Construction of bench style double vault urine diversion toilet and alternatives

The use of Urine Diversion (UD) in dry toilets allows faeces dehydration. Urine can be reused as urea, while faeces are dried in a double vault system of alternate use. The moisture comes out using ventilation pipes. After 2 years the end product can be emptied and reused without having any health risk. Water from washing can be treated in a constructed wetland and reused for instance for irrigation.

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Double vault dry toilets with Urine Diversion (UD)

LIST OF MATERIALS OF THE SANITARY UNIT 2 vaults of adobe, bricks or concrete blocks with reinforced concrete cover, stairs and floor		
150 160 100	unit	Adobes (10 cm:12cm:20cm), or Bricks (pandereta), or Concrete blocks (10 x 20 x 40 cm)
6	wheelbarrows	Of clay to rise the wall (in adobe)
0.8	m^3	Stones for foundation
2, 8 o 4	bags	Cement (adobe, brick or concrete block)
0.3, 0.5 o 0.5	m^3	Concrete (adobe, brick or concrete block)
2 ½	Steel rod	Steel 8 mm
1	kg	Wire # 16
0.3	m^3	Fine sand for stucco
2	unit	Drainage pipes 2“
2	unit	T 2“
3	unit	Bend 2“ /90º
3	unit	Bend 2“ /45º
1	unit	Cover 2“
2	unit	Drainage pipes 4“
2	unit	T 4“
1	unit	Urine diverting seat
1	unit	Toilet seat
1	unit	Adapter for children
1	unit	Urinal
1	unit	Sink
2	unit	Doors made of wood, metal or same material of the vaults using poor mortar
Walls, roofs, windows (mesh) and door, a shower can also be included.		

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Preparation for construction of the vaults

1. Area of 1 x 2 m² close or adjacent to the house, with access to the back (clearance 1.5 m). The digging depth for the vaults is 25 cm (Photo 1).
2. If there is any slope on the ground, it is recommended to use it, placing the vaults' doors in the lower part (Photo 2, see the arrows).
3. Vaults: in dry areas foundation trenches are prepared (Photo 2), in humid areas (jungle) it is advisable to build a concrete slab (Photo 1) and in raining areas a stone foundation using adobe with cement mortar is required, at least 10 cm above ground level (Photo 3).

PHOTO 1


PHOTO 2


PHOTO 3

Using the slope: the yellow arrows marks the floor (entrance) and the green arrows show the gates where the product is removed.

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Vaults of adobe, bricks or concrete blocks


PHOTO 4

4. The wall is raised on the foundation borders (Photo 4 and 5), or in the concrete slab (Photo 6, to waterproof the inside of the vaults in areas with high water table).

5. Then settle walls, the height should be equal or higher than 80 cm (Figure 1). Openings for the doors should be leaved on the back side, through which the product will be removed every two years from each vault.


PHOTO 5


PHOTO 6

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Vaults schema

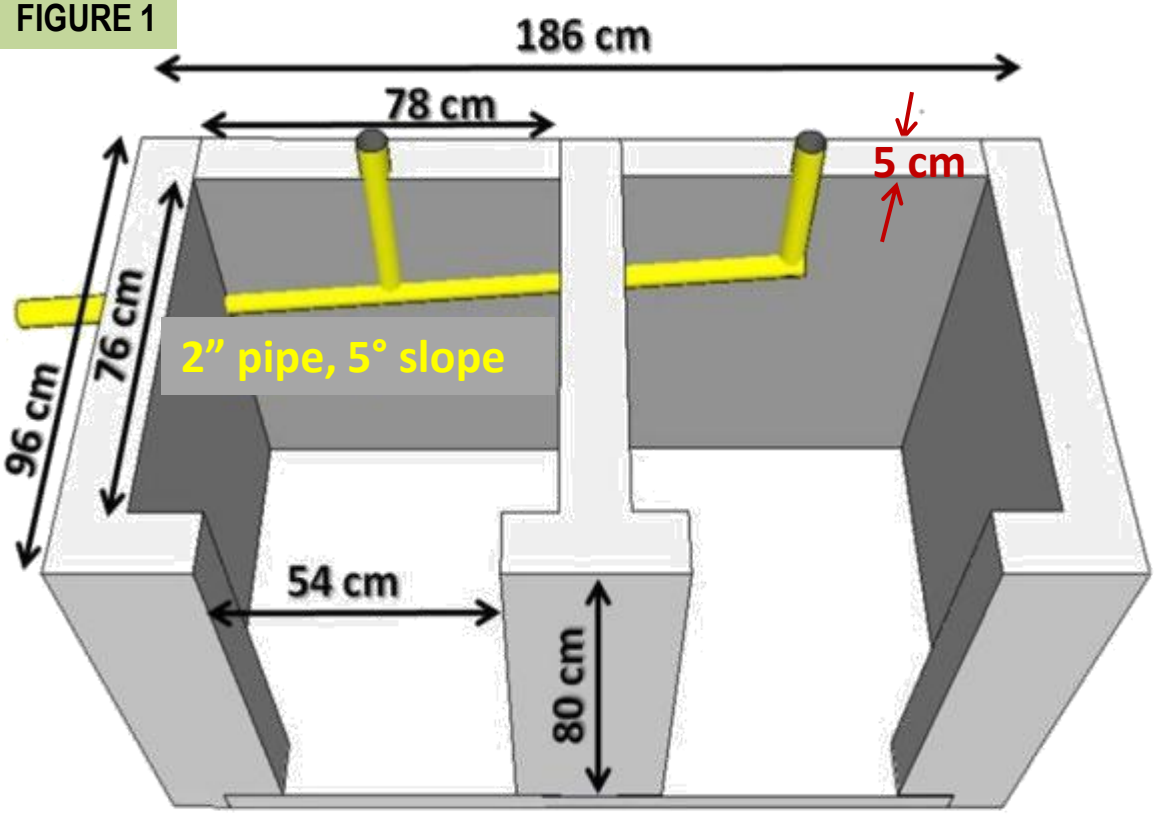
6. The urine pipe (2”) should be installed inside, close to the front wall or inside the wall of the vaults.
The pipe begins with a 90° bend in the center of the first vault, goes through the middle wall and continues with a T in the center of the second vault and exit the unit through the side wall.

