SuDS in Schools

Planter Installation Guide

south east rivers trust

Contents

Introduction

The SuDS in Sutton's Schools (SiSS) Project is a partnership project between the London Borough of Sutton and the South East Rivers Trust, funded by Thames Rivers Trust and the Environment Agency. The primary aim of the project is to alleviate flood risk within Sutton by retrofitting Sustainable Drainage Solutions (SuDS) on school grounds.

In a series of summative reports, the Trust aims to share the expertise and lessons learnt through the various contributions the organisation made to the project; supporting other SuDS in School initiatives in the future.

1. **SuDS Planter Design**
2. **SuDS Planter Installation**
3. **Rain Garden**
4. **Education & Engagement**
5. **Monitoring**

All reports can be found and downloaded from the South East Rivers Trust website:
www.southeastriverstrust.org/sudsinschools/

Information on the future of the SiSS Project can be found on Sutton Council's website here:
https://www.sutton.gov.uk/info/200670/environmental_sustainability/2028/suds_in_sutton_schools

The Raingarden Planter

Raingarden planters can help address flooding risks by mimicking natural processes and managing surface water runoff. The installed planters will attenuate rainwater flowing off the roofs of schools in Sutton by temporarily storing the water and reducing the flashiness of water draining into the surface water network.

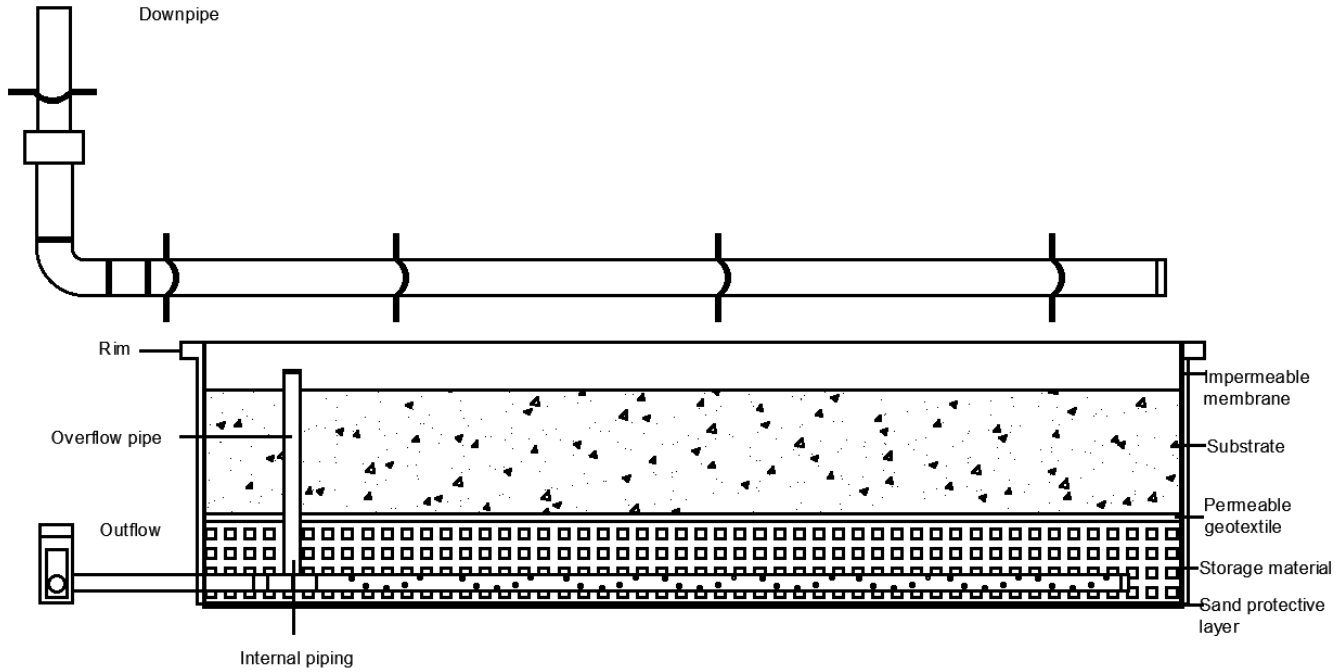

Figure 1: General diagram of a raingarden planter.

