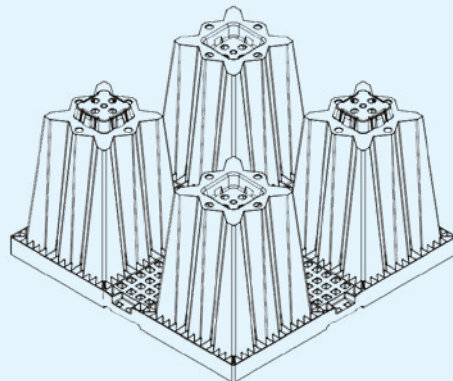
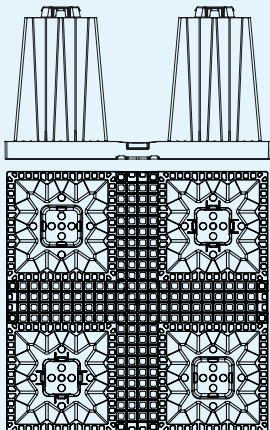




INSTALLATION MANUAL

AQUABOX

MODULAR SYSTEM FOR STORMWATER MANAGEMENT



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INSTALLATION MANUAL

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INTRODUCTION

Aquabox is designed to withstand pedestrian loads, HGV30 and HGV60, according to the design specifications provided by the manufacturer, after installation and backfilling. During installation work, it is recommended to mark off the tank area so that it is clearly visible by prohibiting the transit of unauthorized vehicles in the basin area.

Aquabox is not designed to be used as a loading platform for construction traffic and should be treated accordingly. After completing the work, it is recommended that provide signage indicating the loads maximum allowed on the footprint of the tank.

1. EXCAVATION AND INSTALLATION SURFACE

1.1 EXCAVATION AND BEDDING LAYER

The excavation must be carried out according to the design specifications. During the work, the walls of the excavation must be sloped or constructed in such a way that they do not cause any danger for the workers. In any case, local regulations must be observed. Take all measures to ensure that the trench is free of water during the entire installation phase. Indicatively, a perimeter clearance of at least 19.6" (50 cm) should be created between the plastic material structure and the excavation wall.

For proper installation of AQUABOX and AQUABOX CUBE modules, it is essential to create a flat and stable laying bed. For this purpose, a bedding layer of 6" (15 cm) with crushed stone or fine gravel (3/8"-1/2" or 10-12 mm diameter) has to be created.

This layer must be carefully compacted and smooth to obtain a flat surface. The quality of the bedding layer is critical for the installation of the modules and strongly influences both the load-bearing properties and the installation of the infiltration modules, especially in case of multilayer tanks and high loads (soil and vehicular traffic loads).



Compression level Dpr must be $\geq 97\%$ ($Evd \geq 25 \text{ MN} / \text{m}^2$ or $\text{CBR} \geq 8\%$ top edge of bedding). If soil has been included in the infiltration calculation, the permeability of the compacted layer must at least correspond to the permeability (k_f value) of the backfill soil (soil groups GE, GW, SE, SW, SI). Please consult the paragraph 3.12 for acceptable loads during construction phase.



1.2 AQUABOX PALLETS UNLOADING

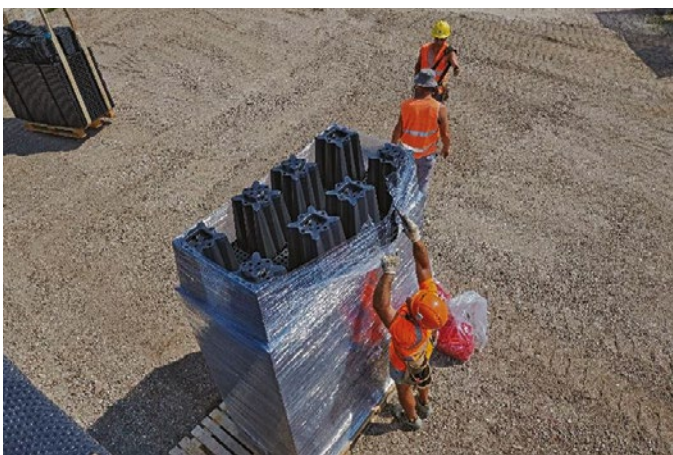
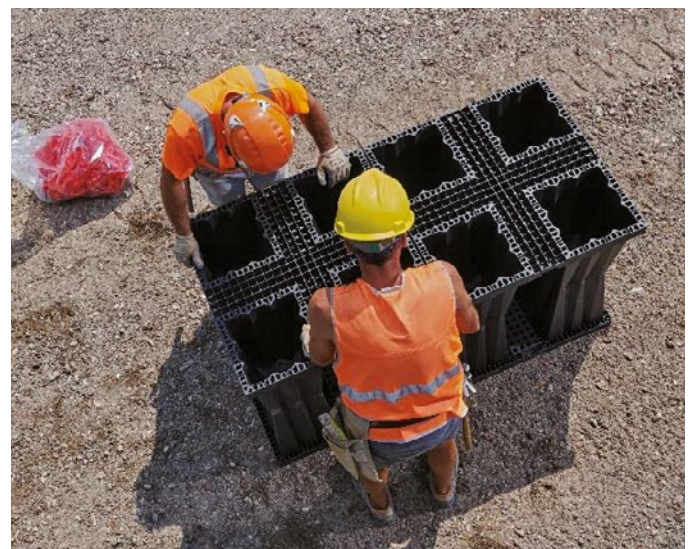
Aquabox modules are delivered stacked on pallets. A standard pallet carries 80 half modules for 40 boxes. The pallet is wrapped in plastic film. Accessories are packed on different pallets.

Unload the pallets using forklifts or others lifting tools. During unloading, the operator should pay attention to any pallets that have moved during transport and may have rested against other pallets or container/truck walls. It is recommended that all necessary measures be taken to prevent these pallets from falling on operators.

Once the pallet has been lifted, make sure it is stable for the entire unloading operation. Otherwise, stop the operation and stabilize the pallet.

CAUTION: Solid and level ground is required for storage. It is also recommended that the material be installed within 12 months if stored outdoors. Avoid dropping or bumping the modules against each other. Also avoid placing the pallet on its side.

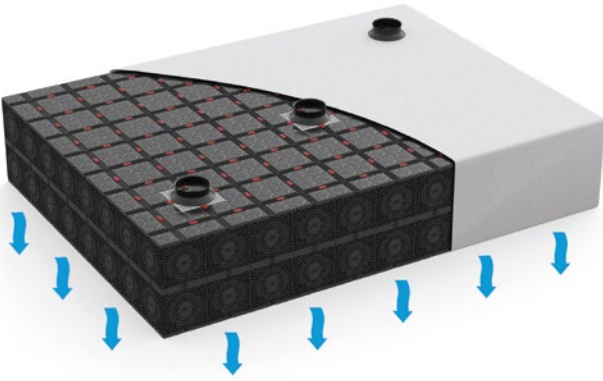
At temperatures below freezing (0°C; 32°F), it is necessary to pay special attention during handling.