Once the pipe is outside, it should end into a container or buried into the ground. A ‘T’ (Photo 7) is used to join the pipe with the urinal pipe.

A 5° slope should be kept along the pipe.

To make sitting comfortably, the front wall should be 5 to 6 cm wide, at least at the part where one sits.

FIGURE 1



A greater height ensures that the vaults is used for longer time, however a higher stair is needed, which difficulties the access to the elderly or small children.

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Urine pipe, vaults of adobe and bricks

7A. ADOBE: The urine pipe is placed inside the front wall (Photo 8). There are some possibilities, such as placing the pipe above the wall before finishing the last two (or three) layers of adobe. Then the wall is flattened with clay and finished with layers of adobe on edge (Photo 9). In this way the thickness of the wall is reduced.


PHOTO 8

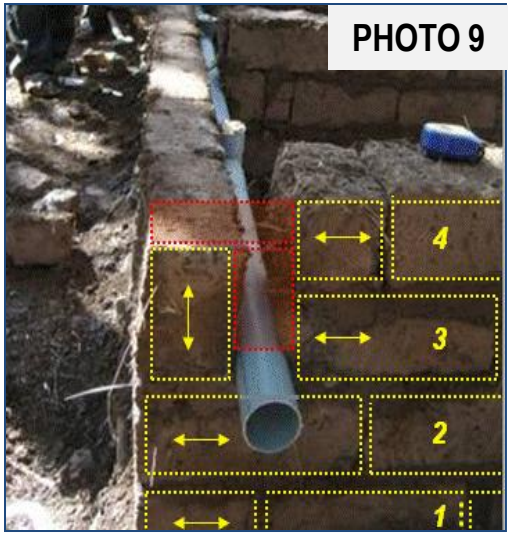

PHOTO 9

PHOTO 10

7B. BRICKS: To reduce the width of the front wall is recommended to cut the bricks in the last three rows of the whole wall crosswise in half (taking into advantage the type of brick) (Photo 10) to the level of the floor (35 cm). Another alternative is to chop only the place of the seats or to chop the wall inside for the urine pipe.

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Urine pipe; vaults of concrete blocks

7C. CONCRETE BLOCKS: The concrete block of the front wall should be chopped inside to place the toilet (Figure 2 and Photos 11 and 12). The urine pipe (2”) goes into the free space of the concrete block below and the third concrete block is chopped on the outside (Photo 13) where the urine pipe goes out and continues below the toilet floor until it joins the urinal pipe.

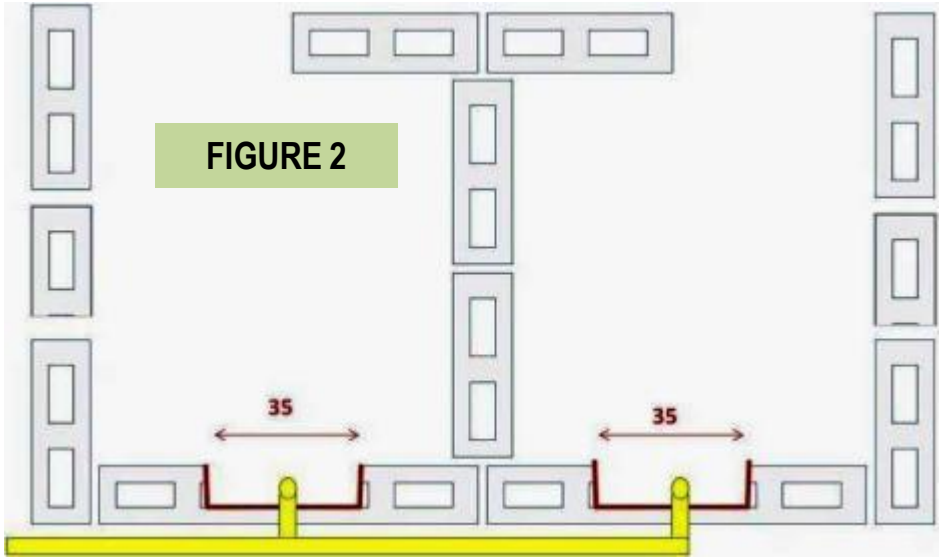

PHOTO 11: View from above

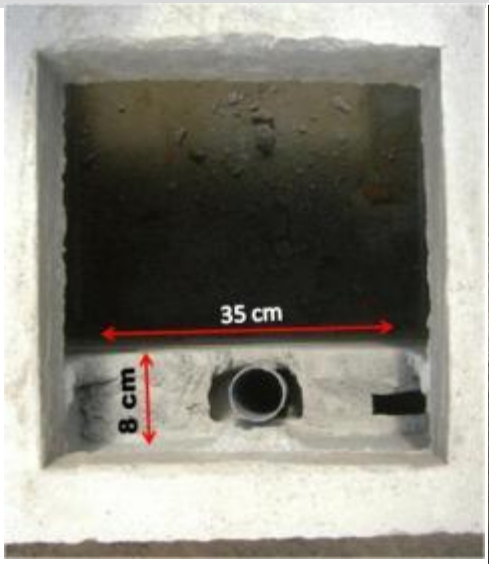

PHOTO 12: Inside view with seat

PHOTO 13: Building site with installed urine pipe

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Waterproofing; Adobe and bricks vaults

