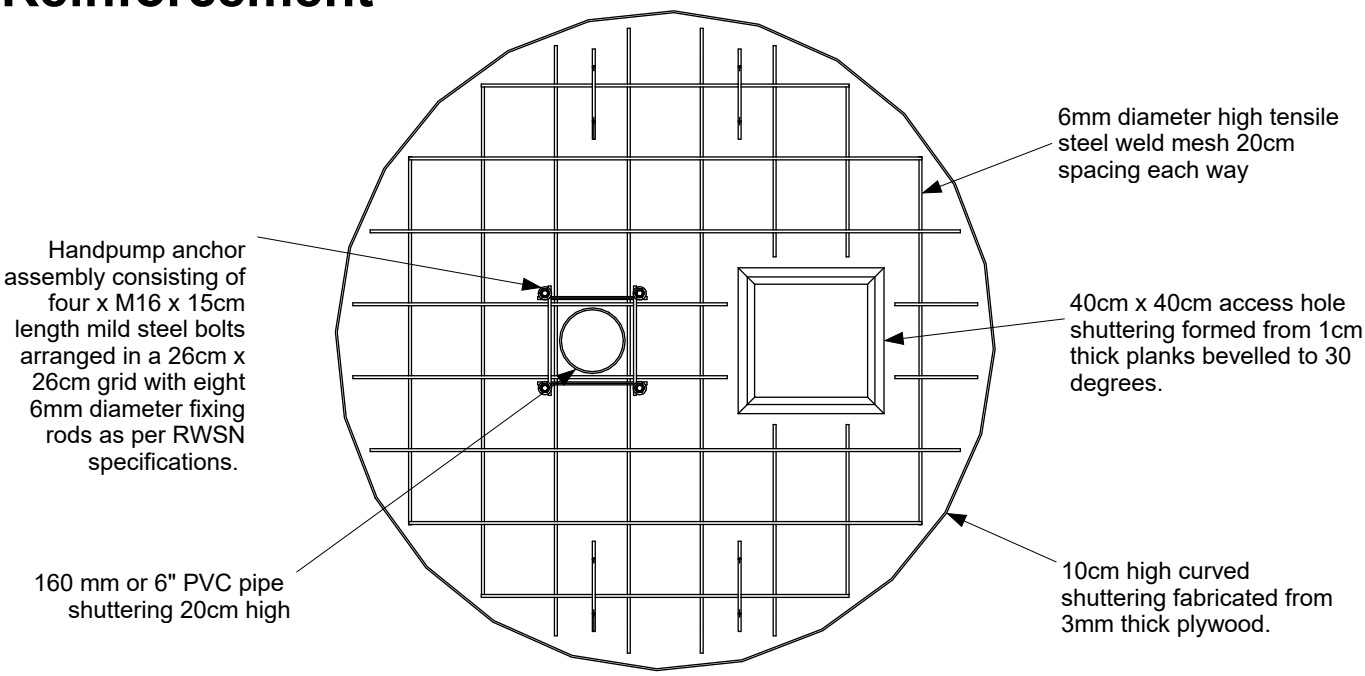
Cover Side View



Cover Top View



Reinforcement



D-303

TITLE
Hand Dug Well Apron
Cover Slab Detail

PROJECT
Project Name, Country

DRAWN BY
B. Harvey - 11/10/15

APPROVED BY
M. Burt - 15/11/15

SCALE
1:30

UNITS
metres

SHEET
4 of 4

DATE PUBLISHED
15/11/15

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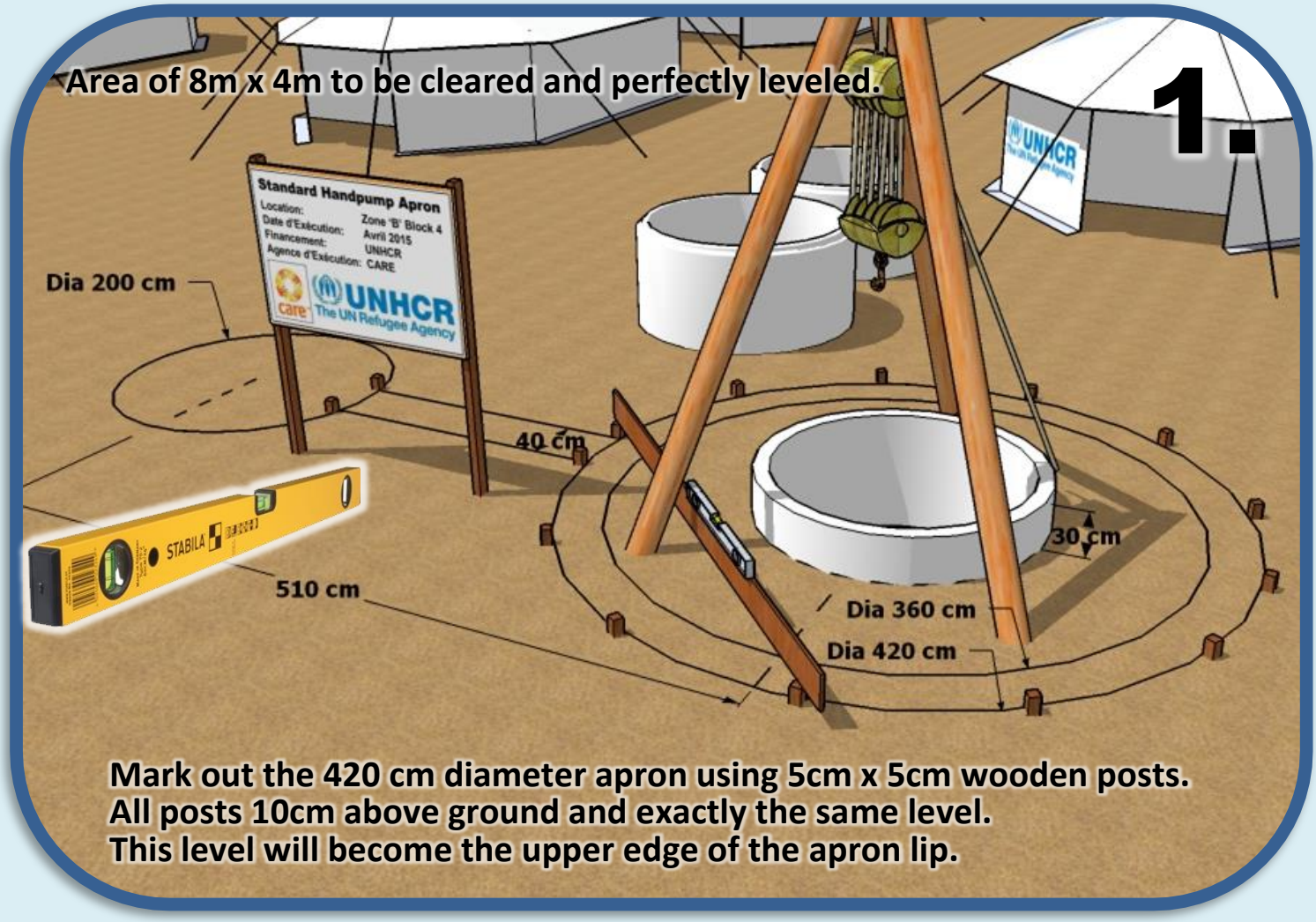
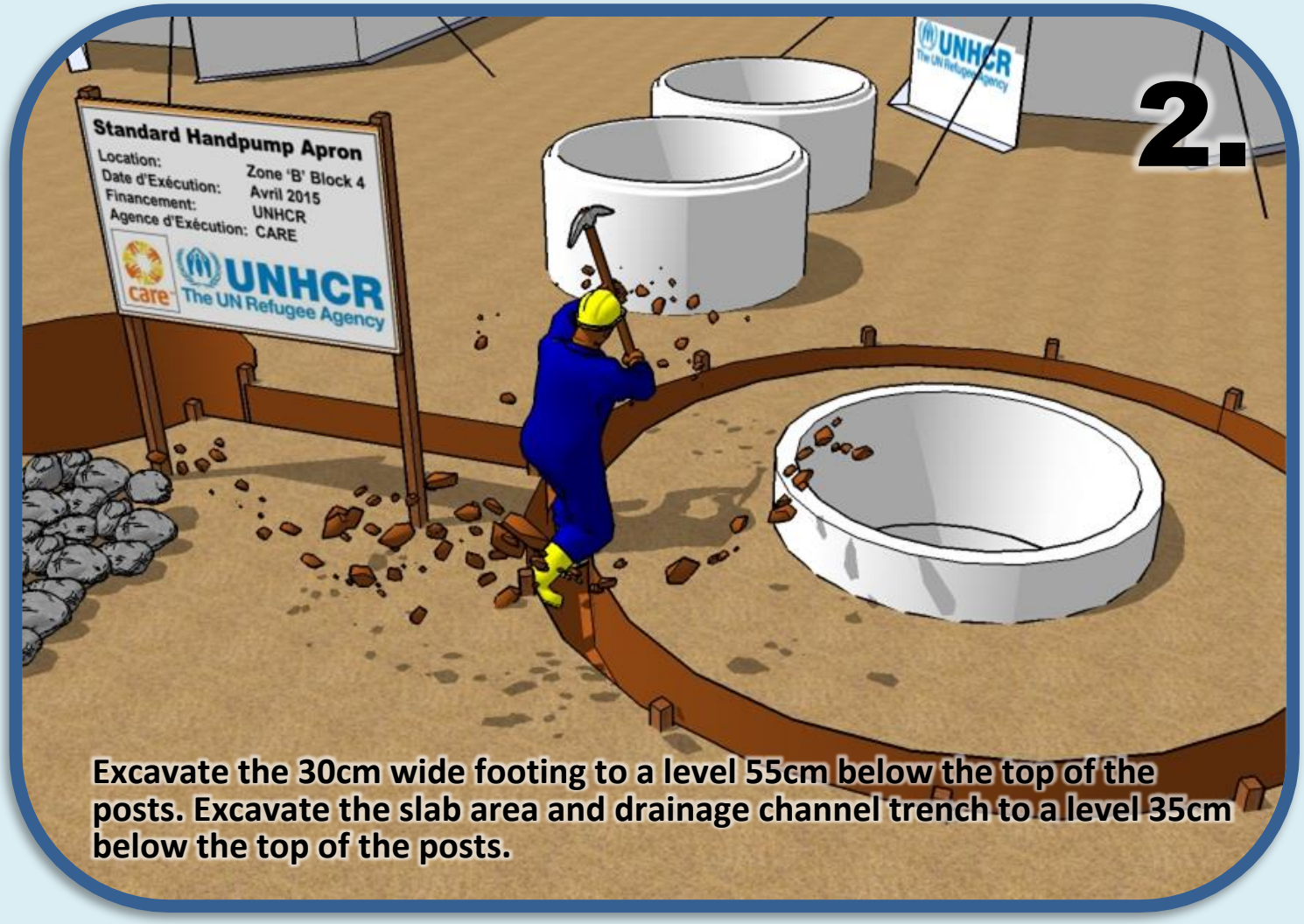
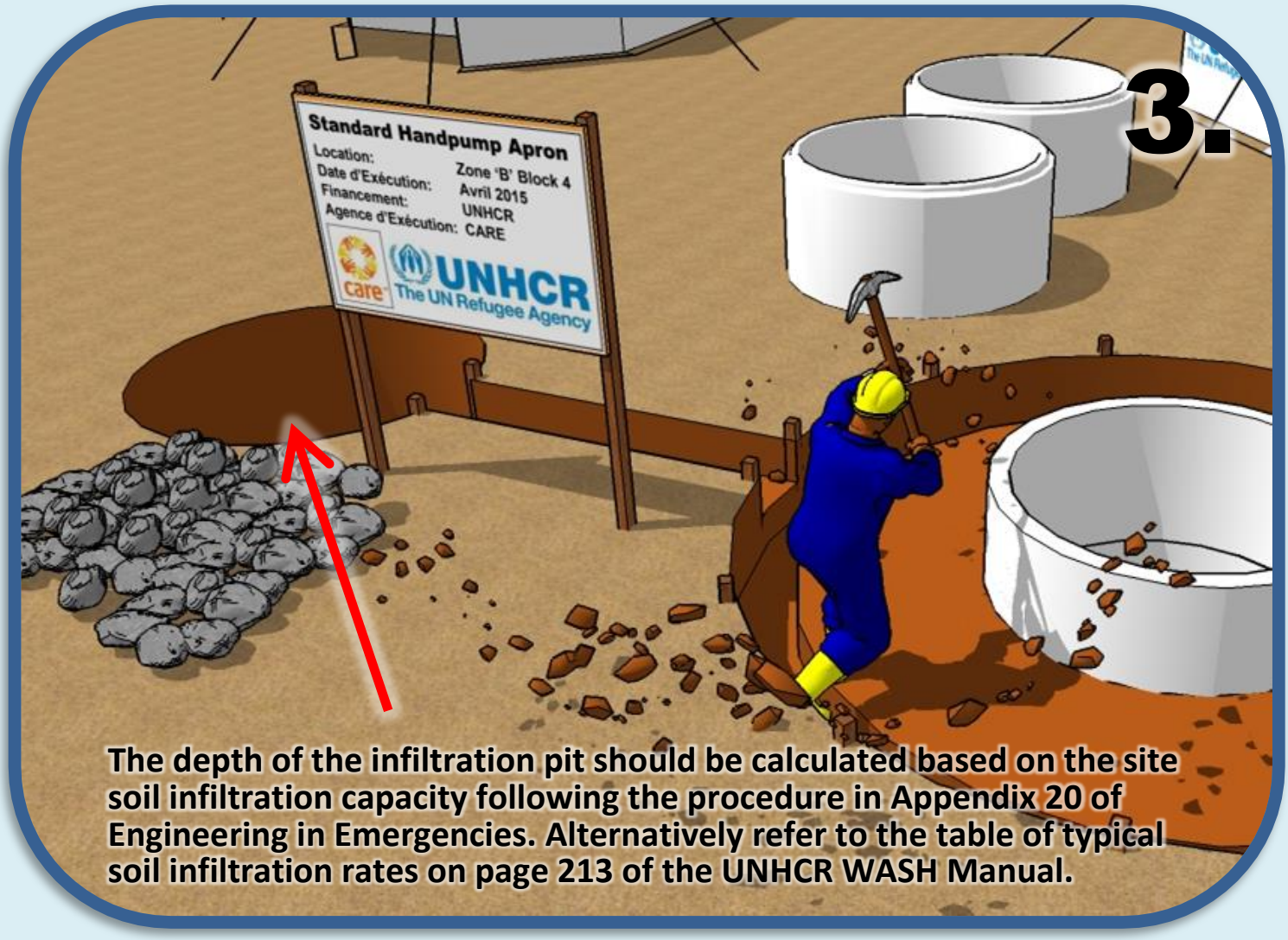
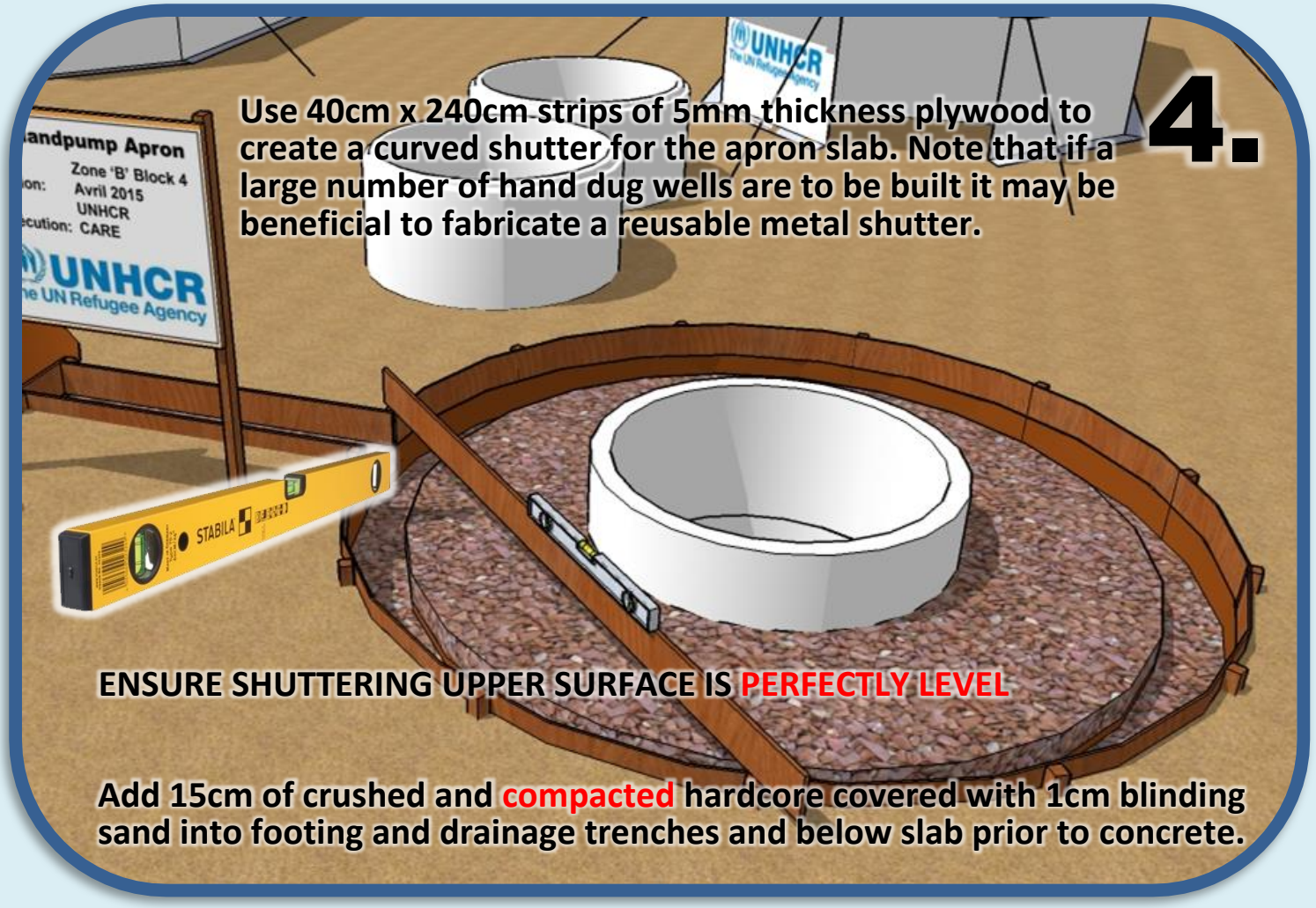

Area of 8m x 4m to be cleared and perfectly leveled.
1.
Standard Handpump Apron
Location: Zone 'B' Block 4
Date d'Exécution: Avril 2015
Financement: UNHCR
Agence d'Exécution: CARE
UNHCR
The UN Refugee Agency
Dia 200 cm
40 cm
30 cm
510 cm
Dia 360 cm
Dia 420 cm
Mark out the 420 cm diameter apron using 5cm x 5cm wooden posts.
All posts 10cm above ground and exactly the same level.
This level will become the upper edge of the apron lip.


2.
Standard Handpump Apron
Location: Zone 'B' Block 4
Date d'Exécution: Avril 2015
Financement: UNHCR
Agence d'Exécution: CARE
UNHCR
The UN Refugee Agency
Excavate the 30cm wide footing to a level 55cm below the top of the posts. Excavate the slab area and drainage channel trench to a level 35cm below the top of the posts.



3.

The depth of the infiltration pit should be calculated based on the site soil infiltration capacity following the procedure in Appendix 20 of Engineering in Emergencies. Alternatively refer to the table of typical soil infiltration rates on page 213 of the UNHCR WASH Manual.