2. GEOTEXTILE AND GEOMEMBRANE LAYERS

2.1 INFILTRATION TANK

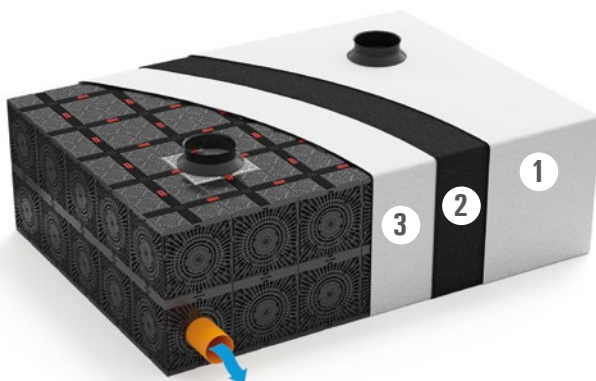
An AQUABOX infiltration tank must be water-permeable, and is simply wrapped in one layer of geotextile.



2.2 DETENTION TANK

In order to create a detention tank 3 layers are required:

- ① First layer-geotextile
- ② Second layer-geomembrane
- ③ Third layer-geotextile



2.3 FIRST LAYER - GEOTEXTILE

The following paragraph applies to both infiltration and detention tanks.

Initially, the first layer of geotextile must be laid on the bedding layer. The purpose of this layer is to protect the underside geomembrane from the roughness of the bedding material.

The geotextile must have an excess side length enough to eventually wrap around the entire system.

It should overlap at least 2' (60 cm) on all edges and 8" (20 cm) between the rolls.

Below minimum characteristics for geotextile:

PROPERTY	TEST METHOD	UNIT	M.A.R.V. (Minimum Average Roll Value)
Grab Tensile	STM D4632	lbs (kN)	160 (0.711)
Grab Elongation	STM D4632	%	50
Trapezoid Tear Strength	ASTM D4533	lbs (kN)	60 (0.267)
CBR Puncture Resistance	ASTM D6241	lbs (kN)	410 (1.82)
Permittivity*	ASTM D4491	sec ⁻¹	1.5
Water Flow*	ASTM D4491	gpm/ft ² (l/min/m ²)	110 (4480)
AOS*	ASTM D4751	US Sieve (mm)	70 (0.212)
Melting Point	ASTM D276	Fahrenheit (Celsius)	320 (160)
UV Resistance	ASTM D4355	%/hrs	70/500

Ensure that the surface of the geotextile is completely closed and that no openings occur during backfilling!



2.4 SECOND LAYER-GEOMEMBRANE

Carry out the following only in the case of a detention/accumulation tanks.

The geomembrane must be laid on top of the previously laid geotextile as indicated at point. 2.1.

Perform all heat welding that cannot be performed after installation of the AQUABOX elements, such as those under the tank.

Below minimum characteristics for geomembrane:

GEOMEMBRANE

FEATURES	VALUE	STANDARD
Mass	240 [g/m ²]	UNI EN 1849-2
Thickness	0,3 [mm]	UNI EN 1849-2
Tensile strength [MD]	20 [kN/m]	UNI EN ISO 527-4
Tensile strength [CMD]	20 [kN/m]	UNI EN ISO 527-4
Resistance to static punching	3,25 [kN]	UNI EN ISO 12236
Temperature resistance	- 30° ≤ T°C ≤ 70°	
UV resistance	A500 kLy	
Liquid tightness	< 10-6 [m ³ · m-2 · d-1]	UNI EN 14150
Root resistance	No penetration or crossing	UNI CEN/TS 14416

2.5 THIRD LAYER-GEOTEXTILE

Before install the AQUABOX modules, a layer of Geotextile must be laid to protect the waterproof membrane from the sharp edges of the AQUABOX.

Some part of AQUABOX module could damage the geomembrane under heavy operating loads.

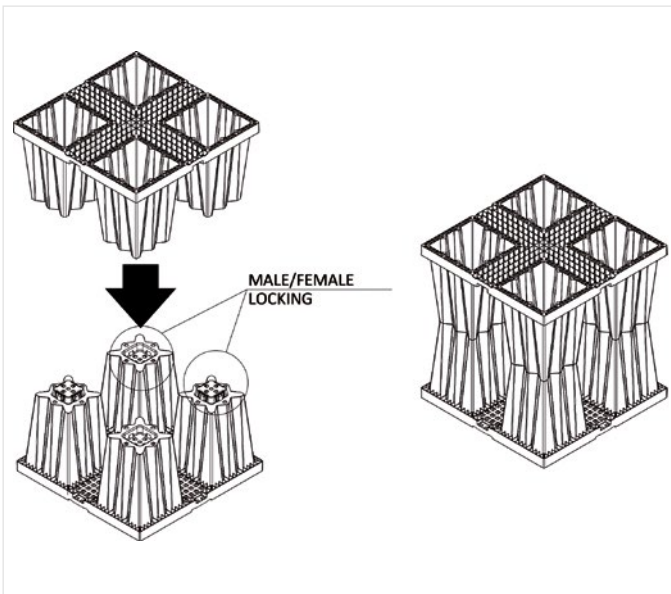


3. INSTALLATION OF AQUABOX MODULES AND ACCESSORIES

Each AQUABOX module consists of two half elements. Thanks to the Aqualock overlapping system, each module can be pre-assembled by a single person without the need of crane or mechanical means of transport. The modules can be pre-assembled either inside or outside the trench. The pre-assembled modules must then be organised according to the design specifications. Complete tightening of the elements will occur once the load is applied (soil backfilling).

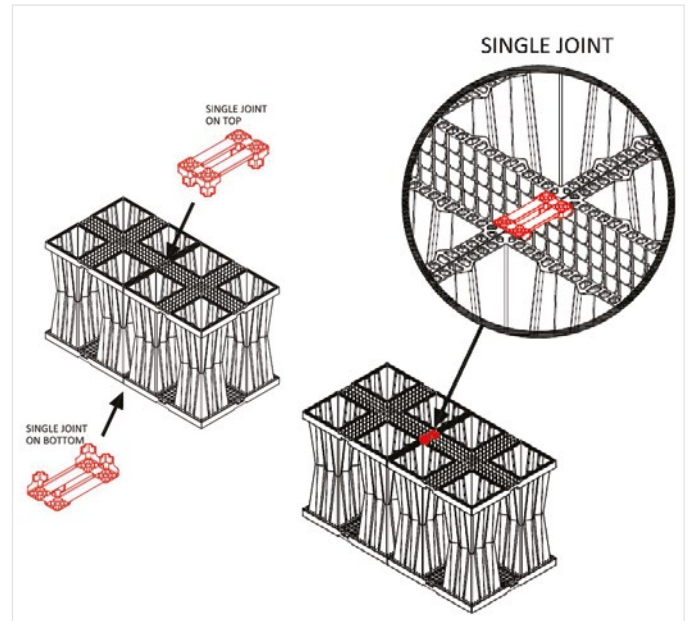
3.1 AQUABOX MODULE ASSEMBLING

Each AQUABOX features plug and socket connections, which makes assembling the modules very quick and easy. Simply lay one element on the ground and join it to another by applying some pressure.