PHOTO 14

PHOTO 15a

PHOTO 15b

8. The bricks walls (Photo 14) should be waterproofed with cement and in the openings (gates). It is also recommended to consider a border to keep out rainwater. The vaults of adobe could be also waterproofed (in regions with high rain), in this case wire mesh is used (Photos 15a and 15b) so the cement can stick on the walls.
9. In regions with frequent flooding (jungle, Photo 16) the concrete slab is not enough. The vaults should be built with good a distance above the ground to ensure that water does not going inside

PHOTO 16

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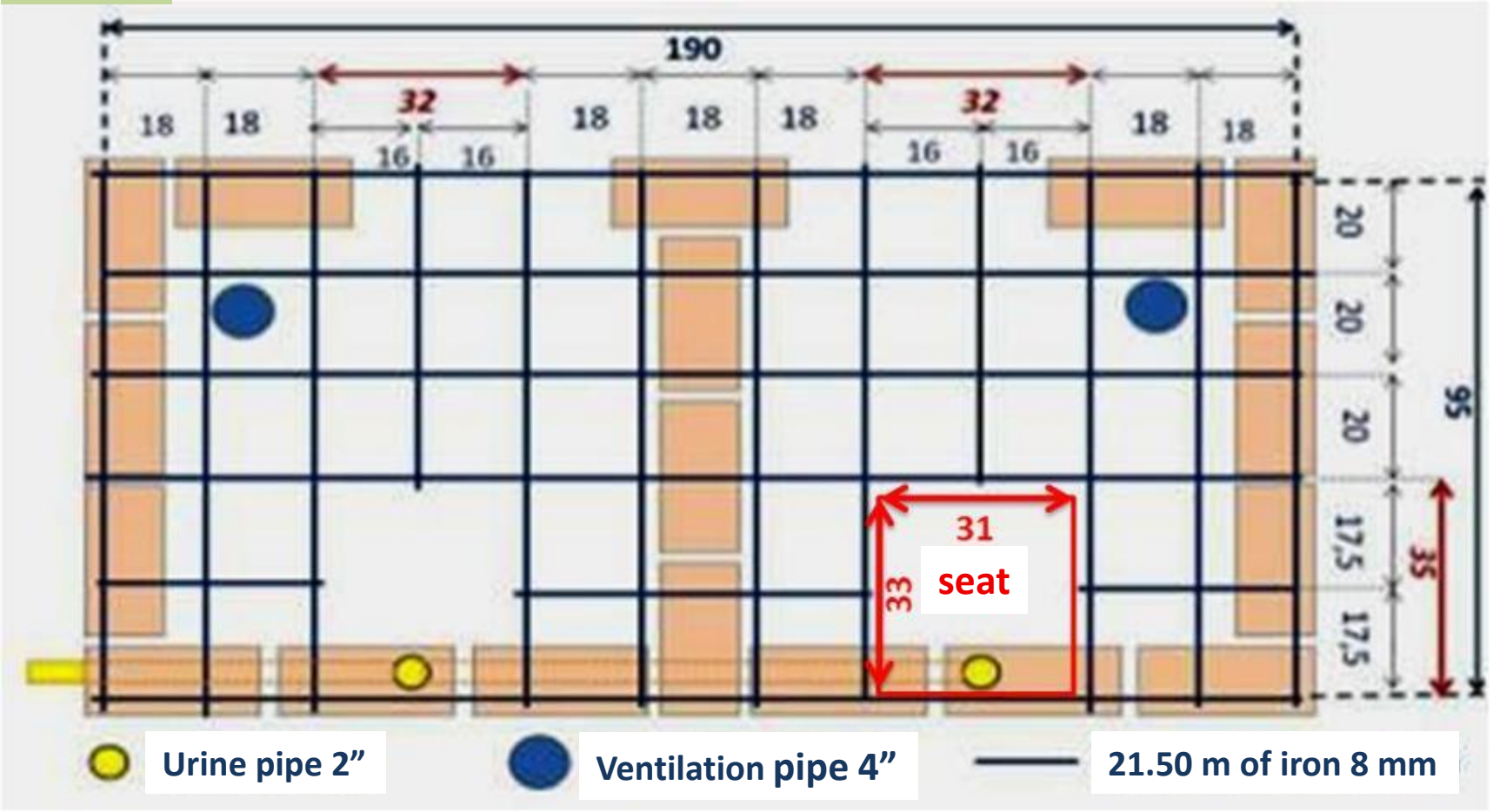
Bench of cement; schematic of the iron grid

10. The cover closes the vaults. The bench is designed as a support to seat in and also holds the urine diverting seat. The recommended material for the bench/cover is a slab of iron and cement. The schema shows the distribution of irons (8 mm) with the locations and dimensions of the holes for the seat and the ventilation pipes.

FIGURE 3



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Bench of cement; Formwork construction 1

PHOTO 17

PHOTO 18

PHOTO 19

10 A. In the formwork construction the bench is built directly on the walls (Photos 17, 18 and 19), that may be made of bricks, adobe or concrete blocks. A pillar platform within the limits of the walls of the vaults is done. This platform can be made of wood, reeds or other material which is removed when the cement is dry. After that the iron grill is assembled (Figure 3). The mixture of concrete is cement, sand and gravel in the ratio 1:2:3.

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Bench of cement; Formwork construction 2

10B Another option is to build the bench offsite (Photos 20 and 21). In this case it is recommended to do 2 platforms (Figure 4). Special attention should be given to the size of the building site. An even surface is required which should be protected with paper or plastic. The platforms should be dried at least 7 days before moved.