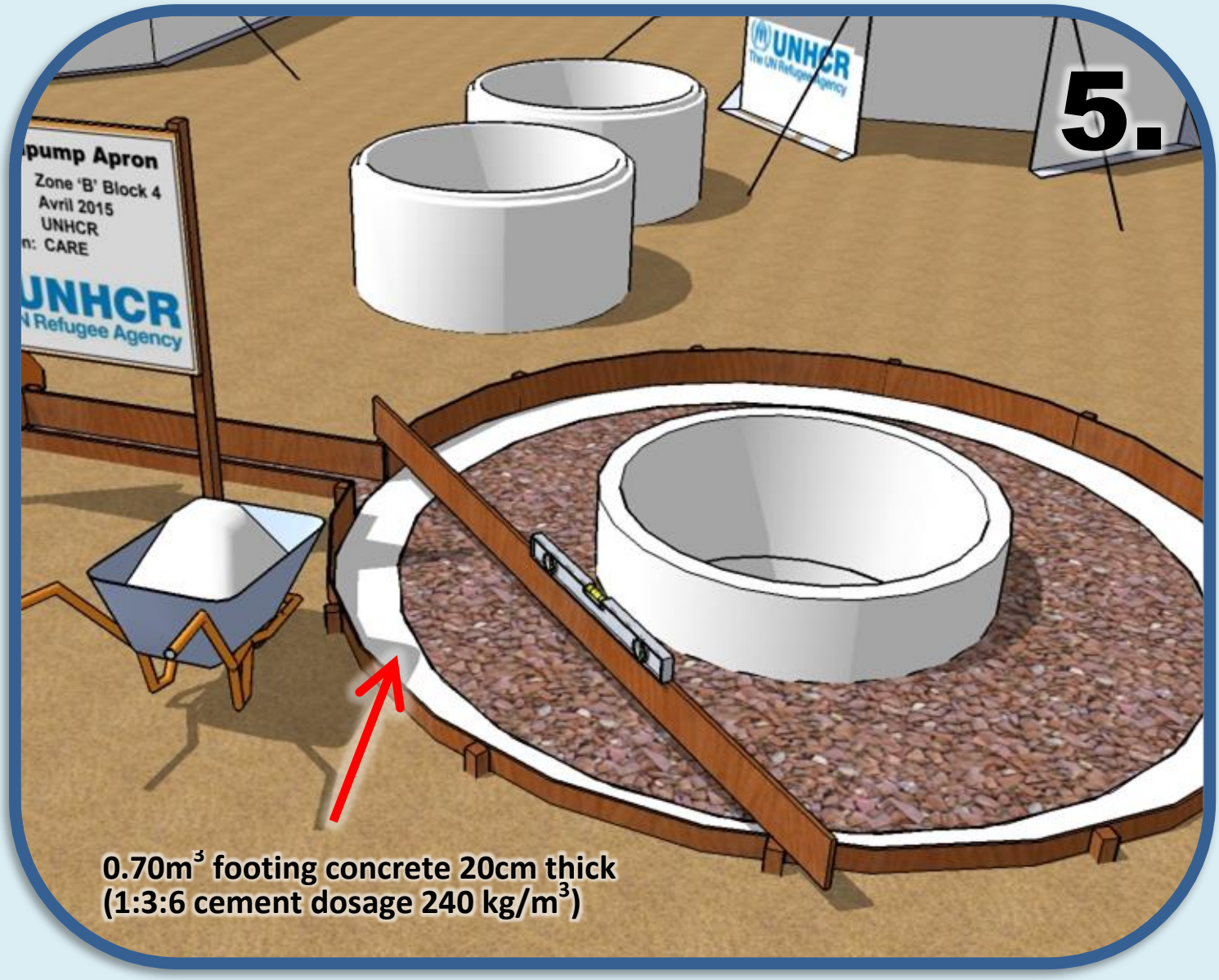


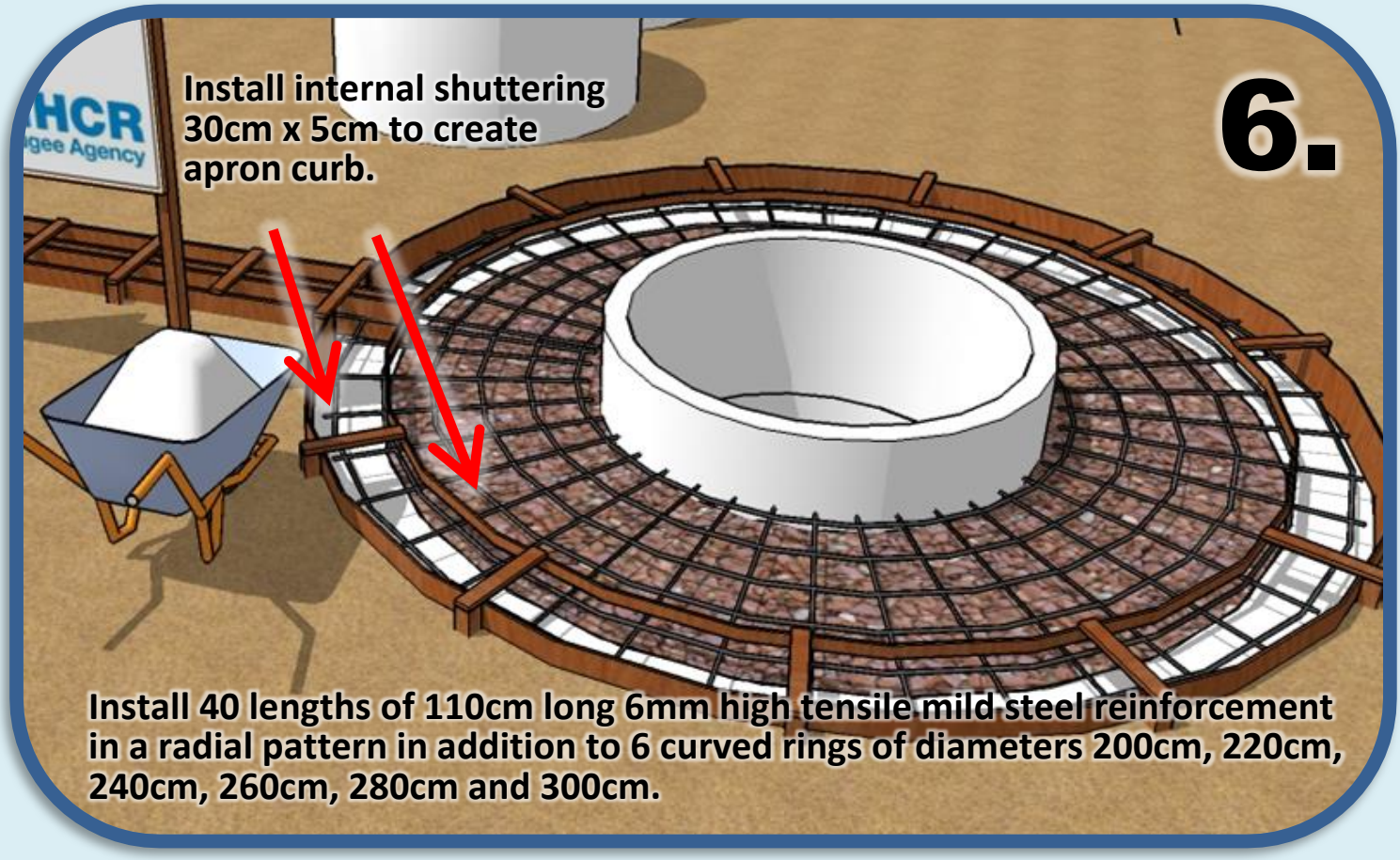
4.

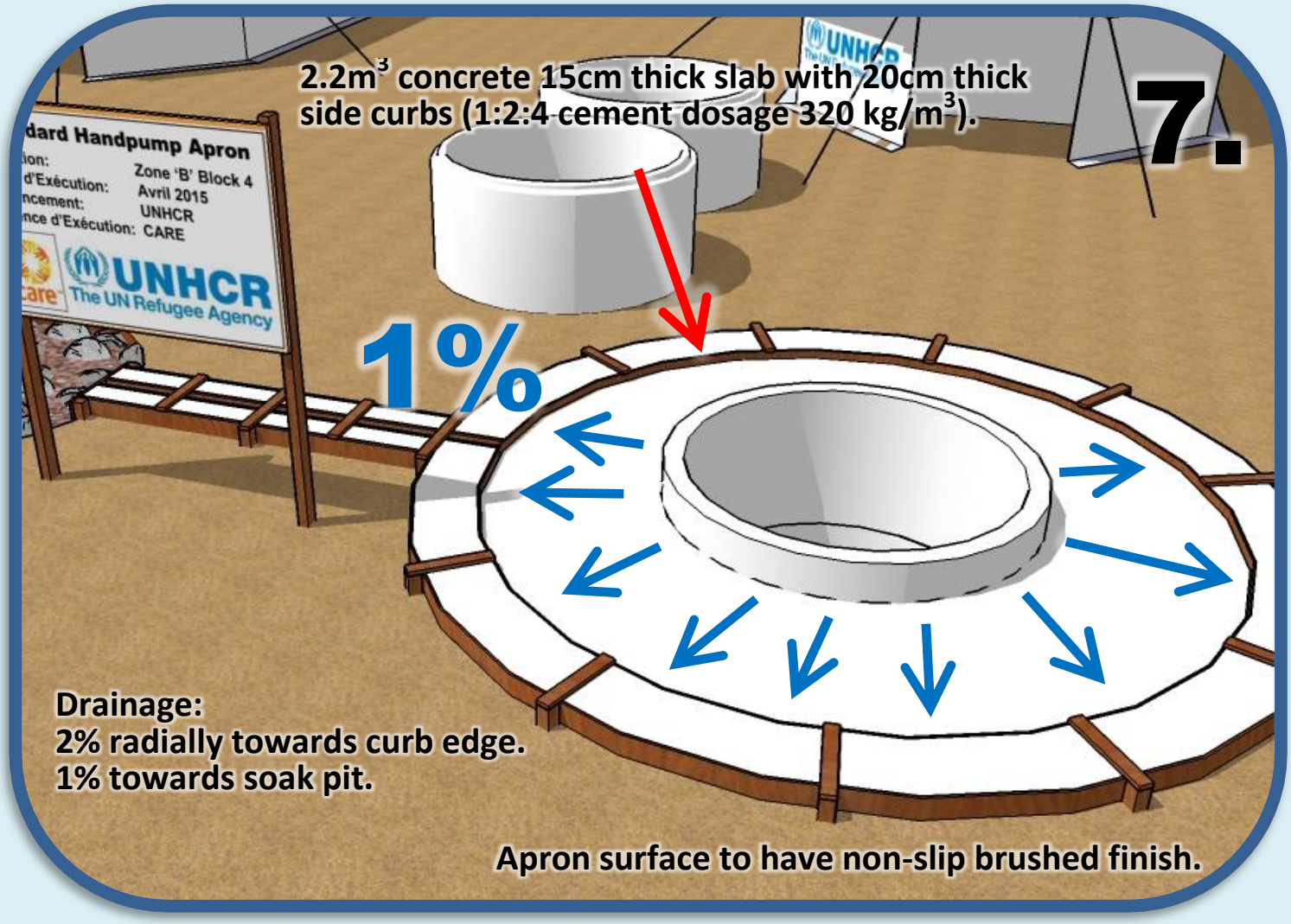
Use 40cm x 240cm strips of 5mm thickness plywood to create a curved shutter for the apron slab. Note that if a large number of hand dug wells are to be built it may be beneficial to fabricate a reusable metal shutter.