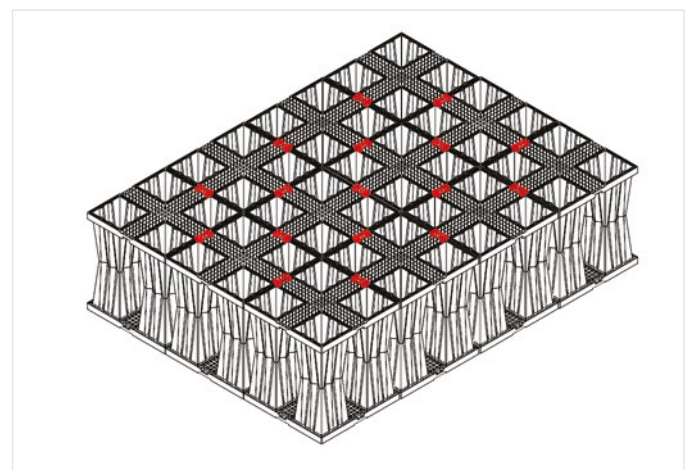


3.2 ONE LEVEL OF AQUABOX

Pre-assembly the AQUABOX. Modules are linked using the SINGLE JOINT, two of which are used per connection, one under and one above. The single joints are inserted in the corresponding slots.



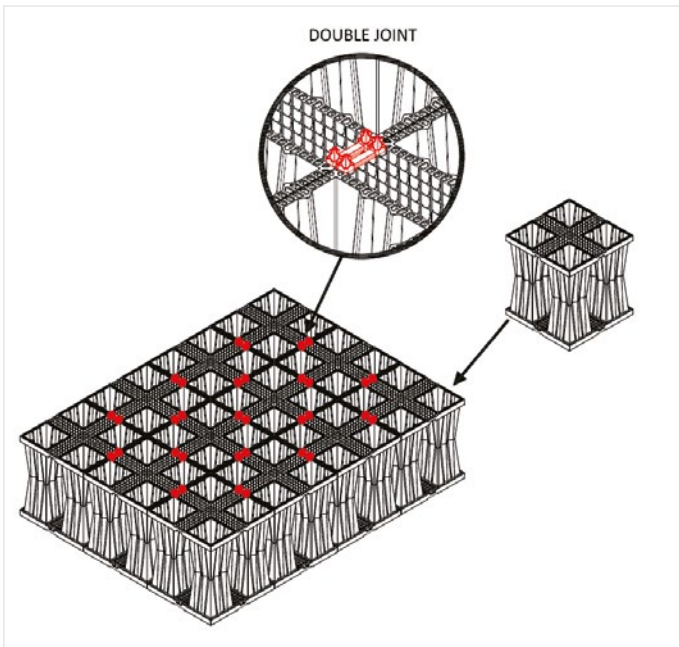
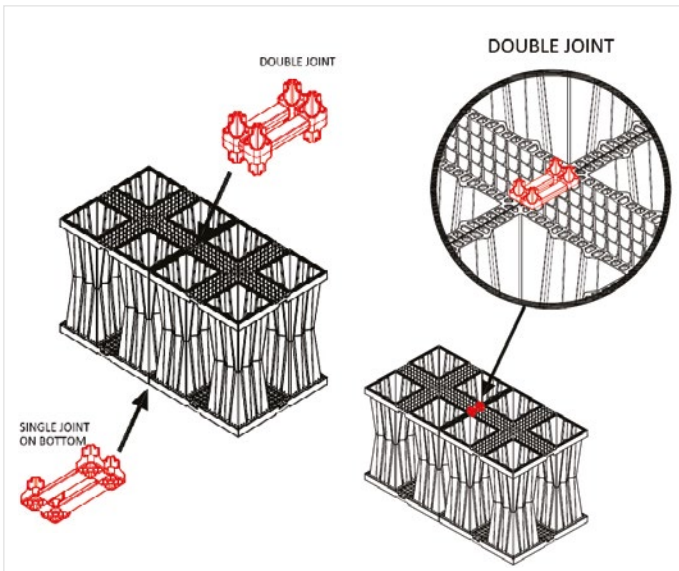
Continue linking the AQUABOX modules using all SINGLE JOINT above and below the modules as required, until all the modules.



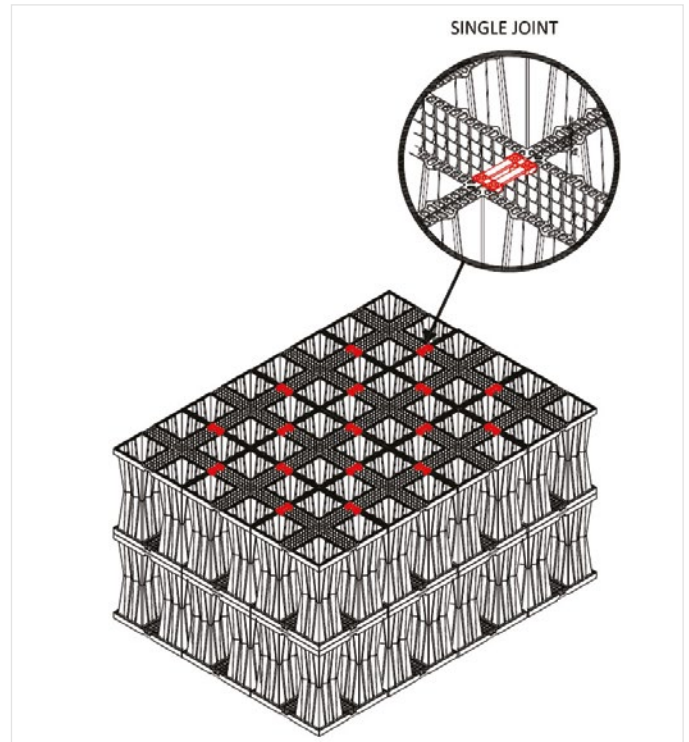
3.3 MULTIPLE LEVELS OF AQUABOX

Pre-assemble the AQUABOX. Modules are linked using the SINGLE JOINT below the modules (same as par. 3.1), and the DOUBLE JOINT in between.

The double joint connector is used to link stacked modules in two or more layers.

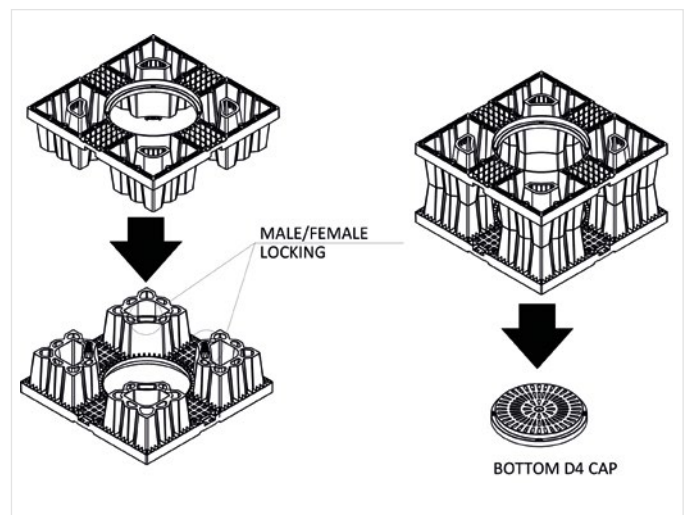


When the last layer of AQUABOX is installed, use the SINGLE JOINT as describe at par. 3.2.