FIGURE 4

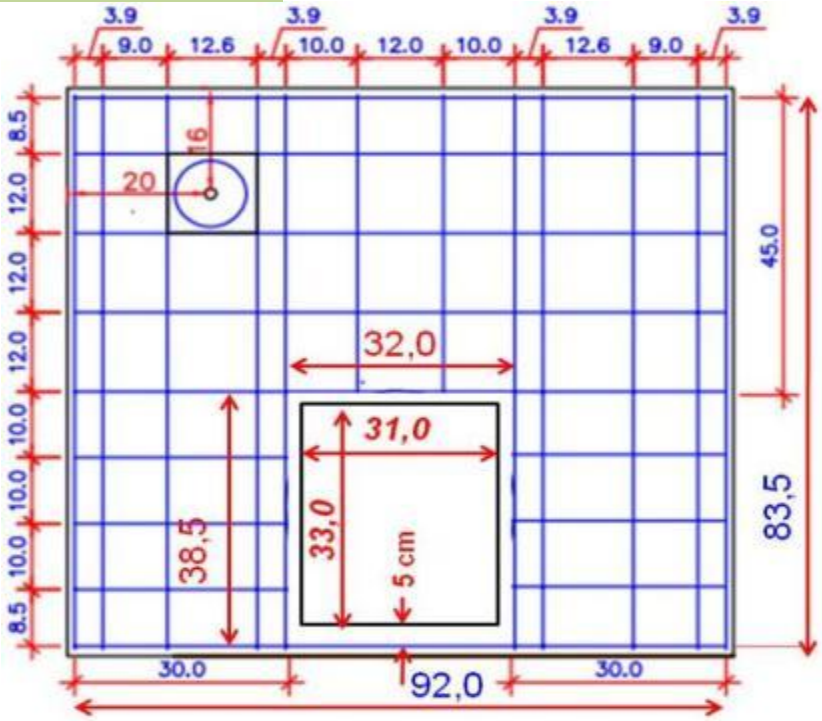
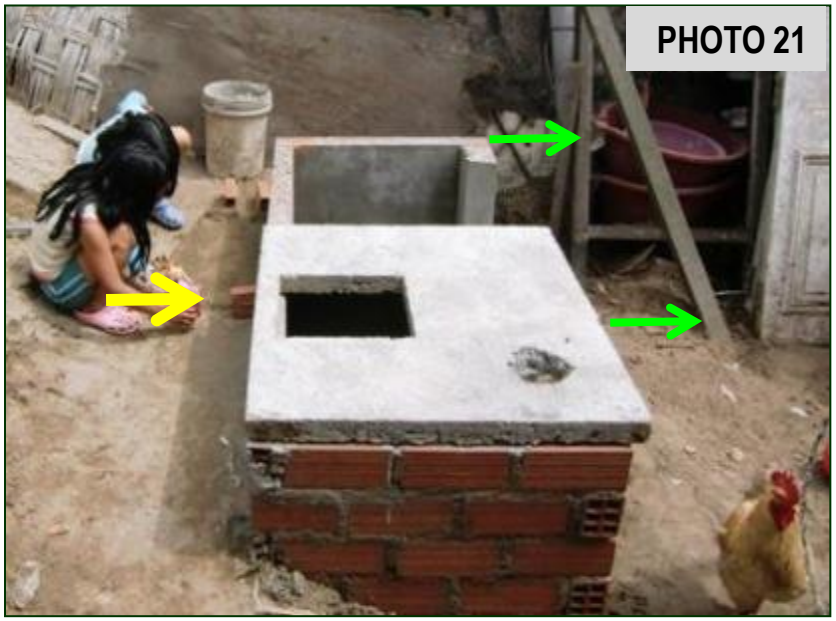


PHOTO 20

PHOTO 21



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Bench of alternative materials: Reed + Mud and Wood


PHOTO 22

10C Local materials can be used to build the bench (Photo 22) where those materials are available.

10C.1 Wood and/or reeds supports are covered with mud mortar, 8 cm thick (Photos 23 and 24) or with concrete/cement. The distance between supports should allow placing the urine diverting seat.

10C.2 Wooden plate of more than 1" thickness, it should be waterproofed (Photo 25) with lacquer, varnish or paint. The installation is very simple.

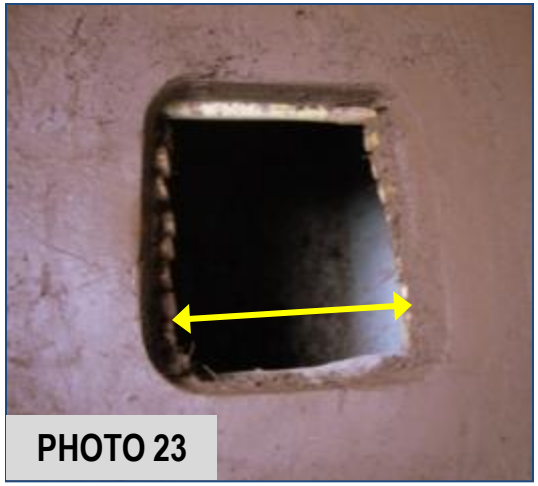
PHOTO 23


PHOTO 24


PHOTO 25

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Floor, stairs, height of the bench to sit

11 **Floor:** The height of the bench is 80 cm or more, but to sit, it is necessary to raise the floor height (Figure 5) until the bench has a height of 36 to 38 cm (toilets for children only - kindergarten - should have a height of 23 cm).

Depending on the height of the vaults 2 to 4 stairs will be needed (Photo 26). The use of the slope of the terrain (Photo 27) can avoid the need of stairs.