ENSURE SHUTTERING UPPER SURFACE IS PERFECTLY LEVEL

Add 15cm of crushed and compacted hardcore covered with 1cm blinding sand into footing and drainage trenches and below slab prior to concrete.


5.
pump Apron
Zone 'B' Block 4
Avril 2015
UNHCR
n: CARE
UNHCR
N Refugee Agency
UNHCR
0.70m³ footing concrete 20cm thick
(1:3:6 cement dosage 240 kg/m³)


6.
Install internal shuttering
30cm x 5cm to create
apron curb.
Install 40 lengths of 110cm long 6mm high tensile mild steel reinforcement
in a radial pattern in addition to 6 curved rings of diameters 200cm, 220cm,
240cm, 260cm, 280cm and 300cm.


2.2m³ concrete 15cm thick slab with 20cm thick side curbs (1:2:4 cement dosage 320 kg/m³).
7.
dard Handpump Apron
Zone 'B' Block 4
Avril 2015
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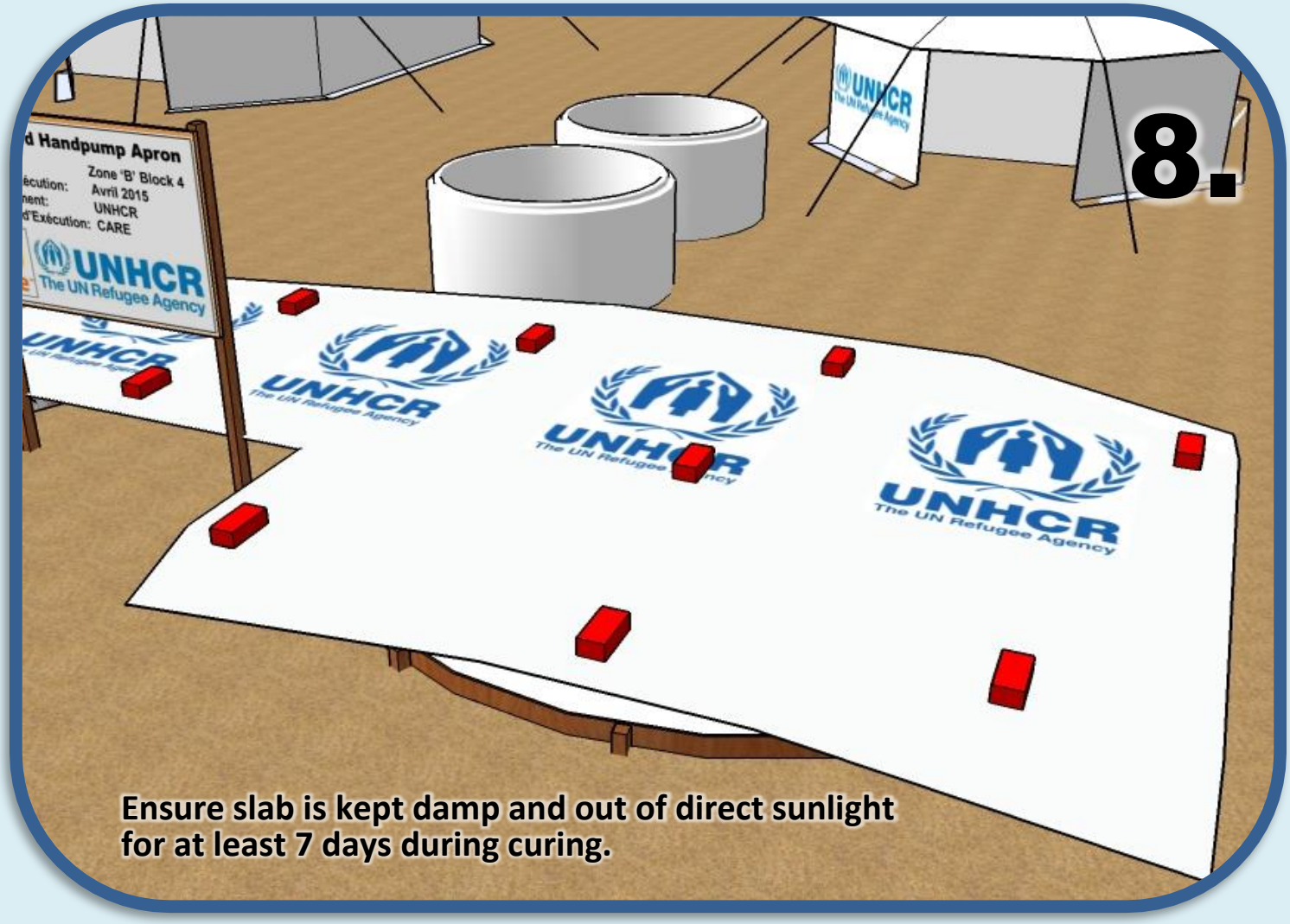
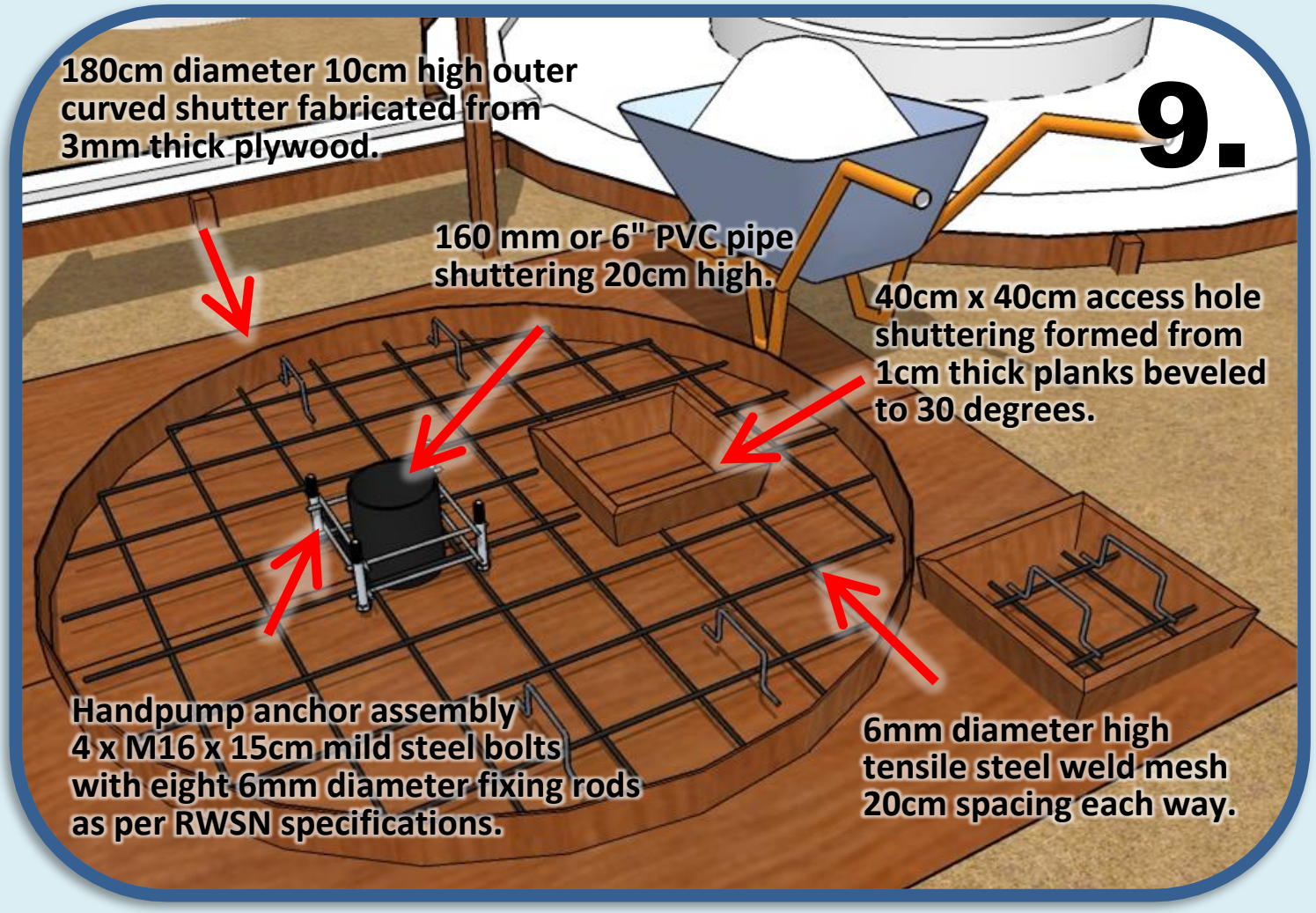
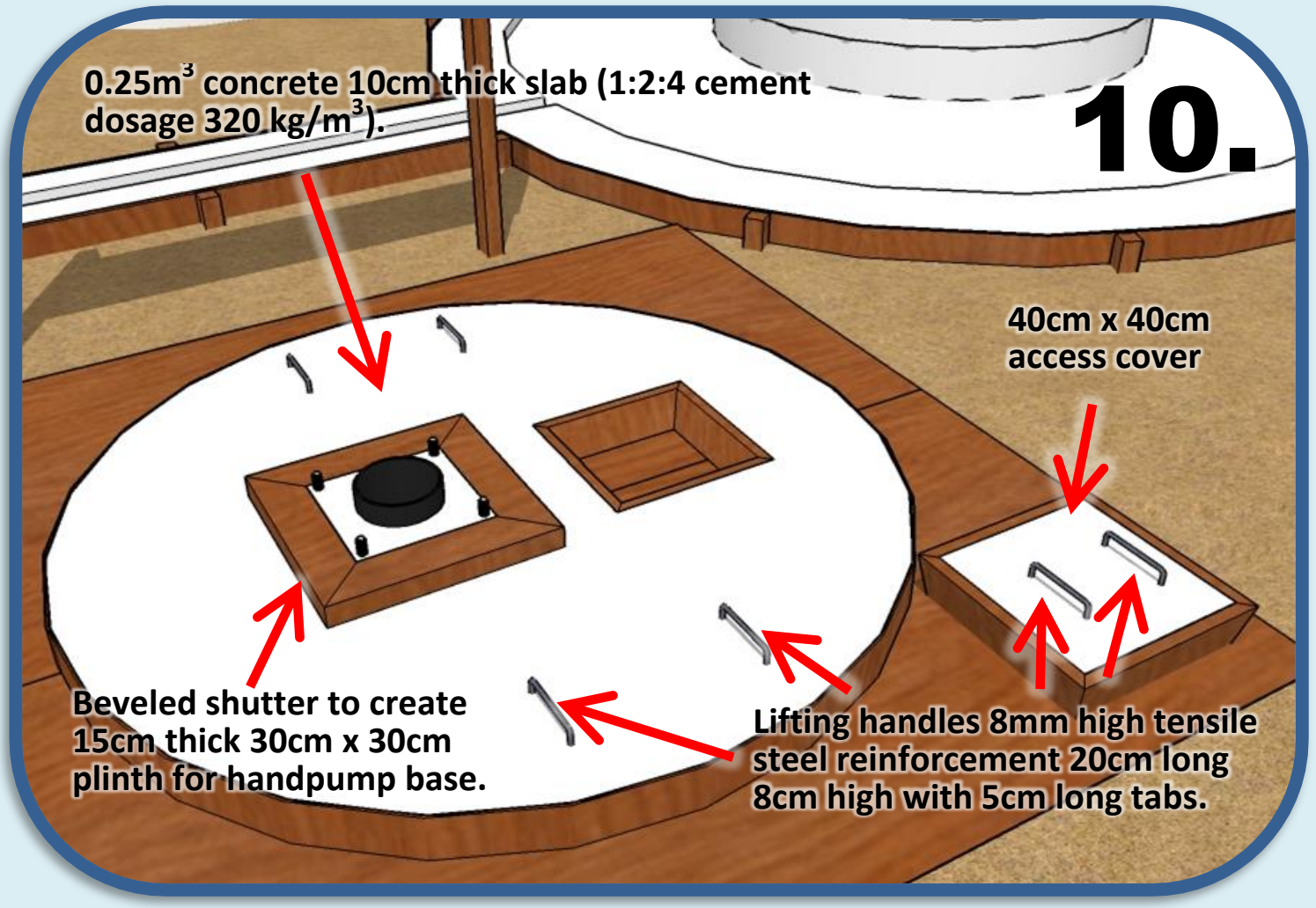
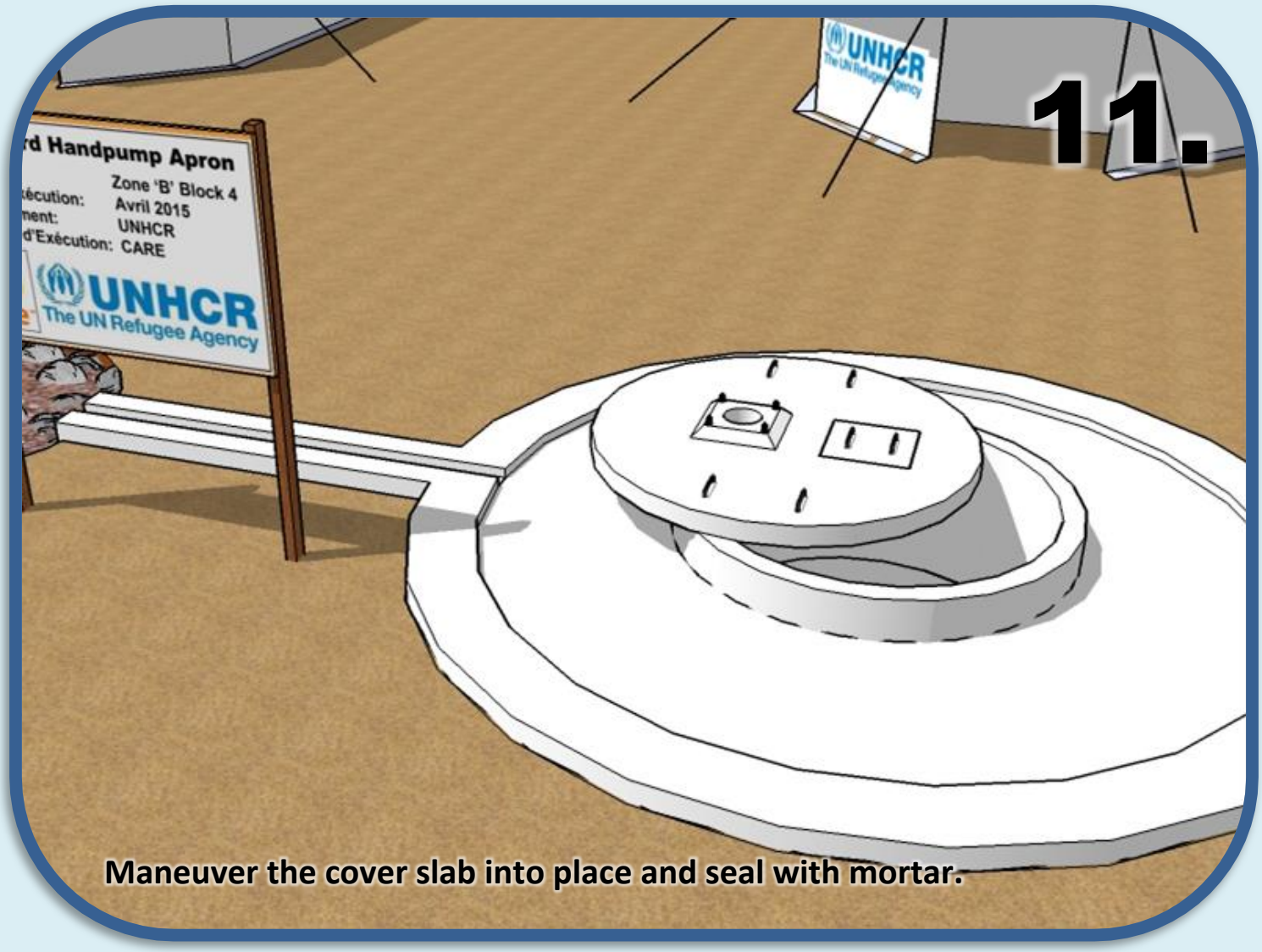
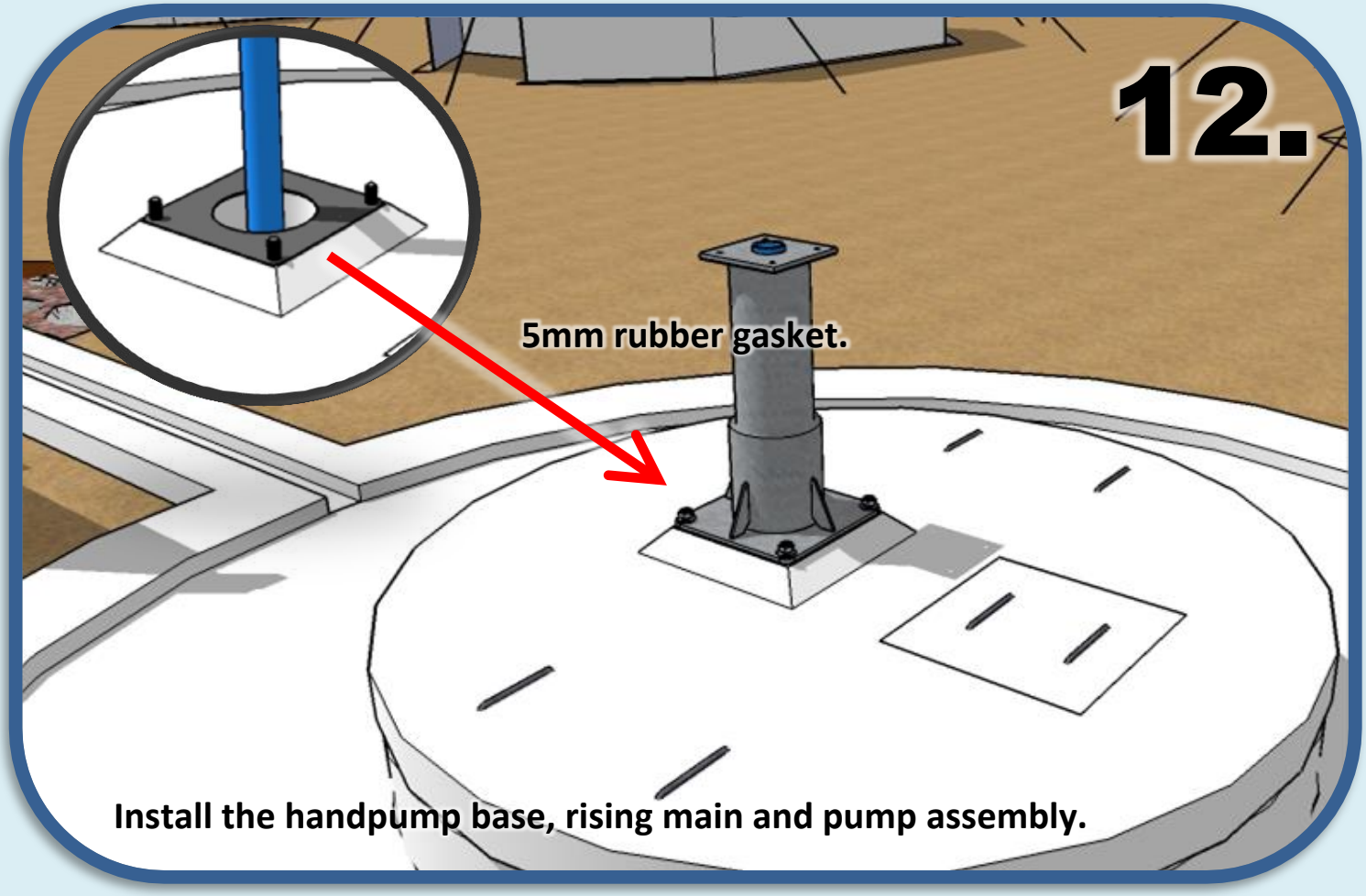
1%
Drainage:
2% radially towards curb edge.
1% towards soak pit.
Apron surface to have non-slip brushed finish.