The planters are waterproof containers that are connected to a downpipe so the water coming from the roof is collected and then guided back into the sewer by the internal piping system (**Figure 1**:). The aim of the planters is to provide onsite benefits for schools as well as slowing the flow of rain to the drains. For more information on the design of the planters, read the full Design Report here.

There are different types of planter structures available and different methods for distributing the rainwater into the planters. This project tried three different types:

- Raised bed Plaswood© planters (supplied by Plaswood)
- Raised bed planters with in-built benches (supplied by Plaswood)
- Metal water troughs

This report is intended to guide and inform further installations by describing the installation processes of each type of planter with varying types of connections. This is based upon our findings after completing 6 raised recycled plastic planters, 2 in-built benches planters, and 2 water troughs planters.

Installing Metal Trough Planters

Metal troughs come ready assembled reducing costs and time in comparison to planters that require assembly or construction. The metal troughs that were used were steel drinking troughs for cattle. They come in a range of shapes and sizes. For this project, the largest size was required (3050 mm x 1200 mm x 610 mm high) to provide sufficient storage for the roof area feeding into it. For more details on how this was calculated, refer to the Design Report.

Table 1: General list of materials to install a water trough planter. Note different site configurations will require different items and quantities.

Materials	Qty.
PVC Tank Connector BSP Male Thread 50mm X 63mm X 2"	1
PVC Adapter Socket 50mm to 2"	1
PVC cap 32mm	2
PVC cap 50mm	1
PVC socket 32mm	2
PVC socket 50mm	1
PVC Reducing Bush 50 X 32	2
PVC Pipe PN10 (3m length) 50mm	1
PVC Pipe PN16 (3m length) 32mm	1
PVC tee joint 50mm	1
PVC 90 Degree Elbow 50mm	1
PVC Cement, 250ml	1

If using planters of this size, special care has to be taken for delivery. If they cannot be delivered in their final position by the delivery lorry equipped with a hi-ab, alternative means to move it will be required. This project hired a pair of 2-tonne hydraulic trolleys which worked well on hard, smooth surfaces.

The process for installation on location was:

- Make sure the ground is levelled.
- If necessary, install recycled plastic timber bearers beneath the planters to create a level surface. A laser level was then used to check the correct levelling of the supporting planks. (**Figure *1***).
- Move and position the planters into its final location.
- Once the planters are on level ground, a hole can be drilled in the planter in a direct line with the position of the outflow using a holesaw.

Figure 1: The ground being prepared for introducing supporting platforms.

The following figure (**Figure *2***) shows the general internal pipe composition of the planters. This design was modified according to the specific configurations of the different installation sites.

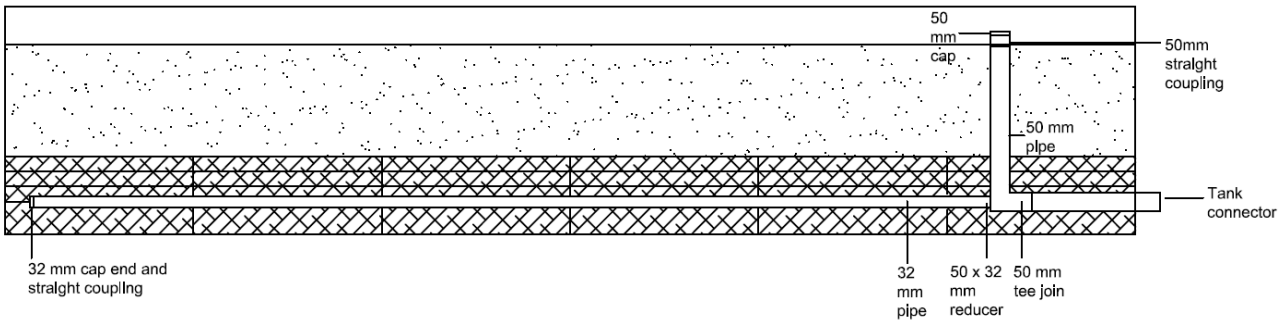

Figure 2: General internal piping of the planters.