3.4 AQUABOX CUBE

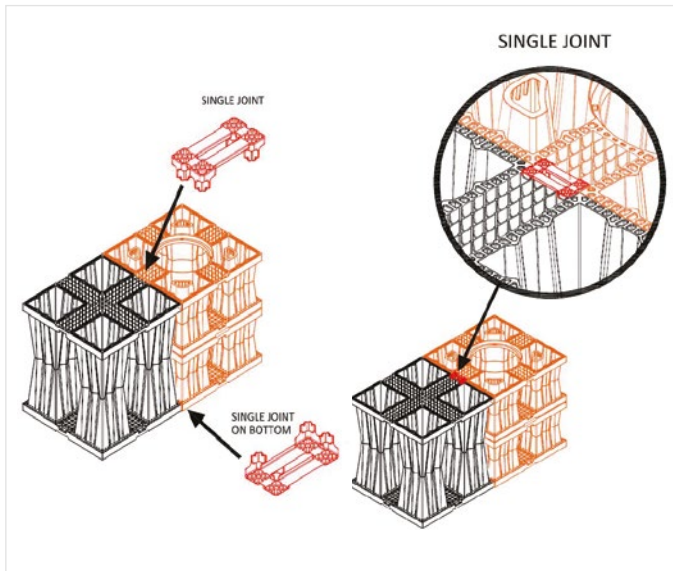
AQUABOX Cube module assembling is very fast and easy, thanks to his plug and socket connection in the middle part of the element, AQUABOX Cube can be assembled just pushing the two half pieces on the floor.



The D4 CAP is placed on the bottom of the tank in order, to lock the circular opening in AQUABOX CUBE.

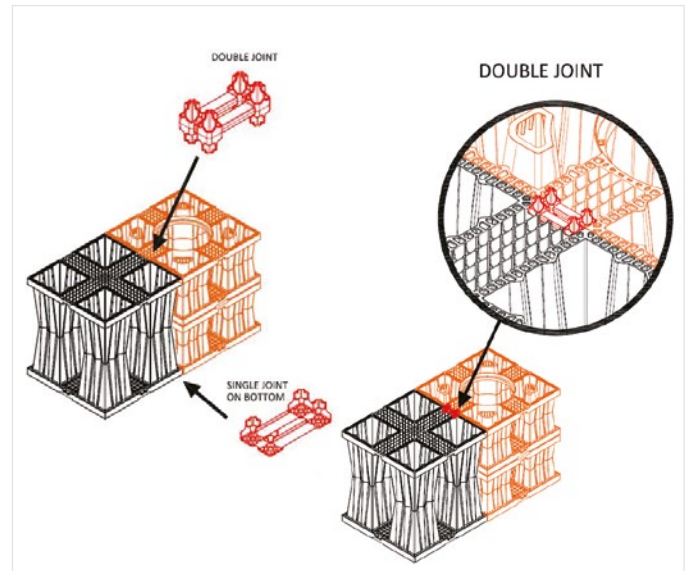
3.5 AQUABOX CUBE ONE LEVEL INSTALLATION

In one-layer installations SINGLE JOINT must be used for all links between elements.

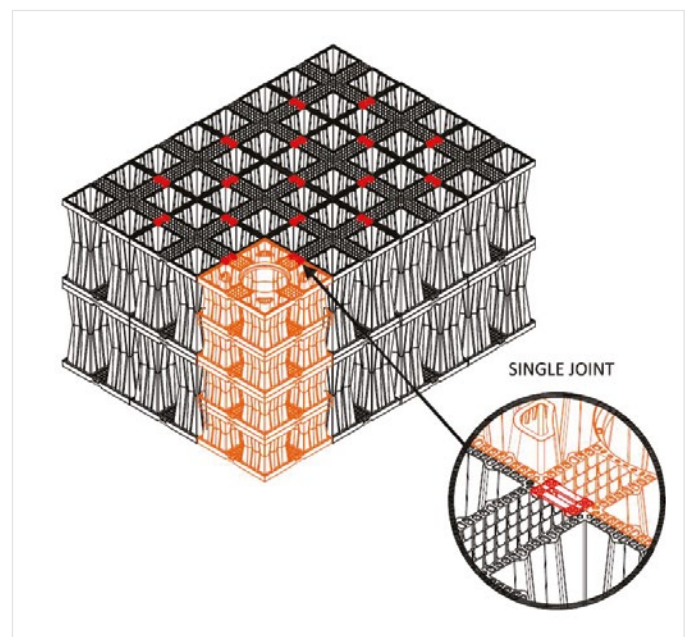
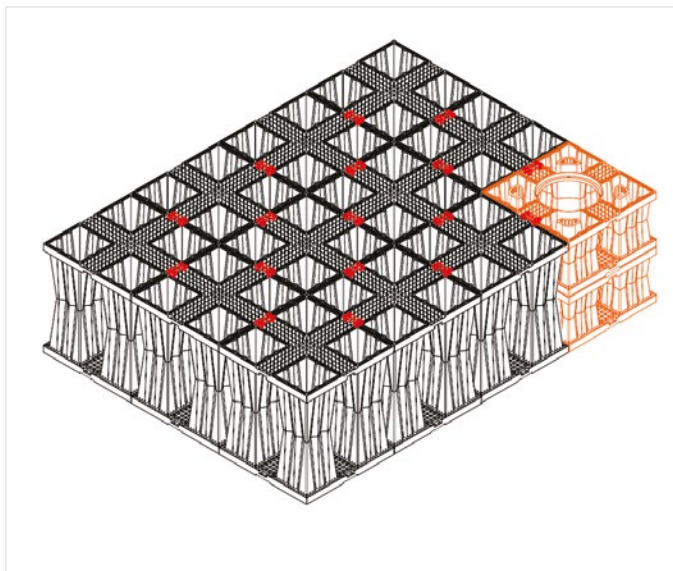


3.6 AQUABOX CUBE MULTIPLE LEVELS INSTALLATION

In case of multiple levels tanks, the connection between layers is done using the DOUBLE JOINT, connections under the first layer are done using the SINGLE JOINT.



Connections at the top of the last layer are done using the SINGLE JOINT connector.



3.7 SHAFT CONNECTION FOR AQUABOX CUBE

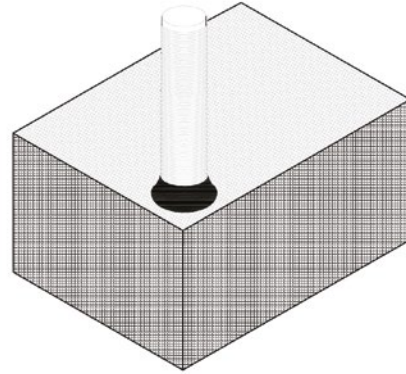
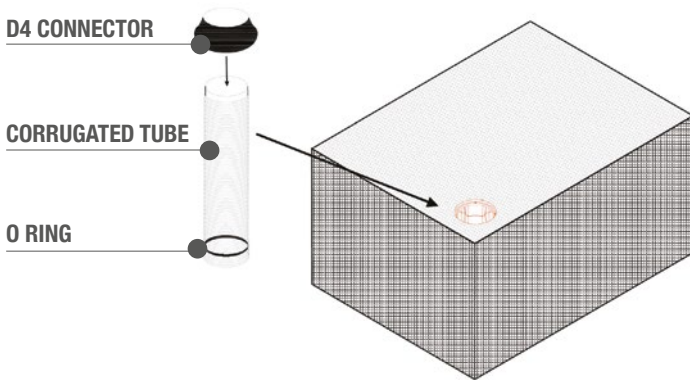
The connection of the shaft on the AQUABOX cube is easy as the tube will fit into the diameter DN 16" (40 cm) opening in the AQUABOX CUBE module, and will remain standing with minimal support required. This operation must be performed after the geomembrane and the geotextile layers are installed above the tank.