PHOTO 26

PHOTO 27

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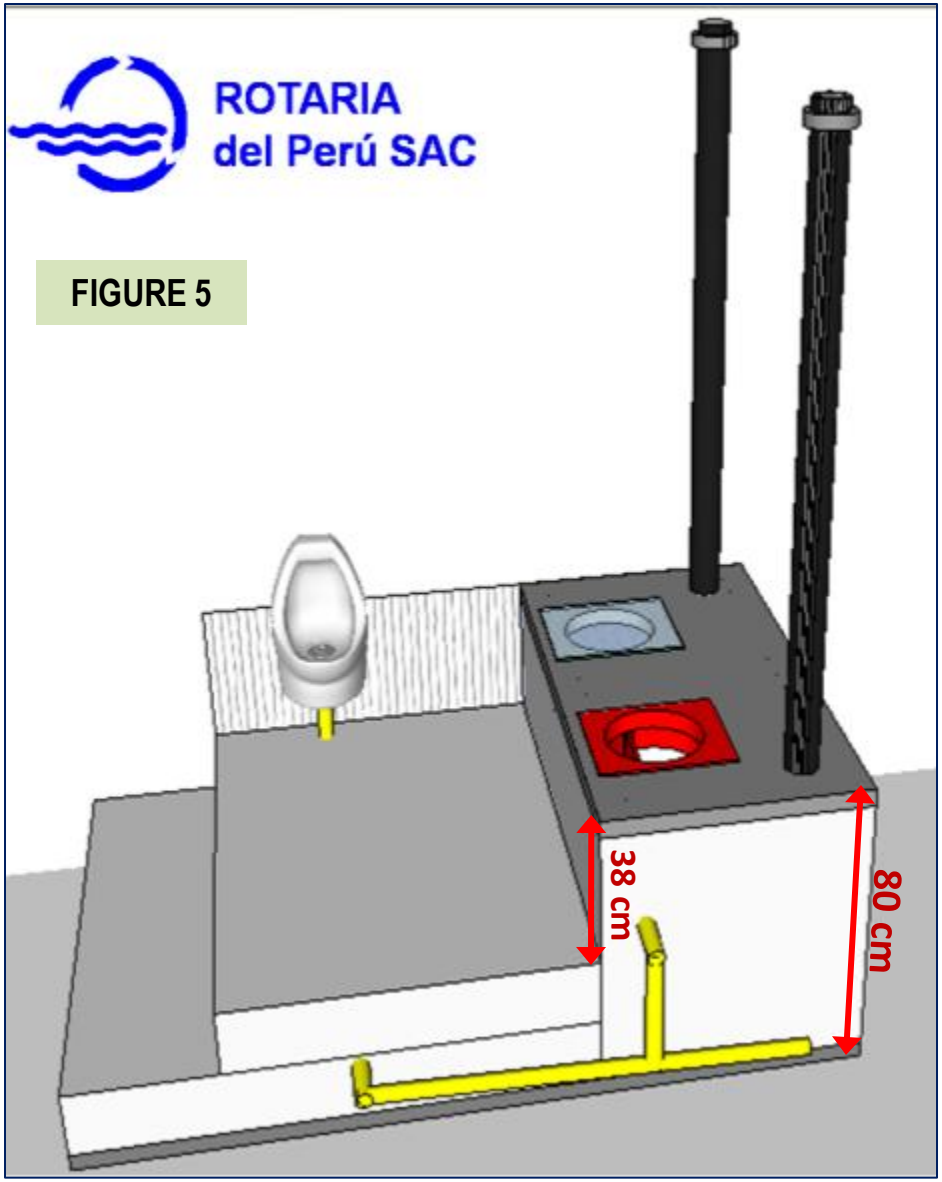
FIGURE 5



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Distance of the seat; Combination of the shower

In the family bathrooms, children can use a stool to match-up the height of the bench to their size. The most important thing for them is that the seat is close enough to the front wall (< 5 cm away). Photo 28 shows a bench with the right height for 6 year-old children (primary school), but the distance to the seat was very large and the edge of the bench had to be cut (Photo 29).

The stairs can be built inside (Photos 30 and 31) or outside of the bathroom (Photo 32) and can be used to combine the shower inside (Photo 31) of the bathroom or it may be placed outside (Photo 32).

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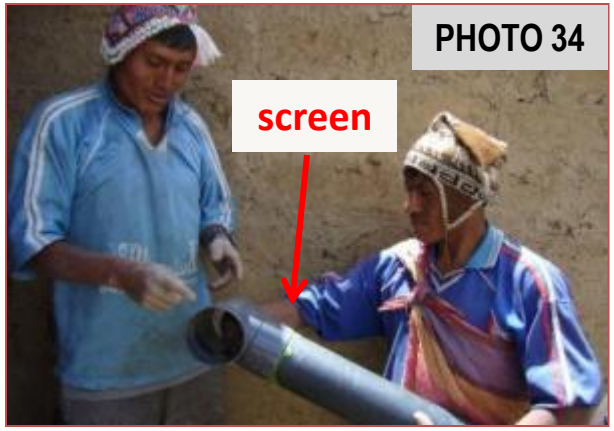
Ventilation pipes; for all types of construction

12. Ventilation pipes (pipe drains 4" 3 m) will be placed when the cover is ready. Pipes should be 30 cm into the vault and if possible are straight without bends (Photo 33).

PHOTO 33

PHOTO 34



The top of the ventilation pipe should be protected from rain and vectors with a cover (or T 4") and mosquito screen (Photo 34).

The pipes should be straight, but if a bend is needed it should be a 45° (Photo 35), never a 90°.

The pipes may be placed inside or outside the unit. The parts of the pipe that are exposed to the sun should be painted black to improve ventilation and to protect the PVC.

PHOTO 35

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Drainage of urine and grey water


PHOTO 36

Urine and grey water should not be mixed; they should always be separately drained. Neat urine is sterile and may be reused after storing it for 2 months, while grey water should be treated before reuse.

13. **Urine:** The urine pipe drains the urine from the seat and the urinal (required for men). It is advisable to collect the urine in 25 L containers (Photo 36) to reuse. One option to reuse the urine is as NPK fertilizer directly to the soil, diluted 3-10 parts water to 1 part urine. There are other uses according to the location.

If urine cannot be reused, it should be infiltrated into the soil. A ditch is dug, filled with gravel and a perforated pipe is placed (Photo 37).


PHOTO 37


PHOTO 38

14. **Grey water** comes from the sink that is needed in each toilet and the shower, which is optional. Grey water should be treated prior to reuse, for instance in a constructed wetland. If it is not possible to reuse, grey water should be infiltrated in the same ditch as the urine. In this case the infiltration pipe for urine should be placed about 15 cm above the pipe used for gray water (Photo 37).