- The internal pipes where installed inside the planter matching the configuration of the downpipe (**Figure *3***). As the planter walls are thinner than the plastic planters, a 2” tank connector was used with its corresponding adapting socket.

Figure 3: Installed configuration of the metal planter. Note the position of the outflow and how it affected the pipe connections and fittings.

- Cut and install the geocelluar crates (Figure *4*).

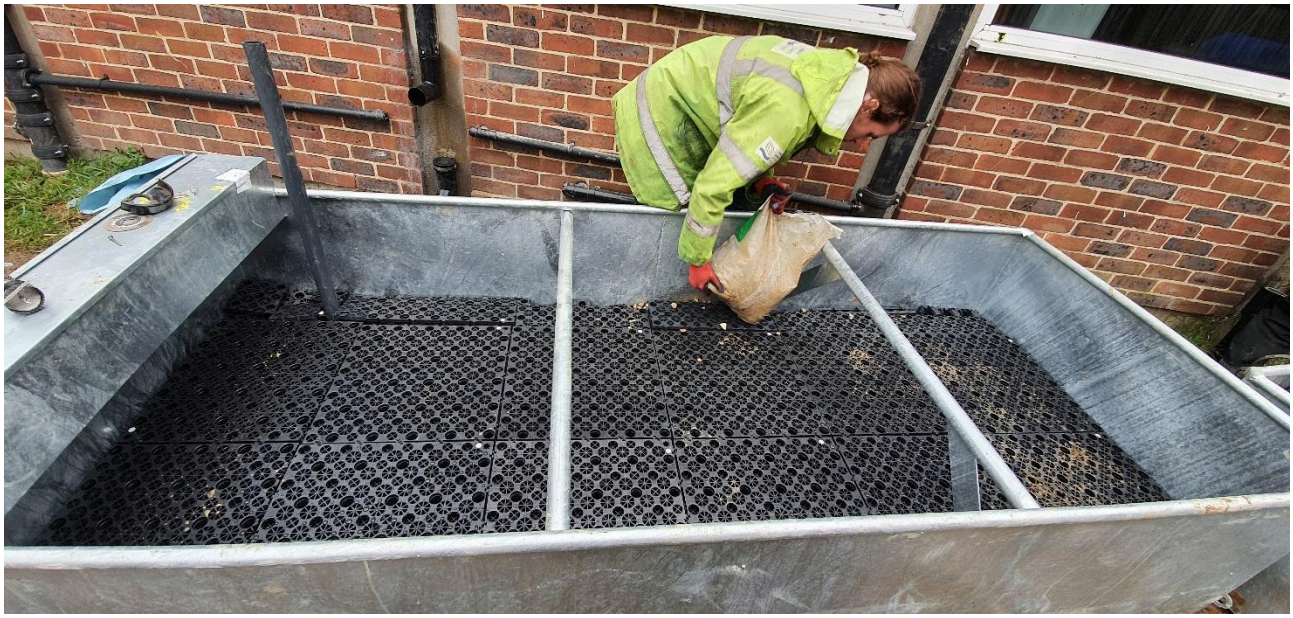

Figure 4: Installation of geocelluar crates and gravel into the water trough.

- Note in the image above that the planter is not exactly on its right position, this was to allow the downpipes to be cut and to install the outflow fittings.
- Install the mechanical boss connectors in the downpipe and connect it with the flexi hose to the planter's outflow (**Figure *5***).