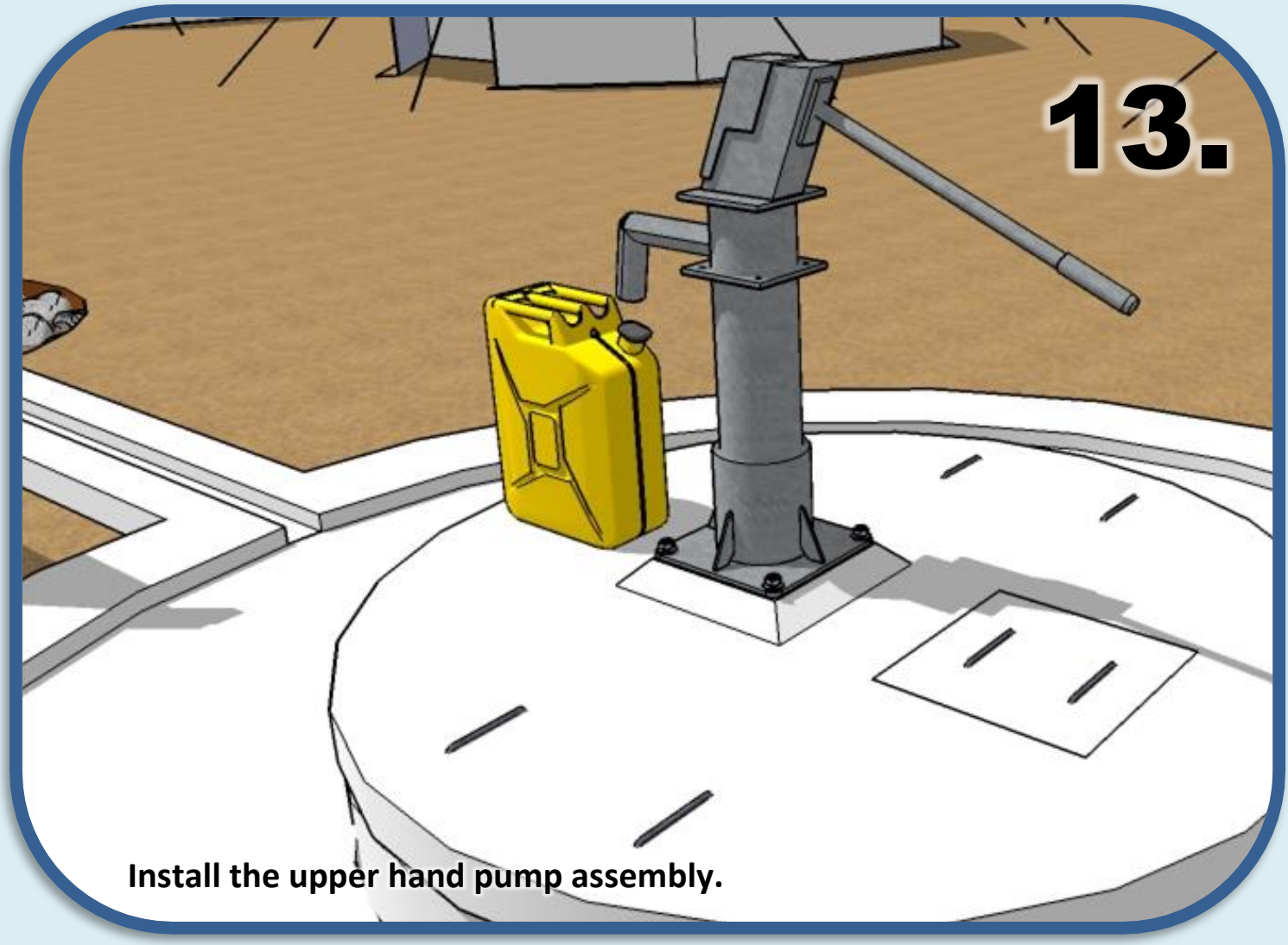

8.
Handpump Apron
Zone 'B' Block 4
Avril 2015
UNHCR
CARE
UNHCR
The UN Refugee Agency
Ensure slab is kept damp and out of direct sunlight
for at least 7 days during curing.

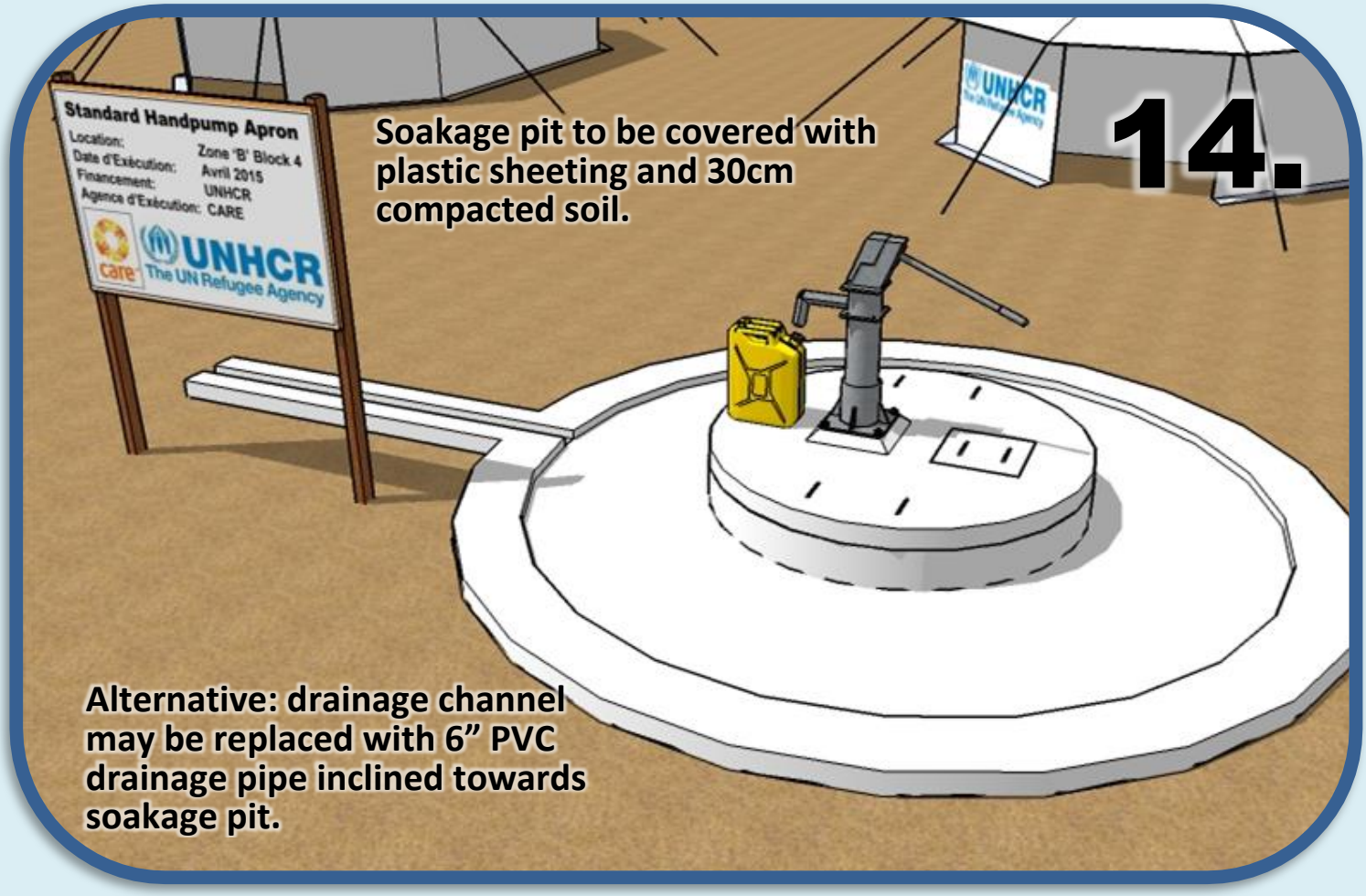

9.
180cm diameter 10cm high outer curved shutter fabricated from 3mm thick plywood.
160 mm or 6" PVC pipe shuttering 20cm high.
40cm x 40cm access hole shuttering formed from 1cm thick planks beveled to 30 degrees.
Handpump anchor assembly 4 x M16 x 15cm mild steel bolts with eight 6mm diameter fixing rods as per RWSN specifications.
6mm diameter high tensile steel weld mesh 20cm spacing each way.