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Finish of the bench

15. The finish of the bench, floor and shower can be made with tiles, polished concrete with or without ocher, mosaic, stucco, wood or other. The rectangular Rotaria urine diverting seat has an outline of 38.5 cm x 47 cm (page 24 first and second foto) and it is advisable to let its' space free (Photos 39 and 42). The toilet cover should be set with the screws on the bench (Photo 42).


PHOTO 39


PHOTO 40


PHOTO 41

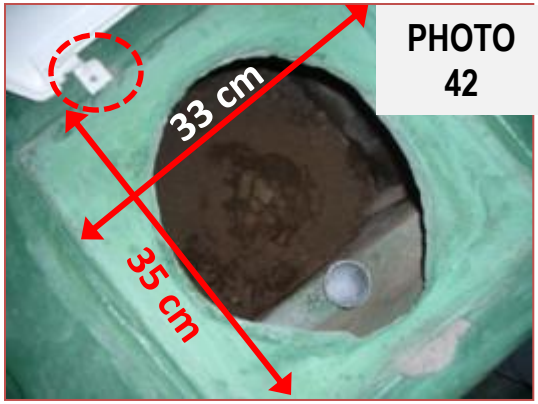

PHOTO 42


PHOTO 43


PHOTO 44

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Gates materials


PHOTO 45


PHOTO 46


PHOTO 47


PHOTO 48

16. The gates to remove the material should be kept tightly closed. They can be made of wood (Photo 45), metal (Photo 46), or simply closed with bricks fixed with mud or mortar (Photos 47, 48 and 49). The plates are sealed with silicone and should be painted on the inside with a waterproof material such as tar.

The dried product is removed every 2 years from each vault. It can be directly reused as fertilizer for trees, banana or other higher growing plants.


PHOTO 49

The gate must be large to make handling easier. It should be at least 50 cm wide and 60 to 80 cm high. Always maintain good access to the gates (1.5 m free space).

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Gates and fly traps

FIGURE 5

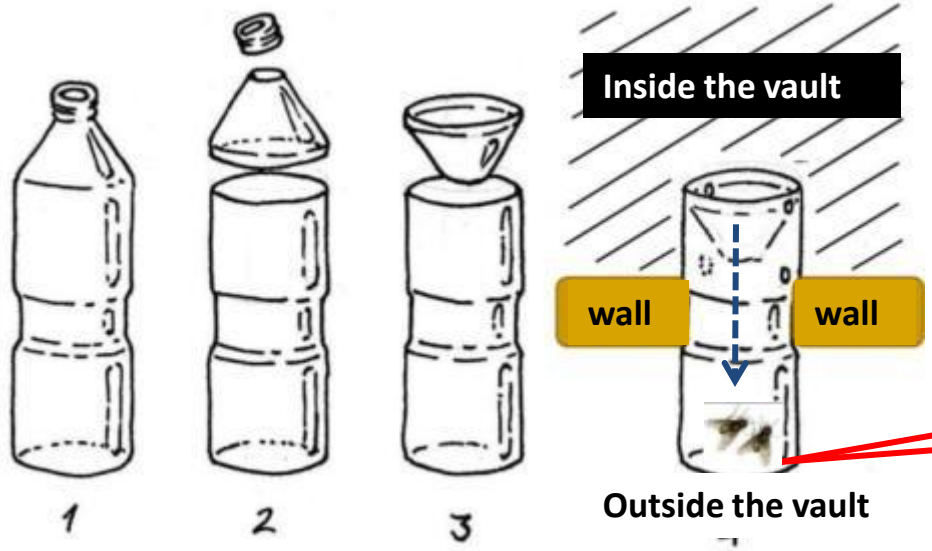

PHOTO 50

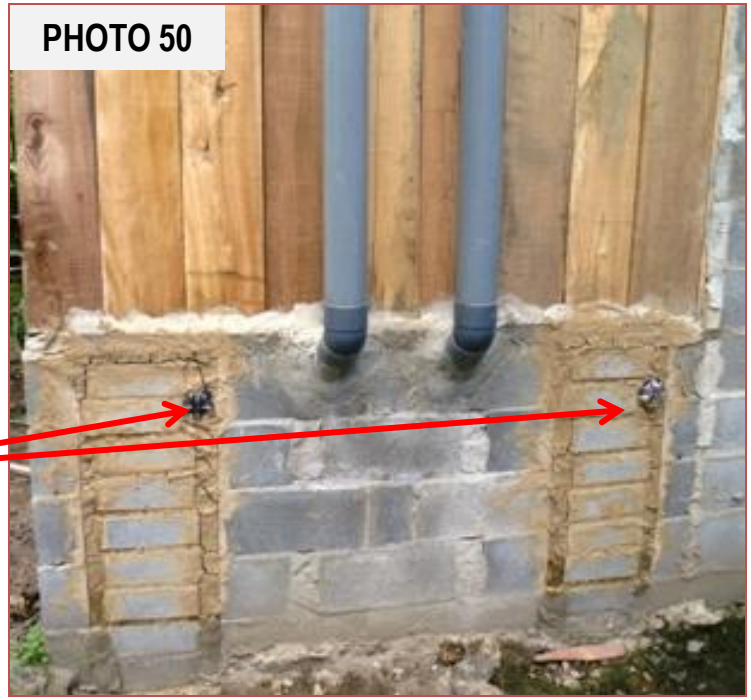

PHOTO 51

When closing the rear gates, in regions or climates with many insects, it is recommended to use flies trap, which consists of a 2.0 L plastic bottle with the opening down as shown in figure 5. This bottle is placed with the bottom toward the light, for example in the mud that closes the gates (Photos 50 and 51). In this way vectors that enter the vault are trapped.