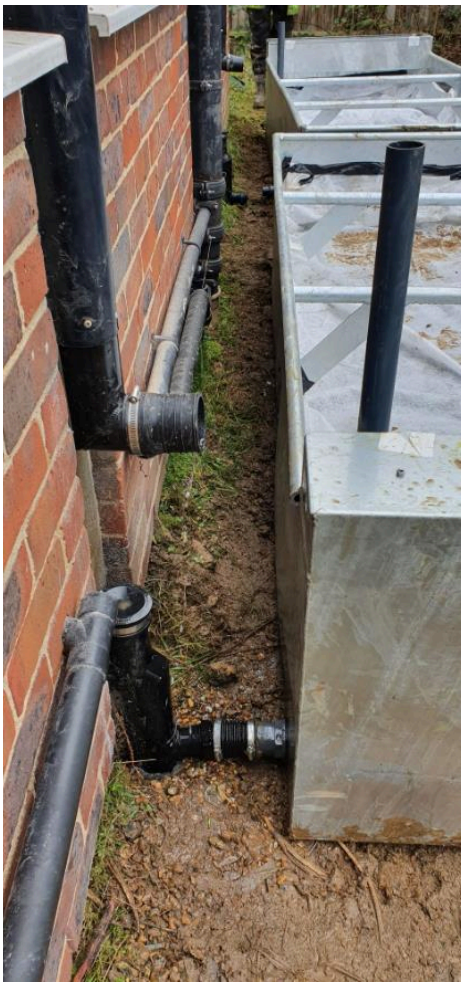

Figure 5: Water trough connected to the drain.

- Install the permeable layer and the soil to the correct specifications. (See page 22 under Substrate section).
- Connect the downpipe to the distribution pipe and install the brackets (**Figure *6***).
- Different configurations of distribution pipes had to be installed, be aware of these needs during the early stages of the project, and make sure the correct quantity and type of fittings are ordered (**Figure *7***).

Figure 6: Connection of the downpipe to the distribution pipe.

Note in the picture above that a halfpipe style of distributing the water was tested, however, the water dribbled off the edge and down to the low point of the pipe without being distributed equally along the planter. This method was rejected and we opted for the "raining pipe". Note that the separation of the planters from the wall required more and longer brackets (**Figure *7***).

Figure 7: Different configuration of the distribution pipe due to the position of the downpipe in relation with the planter.

The water troughs (Figure 8) were cheaper than the recycled plastic planters, they are also more durable and required much less installation time. The ground where this type of planter is to be installed should be preferentially already levelled or easy to modify. Concrete supports for water troughs are available, and they may facilitate the use of these planters in different situations.

Figure 8.- Final look of the water trough planters. Note the changes in the configuration of the downpipe and the distribution pipes.

Connecting Planters using a 'Raining' Downpipe

The method described in the following section was used to connect all types of planters installed during the project. To direct water from the downpipe to the planter, a system was designed that would ensure a good distribution of rainwater across the whole planter. It involves a perforated horizontal pipe that is fixed to the wall and runs the length of the planter. The general diagram of the chosen set up is as described in the following image (**Figure *9***).