Depending from the acting loads, the inspection point cover may be installed directly onto the end of the tube, or instead, in the case of heavy loads, a load-distribution concrete ring to support the cover element is mandatory.

Smooth tubes can be used instead of corrugated tubes.



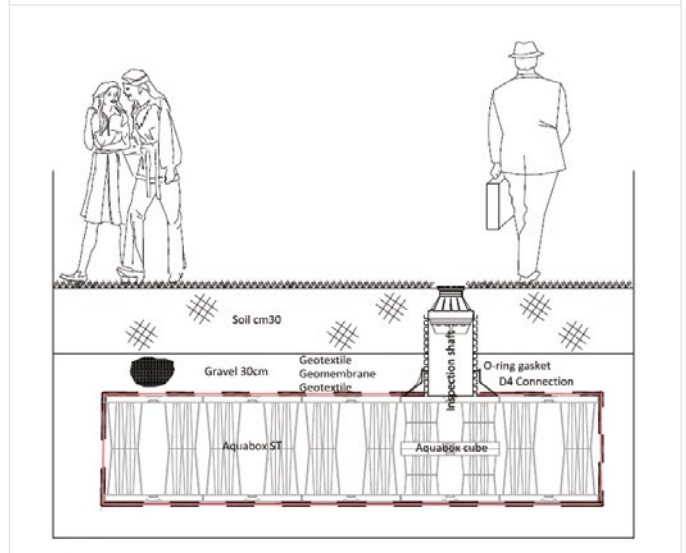
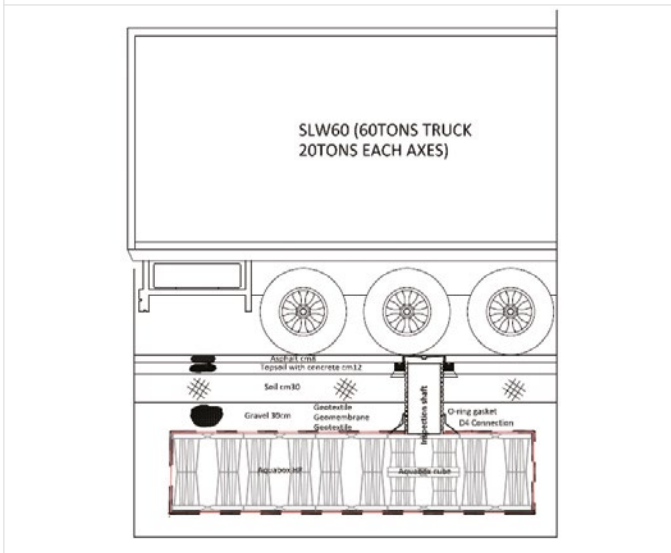
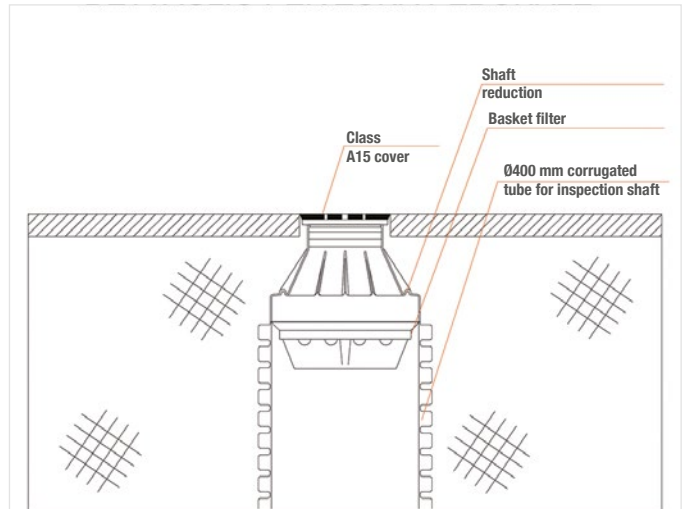
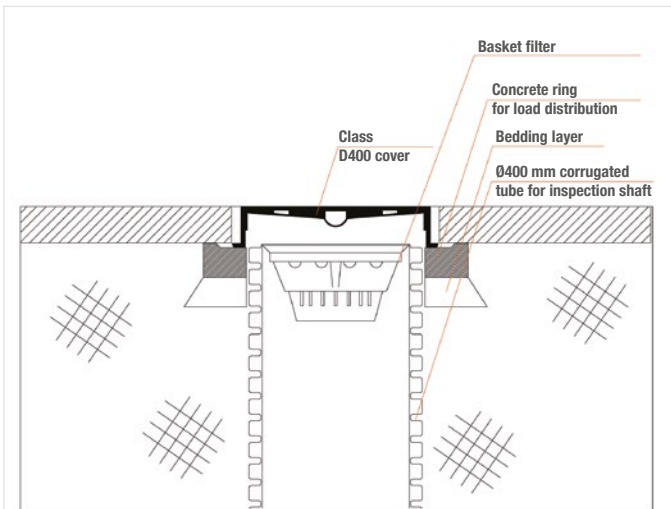
Installation of inspection shaft and accessories shown below.



Heavy traffic Inspection shaft detail. Note that the manhole cover is supported by a concrete ring around the tube.