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Walls and roof construction

Important for the functioning of the toilets with an Eco-Sanitario (urine diverting dry toilet) is the construction of the vaults (sanitary unit) with permanent materials, while for the walls and roof it is advisable to use local materials that can be renew in time.

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Room, walls and roof

17. Walls may be made of local materials such as adobe (Photo 52), reed or quincha (Photo 53), bricks (Photo 54), wood (Photo 55) or others. The roof must be adapted to the local climate: zinc plates, tile or natural materials. Windows should be left open to let in light, ventilation and guarantee a clean and nice environment (Photo 53).

The construction on the side of the house is more economical than a separate single construction (Photo 52), and ensures more sustainability in the use and maintenance of the bathroom.

PHOTO 52

PHOTO 53

PHOTO 54

PHOTO 55

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Use and maintenance recommendations 1

The urine diverting toilet should be easily removable to clean and change to the other vault when the first is filled. The hole which is not in use should be closed with a cover (Photo 56).

PHOTO 56

PHOTO 58

PHOTO 57

PHOTO 59

The urine diverting dry toilet has no smell, if there is a smell then it may be caused by accumulation of urine. Therefore the urine pipe should have a 5° slope (explained in page 5).
Also it is important there is a connection between the urine diverting seat and the pipe. For instance the lack of a connection in Photo 58 was appropriately corrected as shown in Photo 59.

In Photo 57 the urine diverting seat was not connected to the pipe, thus the floor of the vault is wet, but there is also urine accumulated in the bend of the pipe because the required slope was not considered.

All the urine should be drained quickly and completely to avoid smell in the urine diverting dry toilet.

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Use and maintenance recommendations 2

Instead of using water to flush, a dry material is used (Photo 60) to cover the faeces. Water is used for personal hygiene and cleaning the bathroom, but no water is added into the vault.

PHOTO 60

PHOTO 61

PHOTO 62

PHOTO 63

Every bathroom needs:

Access to hand washing, the sink can be inside (Photo 62) or outside the bathroom (see “Good ideas”).

Urinal (Photo 56) for men who do not sit to urinate. The urinal is fixed to the wall and its pipe is connected to the pipe for the urine of the bench.

Adapter seat for children, which is put on the toilet seat (Photo 63) to help them sit correctly.

Dry material: sawdust, shaving, fine straw, rice husk, ash mixed with or not with sand, soil or lime. It should be in a cup or bucket (Photo 60) to be added after defecation.

The floor of the vault is prepared with dry material before using it to absorb the moisture of faeces.

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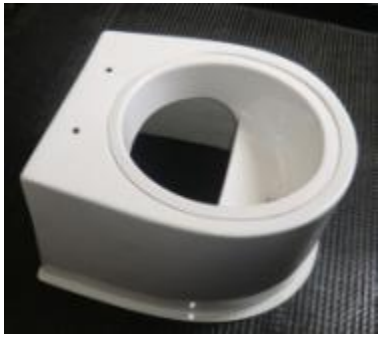
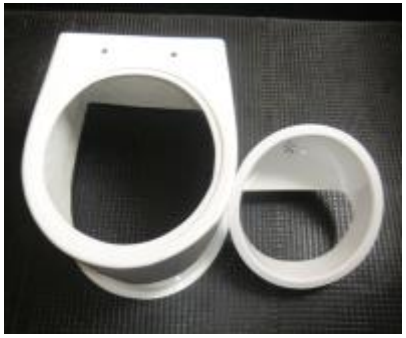
Equipment of Rotaria del Peru for urine diversion dry toilets

http://www.rotaria.net/peru3/rotaria/





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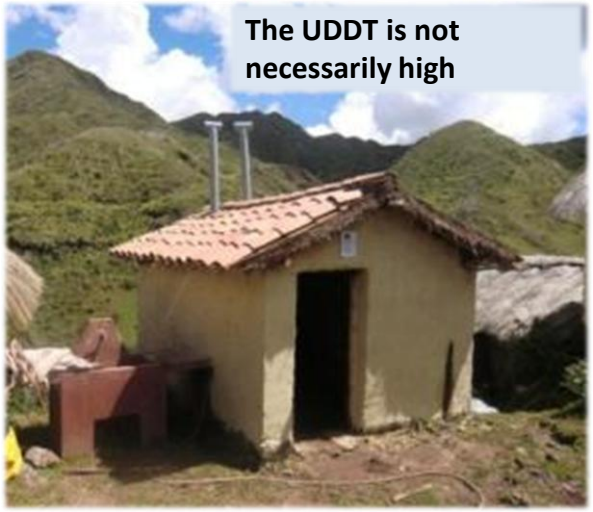
Good ideas for the comfort of the urine diverting dry toilet



Rotaria, Peru, has built more than 500 UD Toilets on the Peruvian coast, highlands and jungle. Thanks to the participation and creativity of families we have learned a lot about the economic, variability and sustainability of use of local materials. The result is a unique toilet, which make their owners proud. Some of the best solutions and practices are published in this summary; moreover alternatives to be applied in the UDDT are also highlighted.