10.
0.25m³ concrete 10cm thick slab (1:2:4 cement dosage 320 kg/m³).
40cm x 40cm access cover
Beveled shutter to create 15cm thick 30cm x 30cm plinth for handpump base.
Lifting handles 8mm high tensile steel reinforcement 20cm long 8cm high with 5cm long tabs.


11.
rd Handpump Apron
Zone 'B' Block 4
Avril 2015
UNHCR
CARE
UNHCR
The UN Refugee Agency
Maneuver the cover slab into place and seal with mortar.


12.
5mm rubber gasket.
Install the handpump base, rising main and pump assembly.


13.
Install the upper hand pump assembly.


Standard Handpump Apron
Location: Zone 'B' Block 4
Date d'Exécution: Avril 2015
Financement: UNHCR
Agence d'Exécution: CARE
UNHCR
The UN Refugee Agency
Soakage pit to be covered with plastic sheeting and 30cm compacted soil.
14.
Alternative: drainage channel may be replaced with 6" PVC drainage pipe inclined towards soakage pit.

D-303/2015a

BILL OF QUANTITIES

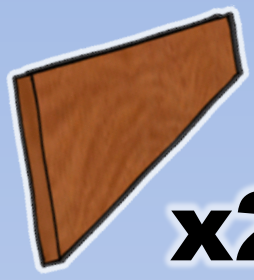
Description	QTY
Wooden Posts (65cm x 5cm x 5cm)	18 pcs
Wooden Planks (4m x 20cm x 2.5cm)	2 pcs
Plywood Sheets (240cm x 120cm x 3mm)	2 pcs
Nails (5cm Galvanized)	1 kg
High Tensile Steel Weld-Mesh Ø6mm 20cm x 20cm	4 m^2
High Tensile Steel Reinforcement Bar Ø6mm	82 m
High Tensile Steel Reinforcement Bar Ø8mm (Handles)	3 m
Plastic Sheeting	20 m^2
Complete Handpump Assembly (Plus Anchor Bolting Assembly)	1 pc
Coarse Sand	1.5 m^3
Coarse Gravel (6mm – 10mm)	2.8 m^3
Cement (50kg sacks)	19 sacks
Compacted Hardcore Sub-Base	2.2 m^3

Bill of Quantities

1. *Wooden Posts (pc) 5cm x 5cm x 65cm*

x18

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



x2

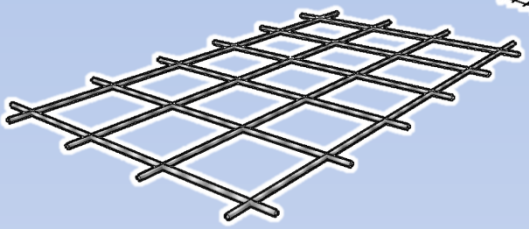
3. *Plywood Sheets (pc) 240cm x 120cm x 3mm*

x3

4. *Nails 5cm (kg)*

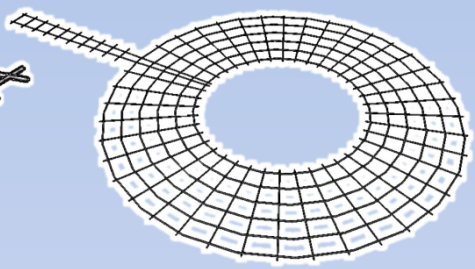
x1

5. *Steel Weld-Mesh 6mmØ x 20cm x 20cm*



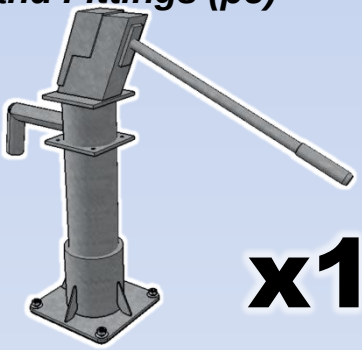
x4m²

6. *High Tensile Mild Steel Rebar 6mmØ*



x82m

7. *Handpump Assembly and Fittings (pc)*



x1

8. *Cement 50kg (sacks)*

x19

9. *Plastic Sheeting (m2)*

x20m²

10. *Gravel (m3)*

x2.8

11. *Compacted Hardcore Sub-Base (m3)*

x2.2

12. *Sand (m3)*

x1.5

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 soak-away 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/cm^2. 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. UNHCR and WASH actors must ensure that only aggregates between 6mm and 10mm are be 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. Mass concrete footings should be cast with a 1:3:6 concrete mixture with a minimum cement dosage of 240 kg/m^3. 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/m^3. 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. The concrete should be cured with frequent watering at least twice daily for at least 10 days before use.

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/mm^2). Steel reinforcement should be placed as per the designs (to ensure the bars function correctly in tension) with at least 12mm concrete covering under every bar.

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.

307 UNHCR STANDARD DESIGNS FOR WATER SUPPLY

307.1 The following drawings should be used in conjunction with these technical design guidelines.

D-300/2015a	Emergency Tapstand (Wooden Pallets) with Drainage
D-301/2015a	Tapstand Design with Drainage (Rectangular Concrete)
D-302/2015a	Handpump Apron with Drainage (Rectangular Concrete)
D-303/2015a	Hand Dug Well Apron (Circular Concrete) with Drainage
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 Tower (Reinforced Concrete)

USEFUL REFERENCES

Emergency water supply

- ACF (2005), 'Water, sanitation and hygiene for populations at risk – second edition'. ACF, Paris, France. http://www.actioncontrelafaim.org/publications/fichiers/wsh_acf_0.pdf
- Chalinder, A. (1994), 'Water & sanitation in emergencies: a good practice review', Overseas Development Institute (ODI), London, http://www.odihpn.org/download/gpr1pdf
- House S., and Reed, B. (2004) 'Emergency water sources 3rd Ed.', WEDC, Loughborough University, UK. http://wedc.lboro.ac.uk/resources/books/Emergency_Water_Sources_-_Complete.pdf
- Lambert, R., and Davis, J. (2002), 'Engineering in emergencies 2nd Ed.', Register of Engineers for Disaster Relief (RedR), London.
- SPHERE (2011) 'Humanitarian charter and minimum standards in disaster response'. http://www.sphereproject.org/resources/download-publications
- UNHCR (2007), 'Handbook for emergencies – third edition'. UNHCR, Geneva. http://www.unhcr.org/472af2972.html
- UNHCR (1992), 'Water manual for refugee situations', UNHCR, Geneva. http://www.unhcr.org/3ae6bd100.pdf

Surface water

- House, S., Reed, B. and Shaw, R., (1989) 'Selecting sources of water: WEDC technical brief #55'. WEDC, Loughborough University, UK. http://www.lboro.ac.uk/well/resources/technical-briefs/55-water-source-selection.pdf
- Smout, I. and Shaw, R. (1989), 'Surface water intakes: WEDC technical brief #22'. WEDC, Loughborough University, UK. http://www.bvsde.paho.org/eswww/tecapropiada/otratec/waterlin/tb22.pdf
- Wijk-Sijbesma, C.A., and Smet, J.E.M. (2002), 'Small community water supplies: Surface water intakes and small dams', IRC International Water and Sanitation Centre, Delft http://www.samsamwater.com/library/TP40_11_Surface_water.pdf
- WEDC (2012), 'Intakes from rivers: WEDC trial course unit'. WEDC, Loughborough University, UK. http://wedc.lboro.ac.uk/resources/units/EWS_Unit_5_Surface_Water_Intakes.pdf
- USAID (1984) 'Maintaining intakes', USAID, Washington USA. http://www.watersanitationhygiene.org/Maintaining_Intakes_(USAID).pdf
- USAID (1984), 'Constructing intakes for ponds, lakes and reservoirs', USAID, Washington USA. http://www.watersanitationhygiene.org/Intakes(USAID).pdf
- USAID (1984), 'Constructing intakes for streams and rivers', USAID, Washington USA.

http://www.watersanitationhygiene.org/Intakes_for_Streams_and_Rivers_(USAID).pdf

- USAID (1984), 'Designing intakes for ponds, lakes and reservoirs', USAID, Washington USA. http://www.lifewater.org/resources/rws1/rws1d2.pdf
- USAID (1984,) 'Designing intakes for streams and rivers', USAID, Washington USA. https://www.lifewater.org/resources/rws1/rws1d3.pdf
- USAID (1984), 'Designing intakes for ponds, lakes and reservoirs', USAID, Washington USA. http://www.lifewater.org/resources/rws1/rws1d2.pdf
- USAID (1984,) 'Designing intakes for streams and rivers', USAID, Washington USA. https://www.lifewater.org/resources/rws1/rws1d3.pdf

Spring captures

- Skinner, B. and Shaw, R. (1989), 'Protecting springs an alternative to spring boxes: WEDC technical brief #34'. WEDC, Loughborough University, UK. http://www.lboro.ac.uk/well/resources/technical-briefs/34-protecting-springs.pdf
- Oxfam GB (2008), 'Spring protection: technical brief #5', Oxfam GB, Oxford, UK. http://oxfamilibrary.openrepository.com/6/tbn5-spring-protection-030608-en.pdf
- USAID (1984), 'Constructing structures for springs', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws1c1.pdf
- USAID (1984), 'Designing structures for springs', USAID, Washington USA. https://www.lifewater.org/resources/rws1/rws1d1.pdf
- USAID (1984), 'Maintaining spring structures', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws1o1.pdf

Hand dug wells

- Abbott, S. (2001), 'Hand dug well manual'. http://www.sswm.info/ABBOT%204000%20Hand%20Dug%20Well%20Manual.pdf
- Colins, S. (2000), 'Hand dug shallow wells', Swiss Resource Centre for Development (SKAT), St. Gallen, Switzerland. http://www.skat.ch/publications/2005-10-31.1053710342/file
- Pickford, J. and Shaw, R. (1989), 'Upgrading traditional wells: WEDC technical brief #39'. WEDC, Loughborough University, UK. http://www.lboro.ac.uk/well/39-upgrading-traditional-wells.pdf
- Reed, A. and Luff, R. (2000), 'Instruction Manual for Hand Dug Well Equipment', Oxfam GB, Oxford, http://oxfamilibrary.openrepository.com/oxfam/1/hand-dug-well-manual-250406-en.pdf