VEHICLE LOAD COVER DETAIL

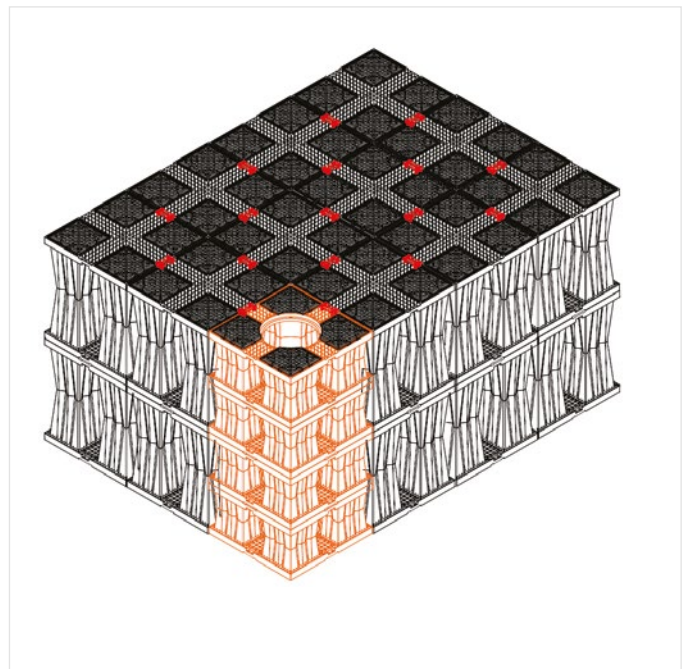
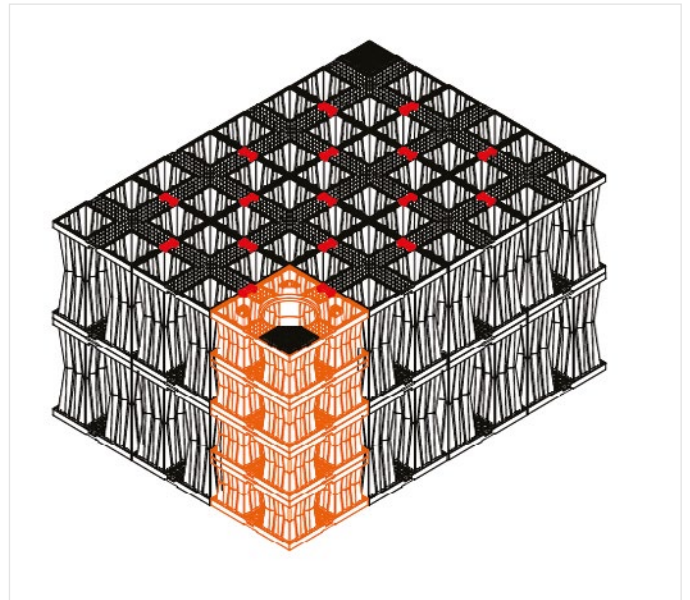
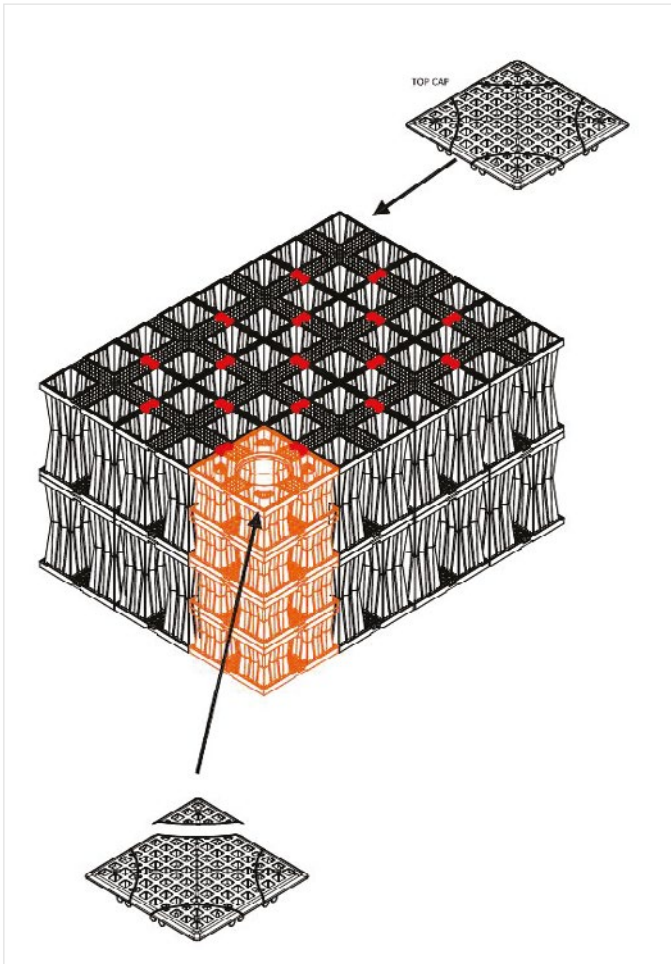
PEDESTRIAN LOAD COVER DETAIL



3.8 TOP CAP ELEMENT FOR AQUABOX AND AQUABOX CUBE

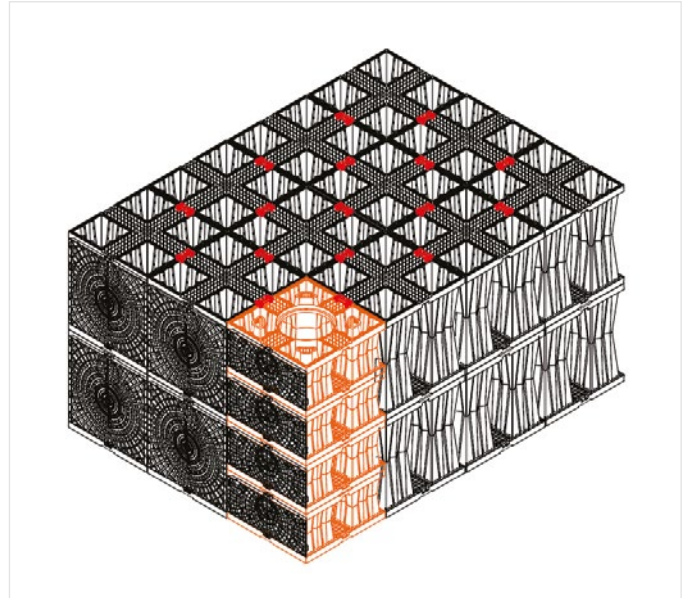
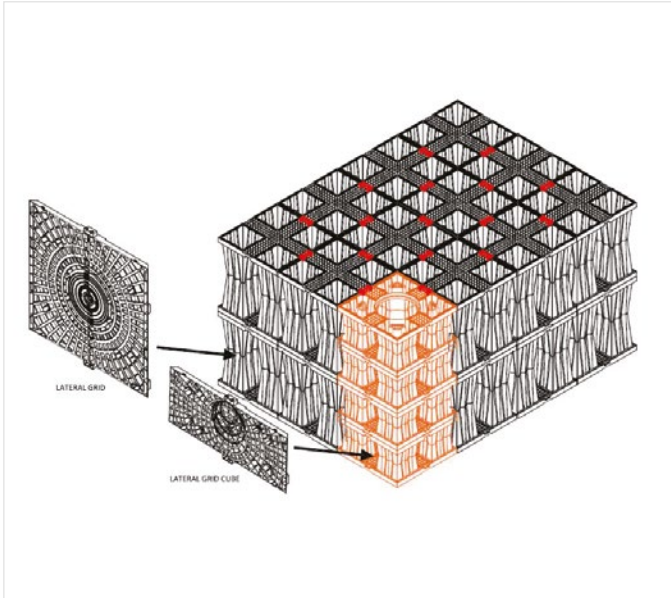
The TOP CAP elements are fitted onto the highest level of AQUABOX modules, its purpose is to provide a continuous support for the geotextile layer.

To fit the Top Cap onto AQUABOX CUBE elements simply cut off the corners along the marked lines. It is suggested to use a rubber hammer to force if the Top caps are hard to install. Do not use the iron hammer.