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Options

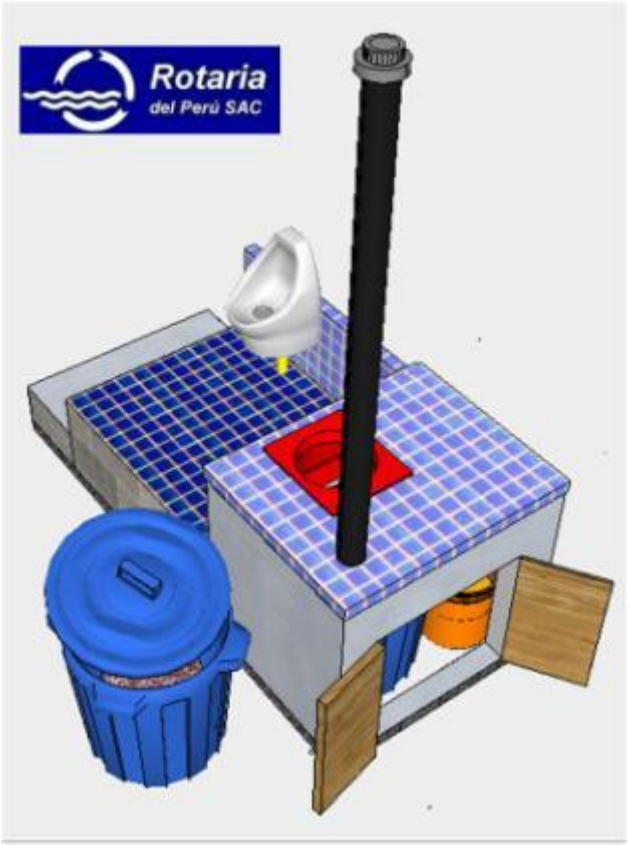
1. Divert the urine without using a urine diverting seat
2. Apply the urine diverting seat in a different way

Up: Instead of urine diverting seat a **tailored and slightly deformed funnel** (or bottle) can be used. This should be cut and fixed in a commercial seat.

Down: Also the Rotaria urine diverting seat can be used in different ways.

Options

3. One vault system with container 1



The container system uses only one vault; the Eco-toilet should not change the place. What changes is the container below, how frequently depends on the use of the toilet. Plastic containers (bins) of 50 to 60 L are used, these are protected using papers and prepared with sawdust (see Photos).

The container is filled in 2 to 12 weeks, but during this time the excreta is not fully treated, and needs further treatment, such as in a compost pile, which reaches temperatures of > 60°C. Papers are decayed together with the excreta and the product is totally sanitized, however, the process needs care and knowledge, it is recommended to apply it where a collection and centralized treatment system of the excreta can be implemented.

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Options

3. One vault system with container 2

The dry toilet with one vault and a mobile container is a good option where the space is not enough to build two vaults and also where the use is very frequent, such as public toilets.

The examples show private and public toilets in Peru. The wooden toilets are movable, but it is always recommended to be able to remove the excreta out of the toilet.

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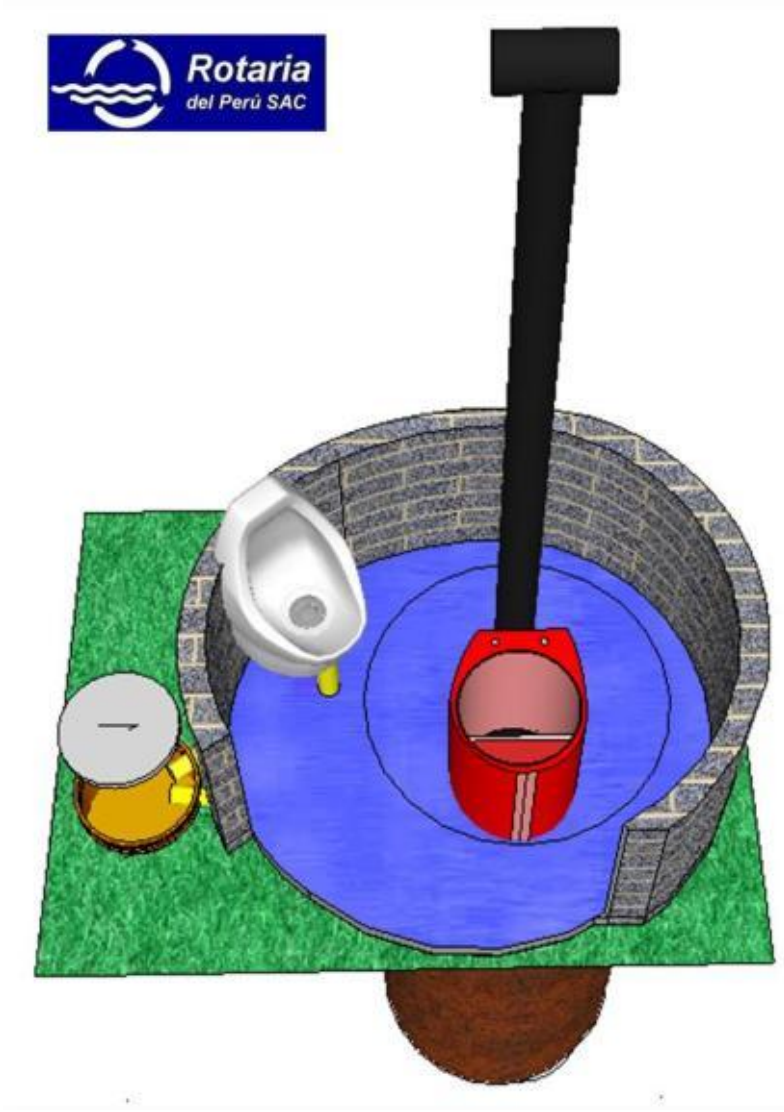
Options

4. EcoLet Rotaria; excreta disposal in the ground 1

The EcoLet is a ventilated pit latrine with urine diversion (UD-VIP), the hole is filled only with faeces.

The EcoLet / UD-VIP has no odors due to:

1. It is a pit totally dry, without urine or water.
2. The faeces are covered with drying materials (ashes, sawdust, soil, leaves).
3. It has a ventilated pit with a toilet seat closed.



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Options

4. EcoLet Rotaria; excreta disposal in the ground 2

The use of the EcoLet is limited to regions without heavy rain, so that no water enters the pit. Use may be temporary (for example in case of disasters) or if the place will be changed when the pit is full, therefore the installation is always outside the house.

EcoLet Rotaria combines the advantages of the latrine (construction is simple, fast and economical) with the advantages of the dry toilet and the opportunity to adapt to the use of a dry toilet without handling faeces. Urine can be reused.

Ventilated covered pit

Urine collection or infiltration