- USAID (1984), 'Designing hand dug wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2d1.pdf
- USAID (1984), 'Selecting a well site', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2p3.pdf
- USAID (1984), 'Constructing hand dug wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2c1.pdf
- USAID (1984), 'Finishing wells', USAID, Washington USA. http://my.ewb-usa.org/theme/technical/rws2c8.pdf

Hand drilled wells

- Elson, B. and Shaw, R. (1989), 'Simple drilling methods: WEDC technical brief #43'. WEDC, Loughborough University, UK. http://www.lboro.ac.uk/well/resources/technical-briefs/43-simple-drilling-methods.pdf
- Herwijnen, A. (2005), 'Rota Sludge and Stone Hammer Drilling Part One - Drilling Manual', ETC Foundation, Leusden. http://www.itacanet.org/doc-archive-eng/water/Rota_sludge_drilling_Pt1.pdf
- Herwijnen, A. (2005), 'Rota Sludge and Stone Hammer Drilling Part One - Production Manual', ETC Foundation, Leusden. http://www.itacanet.org/doc-archive-eng/water/Rota_sludge_drilling_Pt2.pdf
- Wurzel, P. (2001), 'Drilling boreholes for handpumps', Swiss Resource Centre for Development (SKAT), St. Gallen, Switzerland. http://www.rural-water-supply.net/_ressources/documents/default/148.pdf
- USAID (1984), 'Designing bored and augured wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2d4.pdf
- USAID (1984), 'Designing driven wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2d2.pdf
- USAID (1984), 'Designing jetted wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2d3.pdf
- USAID (1984), 'Constructing bored and augured wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2c4.pdf
- USAID (1984), 'Constructing driven wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2c2.pdf
- USAID (1984), 'Constructing jetted wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2c3.pdf

Machine drilled wells

- Ball, P. (2001), 'Drilling wells', Swiss Resource Centre for Development (SKAT), St. Gallen, Switzerland. http://www.rural-water-supply.net/_ressources/documents/default/1-147-2-1355235564.pdf
- Carter, R., Chilton, J., Danert, K. and Olschewski, A., 'Siting of Drilled Water Wells - A Guide for Project Managers', Rural Water Supply Network (RWSN), St. Gallen, Switzerland. http://www.rural-water-supply.net/_ressources/documents/default/187.pdf
- Danert, K. et al (2010), 'Code of Practice for Cost Effective Boreholes', Rural Water Supply Network (RWSN), St. Gallen, Switzerlan. http://www.rural-water-supply.net/_ressources/documents/default/1-128-2-1344514867.pdf
- ICRC (2010), 'Borehole Drilling and Rehabilitation under Field Conditions: Technical Review', International Committee of the Red Cross (ICRC), Geneva. https://www.icrc.org/eng/assets/files/other/icrc-002-0998.pdf
- USAID (1984), 'Designing cable tool wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2d5.pdf
- USAID (1984), 'Constructing a cable tool wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2c5.pdf
- USAID (1984), 'Finishing wells', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws2c8.pdf
- Wurzel, P. (2001), 'Drilling boreholes for handpumps', Swiss Resource Centre for Development (SKAT), St. Gallen, Switzerland. http://www.rural-water-supply.net/_ressources/documents/default/148.pdf

Rainwater harvesting

- ITDG (2002), 'Rainwater harvesting technical brief', Intermediate Technology Development Group (ITDG), http://www.watersanitationhygiene.org/Rainwater%20Harvesting%20(ITDG).pdf
- USAID (1984), 'Evaluating rainfall catchments', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws1p5.pdf
- USAID (1984), 'Designing roof catchments', USAID, Washington USA. https://www.lifewater.org/resources/rws1/rws1d4.pdf
- USAID (1984), 'Constructing, operating and maintaining roof catchments', USAID, Washington USA. http://my.ewb-usa.org/theme/library/myewb-usa/project-resources/technical/rws1c4.pdf

Water network design

- Jordan, D. (1984), 'A Handbook of Gravity-Flow Water Systems', Practical Action, IT Publishing, UK.

- Knight, J. and Gonzalez Otalora, C. (2014), 'Design and installation of a water supply network, Batil refugee camp Maban County, South Sudan', Medair and Solidarites International. https://data.unhcr.org/SouthSudan/download.php?id=1168
- Oxfam GB (1999), 'Water supply scheme for emergencies', Oxfam GB, Oxford, UK. http://www.bvsde.paho.org/texcom/desastres/oxfamwfm.pdf
- Reed, B. and Shaw, R. (1989), 'Emergency water supply: WEDC technical brief #44', WEDC, Loughborough University, UK. http://www.lboro.ac.uk/well/resources/technical-briefs/44-emergency-water-supply.pdf
- USAID (1984), 'Designing gravity flow systems', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4d1.pdf
- USAID (1984), 'Designing a transmission main', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4d3.pdf
- USAID (1984), 'Designing community distribution systems', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4d4.pdf
- USAID (1984), 'Constructing a distribution system with household connections', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4c5.pdf
- USAID (1984), 'Constructing community distribution systems', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4c4.pdf
- USAID (1984), 'Detecting and correcting leaking pipes', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4o1.pdf
- USAID (1984), 'Installing pipes', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4c1.pdf
- USAID (1984), 'Operating and maintaining household water connections', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4o5.pdf
- USAID (1984), 'Selecting pipe materials', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4p3.pdf

Motorized water pumping

- Baumann, E. (2000), 'Water Lifting', Swiss Resource Centre for Development (SKAT), St. Gallen, Switzerland. http://www.skat.ch/publications/2005-10-31.4419482767/file
- Oxfam (2000), 'Instruction manual for surface water pumping' (Oxfam, 2000), Oxfam GB, Oxford, http://www.oxfam.org.uk/equipment/Pumping%20Equipment%20Manual.pdf
- Oxfam GB (1999), 'Water supply scheme for emergencies', Oxfam GB, Oxford, UK. http://www.bvsde.paho.org/texcom/desastres/oxfamwfm.pdf
- USAID (1984), 'Determining pump requirements', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4d2.pdf
- USAID (1984), 'Selecting pumps', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4p5.pdf

- USAID (1984), 'Selecting a power source for pumps', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4p4.pdf
- USAID (1984), 'Installing mechanical pumps', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4c2.pdf
- USAID (1984), 'Operating and maintaining mechanical pumps', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4o2.pdf

Handpumps

- Arlosoroff S. et al. (1987), 'Community water supply: the handpump option', The World Bank, Washington, DC. http://www-wds.worldbank.org/external/PDF/multi0page.pdf
- Baumann, E. (2000), 'Water Lifting', Swiss Resource Centre for Development (SKAT), St. Gallen, Switzerland. http://www.skat.ch/publications/2005-10-31.4419482767/file
- Erpf, K. (2007), 'Afridev handpump installation and maintenance manual (Revision 2-2007)', Swiss Resource Centre for Development (SKAT), St. Gallen, Switzerland. http://rural-water-supply.net/_ressources/documents/default/286.pdf
- http://wedc.lboro.ac.uk/docs/research/WEJW2/Report_-_Uganda.pdf
- Skinner, B. and Shaw, R. (1989), 'VLOM Pumps: WEDC technical brief #41', WEDC, Loughborough University, UK. http://www.lboro.ac.uk/well/resources/technical-briefs/41-vlom-pumps.pdf
- USAID (1984), 'Installing Handpumps', USAID, Washington USA. https://www.lifewater.org/resources/rws4/rws4c3.pdf
- USAID (1984), 'Operating and Maintaining Handpumps', USAID, Washington USA. http://water.engr.psu.edu/hill/teaching/rural_water/rws4o3.pdf

Water storage

- Oxfam (2006), 'Water storage manual', Oxfam GB, Oxford, UK. http://oxfamilibrary.openrepository.com/oxfam/bitstream/10546/126731/1/water-storage-manual-260406-en.pdf
- Skinner, B., and Shaw, R. (1989), 'Buried and semi submerged water tanks : WEDC technical brief #56', WEDC, Loughborough University, UK. http://www.lboro.ac.uk/well/resources/technical-briefs/56-buried-and-semi-submerged-tanks.pdf
- Skinner, B., Reed, B., and Shaw, R. (1989), 'Ferrocement water tanks : WEDC technical brief #36', WEDC, Loughborough University, UK. http://www.lboro.ac.uk/well/resources/technical-briefs/36-ferrocement-water-tanks.pdf
- UNHCR (2006), 'Large ferro-cement water tank design parameters and construction details ', United Nations High Commissioner for Refugees UNHCR, Geneva. http://www.unhcr.org/49d089a62.pdf
- USAID (1984), 'Methods of storing water', USAID, Washington USA. https://www.lifewater.org/resources/rws5/rws5m.pdf

- USAID (1984), 'Designing a ground level water storage tank', USAID, Washington USA. https://www.lifewater.org/resources/rws5/rws5d2.pdf
- USAID (1984), 'Constructing a ground level water storage tank', USAID, Washington USA. https://www.lifewater.org/resources/rws5/rws5c2.pdf
- USAID (1984), 'Constructing a household cistern', USAID, Washington USA. http://wiki.watermissions.org/GetFile.aspx?Page=Water%20Storage%20RWS5&File=rws5c1.pdf
- USAID (1984), 'Designing an elevated water storage tank', USAID, Washington USA. http://wiki.watermissions.org/GetFile.aspx?Page=Water%20Storage%20RWS5&File=rws5d3.pdf
- USAID (1984), 'Constructing an elevated water storage tank', USAID, Washington USA. http://wiki.watermissions.org/GetFile.aspx?Page=Water%20Storage%20RWS5&File=rws5c3.pdf
- USAID (1984), 'Determining the need for water storage', USAID, Washington USA. http://wiki.watermissions.org/GetFile.aspx?Page=Water%20Storage%20RWS5&File=rws5p1.pdf
- USAID (1984), 'Maintaining water storage tanks', USAID, Washington USA. http://wiki.watermissions.org/GetFile.aspx?Page=Water%20Storage%20RWS5&File=rws5o1.pdf