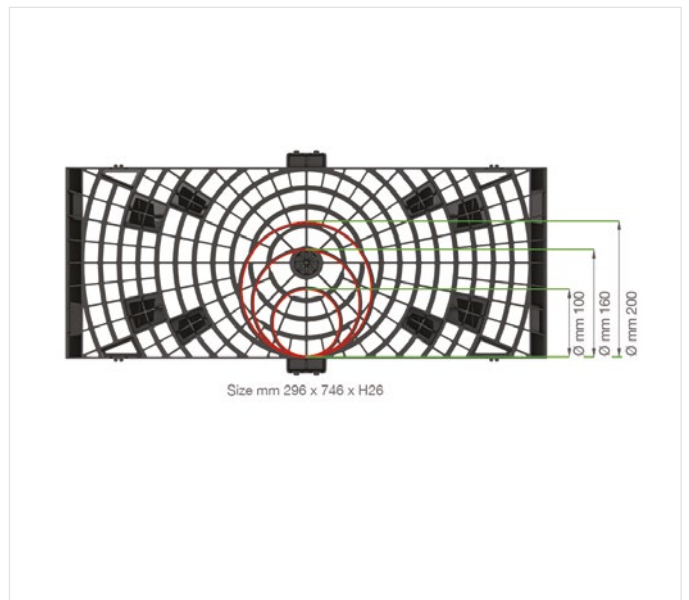
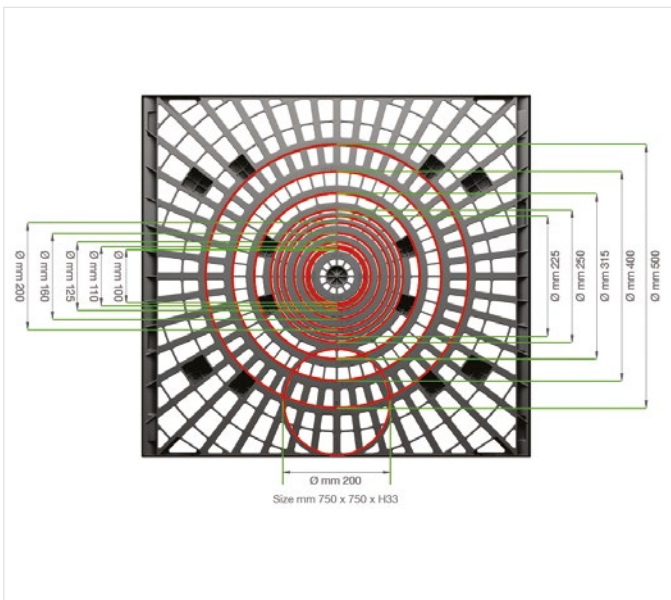


3.9 SIDEWALL GRIDS

Once the AQUABOX modules have been installed, the sides of the tank are closed using the SIDE GRIDS.



On the grid elements there are several dimension of tubes indicated. In this way is easily to understand which dimensions has be to cut with perfect accuracy.



3.10 COVERING WITH GEOTEXTILE

AQUABOX systems must be completely wrapped in the geotextile that was previously laid underneath. At the edges, it is important to ensure enough overlap of the geotextile (at least 2' or 60 cm) to prevent the intrusion of the backfill material into the system. Make a cross-shaped cut in the geotextile at inlet/outlet points. Before backfilling be sure that the surface of the geotextile is completely closed and without any openings.



3.11 LATERAL BACKFILLING

For lateral backfill, it is recommended to use a noncohesive, unfrozen material with max grain size 1" (2.5 cm). Suggested is 3/4" (19mm) angular stone. The backfill material shall be well distributed and compacted in layers of max 12" (30 cm) using a compaction method that always spreads the layers over the entire tank and compacts them with a vehicle or medium-heavy vibrating machine with a maximum compaction force of 6,000 lbs (3 ton). The space between the structure and the edge of the excavation should be filled initially, rising evenly. Do not be fill only one side at a time, leaving the others empty. In doing so, a Dpr \geq 97% must be achieved as a level of compaction. Modules must NOT be damaged. National soil handling guidelines must be followed. Care must be taken to ensure that the geotextile is properly overlaid and not damaged during backfilling and compaction. Remarks for lateral filling:

- Do not use coarse/crushed fill materials > 1" (2,5 cm) and do not use clay materials;
- Do not damage the geotextile and/or geomembrane.



3.12 TOP BACKFILLING/EQUIPMENT DURING INSTALLATION

According to the intended use of the area, we proceed with the backfilling of the system up to the design elevation and the construction of the planned finish.

The top overlay of the drainage/retention system, shall be made according to the design thickness (with gravel of grain size 3/8"-1/2" or 10-12 mm diameter for the first 6" (15 cm). This lift does not need to be compacted, always spreading the layers evenly over the entire basin.

Only after 12" (30 cm) of gravel is in place can low pressure tracked vehicles be used over the system according to the next table.

The first layer of cover (6" or 15 cm) can be laid using means such as wheel loaders or small excavators from the outside of the excavation area. No mechanical equipments are allowed on top of the until 12" (30 cm) are reached.

It should be noted that Geoplast Spa is not liable for any damage to the system if the requirements are not met indicated above.



MATERIAL LOCATION	FILL DEPT OVER AQUABOX IN. (mm)	MAX ALLOWABLE WHEEL LOAD		MAX ALLOWABLE TRACK LOAD		MAX ALLOWABLE ROLLER LOADS
		MAX AXLE LOAD FOR TRUCKS lbs (kN)	MAX WHEEL LOAD FOR LOADERS lbs (kN)	TRACK WIDTH IN. (mm)	MAX GROUND LOAD PSF (kPa)	MAX DRUM WEIGHT OR DINAMIC FORCE lbs (kN)
Final fill material (from the top of previous layer, going up)	36" (900) compacted	32,000 (142)	16,000 (71)	12" (305)	3,880 (186)	38,000 (169)
				18" (457)	2,640 (126)	
				24" (610)	2,040 (997)	
				30" (762)	1,690 (81)	
				36" (914)	1,470 (70)	
Initial fill material (from the top of modules, going up)	24" (600) compacted	32,000 (142)	16,000 (71)	12" (305)	2,690 (128)	20,000 (89)
				18" (457)	1,880 (90)	
				24" (610)	1,490 (71)	
				30" (762)	1,280 (61)	
				36" (914)	1,150 (55)	
	24" (600) loose/dumped	32,000 (142)	16,000 (71)	12" (305)	2,390 (114)	20,000 (89) Roller gross vehicle weight not to exceed 12,000 lbs (53kN)
				18" (457)	1,700 (81)	
				24" (610)	1,370 (65)	
				30" (762)	1,190 (57)	
				36" (914)	1,080 (51)	
	18" (450) compacted	32,000 (142)	16,000 (71)	12" (305)	2,110 (101)	20,000 (89) Roller gross vehicle weight not to exceed 12,000 lbs (53kN)
				18" (457)	1,510 (72)	
				24" (610)	1,250 (59)	
30" (762)				1,100 (52)		
36" (914)				1,020 (48)		
12" (300)	16,000 (71)	NOT ALLOWED	12" (305)	1,540 (74)	20,000 (89) Roller gross vehicle weight not to exceed 12,000 lbs (53kN)	
			18" (457)	1,190 (57)		
			24" (610)	1,010 (48)		
			30" (762)	910 (43)		
			36" (914)	840 (40)		
Perimeter Stone (space between the excavation wall and the modules)	6" (150)	8,000 (35)	NOT ALLOWED	12" (305)	1,070 (51)	NOT ALLOWED
				18" (457)	900 (43)	
				24" (610)	800 (38)	
				30" (762)	760 (36)	
				36" (914)	720 (34)	

3.13 CONNECTIONS

Inflow water should be as clean as possible in order to avoid clogging of the system and contamination of the final receptor.

The degree of cleaning to be achieved depends by:

- Inlet water quality.
- Standards and codes.
- The final receptor.



In the absence of regulatory requirements we recommend:

- Provide systems to remove coarse solids (sediment traps). An increase in the depth of inlet wells can be provided to facilitate sediment settling.
- Install an oil separator if the system disposes of runoff from a parking lot /gas station and the final discharge is the soil.

The sizing of the collectors is the responsibility of the designer of the project.

The maximum pipe diameter that can be inserted into the Lateral Grid is Ø 20" (50 cm).

Pipe is recommended to be inserted at least 2"-5" (5-13 cm) (depending on the diameter of the pipe) inside the grid of the side closure.

Correct positioning of the pipe will occur due to the material gravel used for the side backfill (please pay special attention for this operation in order to keep the pipe on axis).

We also recommend to skim the grate/pipe joint to enhance sealing.

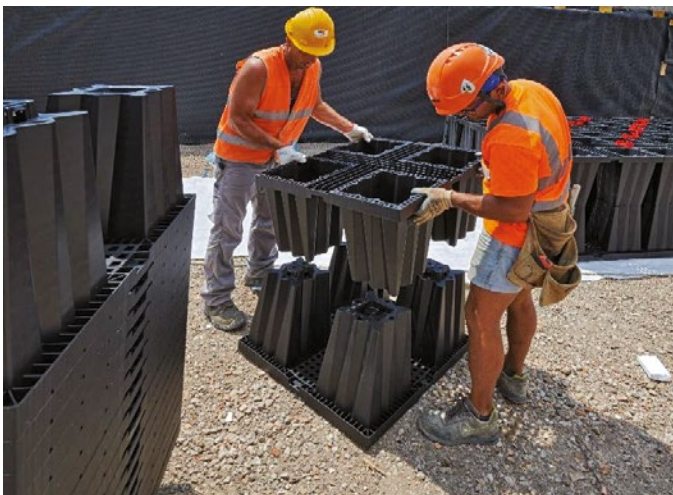
If the collector is larger of diameter 20" (50 cm).

- Branches of the line should be provided with grafting into the system by reductions of the diameter.
- The number of branches will depend on the inlet flow rate planned;
- The adoption of an outlet line is necessary for the disposal of the incoming flow rates exceeding the volume of expected accumulation.

An emergency by-pass can also be provided called outflow.

4. INSTALLATION SEQUENCE - VISUAL GUIDE

4.1 INSTALLATION OF AQUABOX MODULES





4.2 AQUABOX CUBE INSTALLATION



4.3 GEOTEXTILE WRAPPING AND BACKFILL MATERIAL



5. MAINTENANCE AND CLEANING

INTRODUCTION

Make sure that no unwanted objects flow into the pipes and in the AQUABOX system. Special attention is required if a polluting substance will be present in near the installation area. first checks (and all cleaning operations) should take place before the delivery of the material and after the complete installation of the system.

A visual inspection of the system and inlet shaft, as well as an inspection with video camera robots are recommended these inspections should then be recorded in a maintenance book of the tank further checks should take place every six months for the first year of use.

These inspections will give information useful to program the inspection and cleaning interventions for the future until finding the right frequency with which to perform them. In the case of intense storm events (e.g. events with return times of 10 years) it is recommended to inspect the system in all its parts and consider the possible cleaning.

To this end, cleaning operations must start with cleaning of supply pipes and upstream wells, especially if they also act as a sediment trap.

There after the system should be inspected and cleaned at least twice a year, preferably in Spring and Autumn, and after every extreme weather event.

System control is essential the in the following periods:

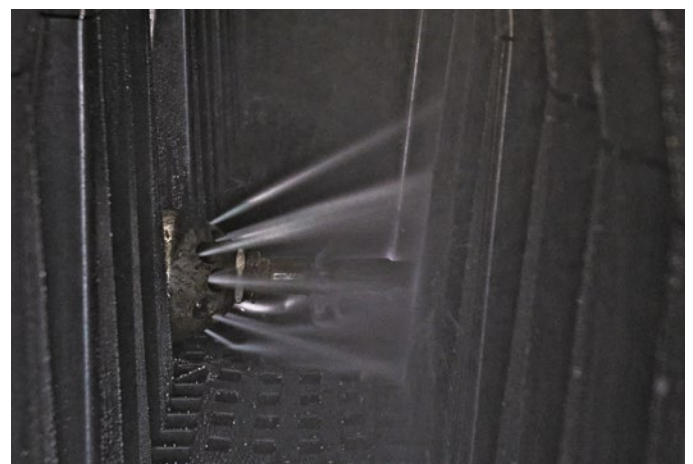
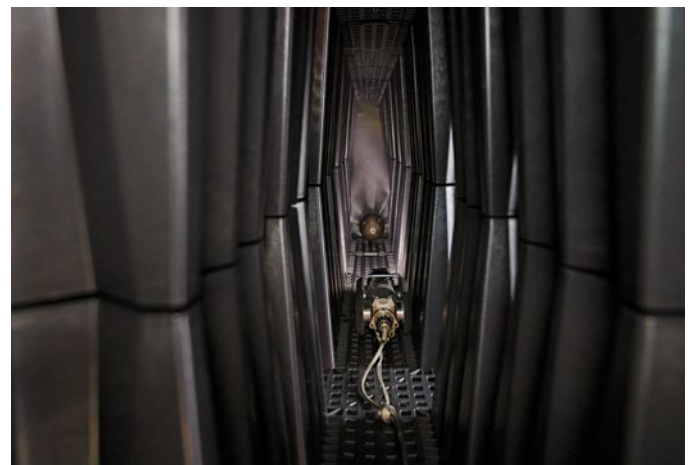
- End of construction site operations;
- After intense rainfall events;
- In case of failure or malfunction of the pretreatment units, if applicable;
- At least once a year.

5.1 CLEANING OF THE AQUABOX MODULES

Cleaning of the drainage system can usually be carried out by cleaning and vacuuming the dirt from the inspection shaft.

Cleaning operations must begin from the cleaning and vacuuming of the upstream pipes and from the upstream inspection shaft or the sediment trap if present. In case of heavy pollution (high amount of sediment) cleaning of the whole Aquabox system must be done with high pressure cleaning of the internal channels.

When cleaning with a spray probe, it is recommended to use nozzles with a rotation of 90° and a water jet at 45°. The nozzles used must have a pressure between 1,160 *psi* (80 bar) and 1,740 *psi* (120 bar), higher pressure values could damage the geotextile. The clear passage within the Aquabox modules is 6.5" (16 cm). Please make sure that any inspection or cleaning equipment used within the tank does not exceed this width. For systems with multiple layers, only the elements located at the lower part should be inspected.



Diameter of the AQUABOX CUBE extension tube: 400 mm
Maximum shaft depth: 6,5 m
Tunnel section, width x height: 17 x 30 cm

6. MAINTENACE SCHEDULE

Control programs are given below:

ITEM	TYPE OF WORK	FREQUENCY	TYPE OF CONTROL	WORKER
Pipelines and manifolds	Check of the integrity of the hydraulic seal (leakage) of pipelines. Check for the absence of deposits and clogging.	12 months	Visual and instrumental	Licensed worker
Manholes	Checking the condition of the manhole and absence of deposits and clogging.	12 months	Visual check	Licensed worker
Accumulation and retention tank	Checking for the presence of micro-cracks in the membrane. Check Hydraulic seal and absence of deposits and clogging inlet and outlet pipelines.	12 months	Visual and instrumental	Licensed worker
Infiltration tank	Control of infiltration efficiency and absence of deposits and duct clogging at the inlet and outlet.	12 months	Visual and instrumental	Licensed worker

7. DISCLAIMER

All images of AQUABOX components and products contained in this document are for illustrative purposes only. Colour, size, scale of the element and its representation may not correspond exactly to the product, but are represented in such a way to most effectively convey meaning.

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