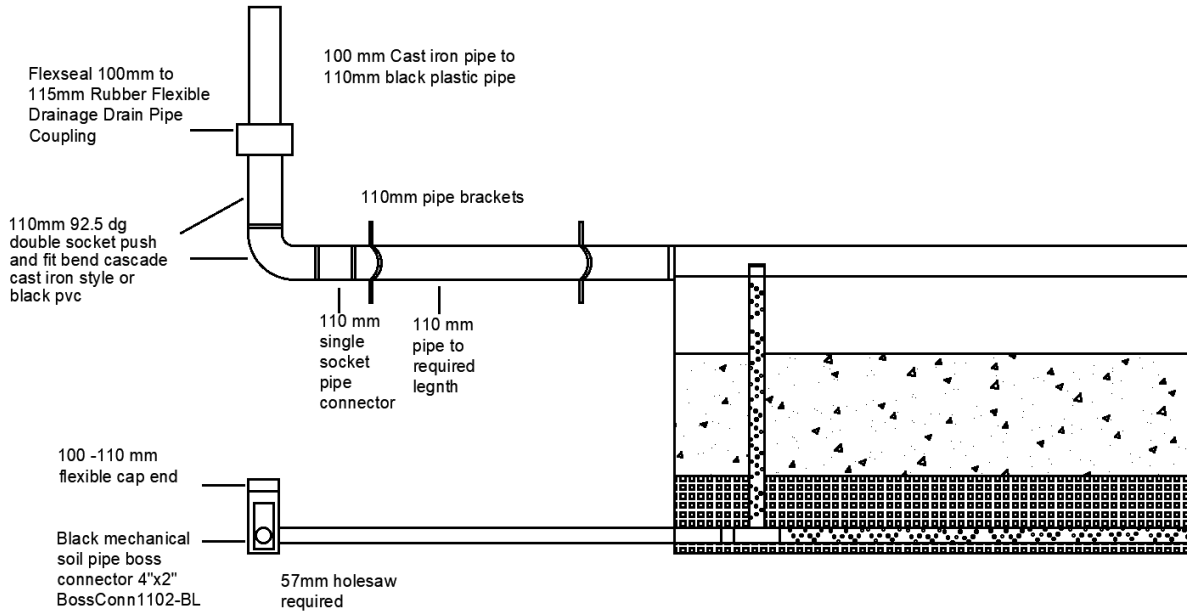

Figure 9: Drawing showing a generalised set up and material required for connecting the downpipes to the planters. Note that this configuration varied according to the site specific details.

Table 2: General list of materials to install the raining downpipe.

Materials Brackets	Qty.
M10 galvanised rod 500 mm	5
M10 galvanised nut	50
8mm x 50 mm galvanised hex screws	20
Galvanised Backplates	5
Galvanised pipe bracket (Select appropriate diameter range)	5
10 mm Rawl plugs	20
Raining pipe connection	
Flexseal 100 mm to 115 mm Rubber Flexible Drainage Drain Pipe Coupling	1
Cascade cast iron style 110 mm 92.5 dg single socket bend	3
Cascade cast iron style 110 mm x 2.5m single socket pipe	1
Flexible end caps	2
Leaf filter	1
Water chute connection	
	2
M16 threaded bar x 1m	2
M16 galvanised nuts	4
M16 galvanised washers	8
10 mm Rawl plugs	4
8 mm x 75 mm galvanised screws	4
Flexseal 75 mm to 85 mm Rubber Flexible Drainage Drain Pipe Coupling	2
82 mm Solvent Weld PVCu Soil Pipe x 3 m	1
82 mm Solvent Weld PVCu Soil Pipe Bend 92.5 Degrees Double Socket	4
82 mm Solvent Weld PVCu Soil Pipe Clip Double Fix	4

The materials and quantities needed to connect the downpipe to the planter and the outflow to the drains varies depending on site conditions and the size and material of the downpipe to be connected to. The above list of material was used for connecting a 100mm cast iron downpipe. To connect different downpipe diameters, use the correct flexible connection that allows to connect the downpipe to the desired pipe diameter to be used in the “raining” system.

Drilling the Distribution Pipe

To ensure that the new installed pipe has adequate conveyance so that it does not hold back any rain water, the area of the drilled holes will have to be equal or greater than the sectional area of the pipe being used. After observing moss and other debris accumulating in the raining downpipes, 8 and 10mm holes were preferred. To further address this issue and to minimise maintenance, leaf filters were installed in the downpipes (**Figure *15***).

The following method was followed to obtain the number of holes to be drilled in the distribution pipe:

E.g. Area of 100 mm (internal)diameter pipe = 7854 mm^2
Area of 8 mm di. hole = 50.3 mm^2
156 x 8 mm di. holes (52/metre) (based on using a 3 m length of pipe).

- Fix masking tape into one end of the 3 metre section of distribution pipe, then walk to the other end and hold the tape until it is tense without sticking it to the pipe. Lower the tape closer to the pipe and correct its direction until it follows a straight line, once a straight line is achieved stick the tape onto the pipe.

Mark the position of the holes in the desired intervals using a pen (

- Figure *10*).
- Drill the holes with an 8 mm wood drill bit.

Figure 10: Marked masking tape in a straight line on the pipe before being drilled.

Cutting the Downpipe

- Join the fixings and elbows that will direct the water from the downpipe to the distribution pipe, and lay them in front of the downpipe. Try different configurations until a correct alignment is obtained.
- Double check the position of the elbows and mark the place where the downpipe will be cut, do not forget to estimate the length of downpipe that will be used to attach the fittings.
- If in doubt, cut the pipe to a longer length than required and check again the position of the fittings.
- Cut the downpipe to the correct height (Figure *11*). Cast iron pipes were cut using a cut off saw. Make sure the cut is straight and levelled.

Figure 11: Downpipe being cut after checking the position of the fittings.

Installing Brackets

The distribution pipe was held to the wall using brackets consisting of a backplate (or foot) and a pipe clamp ring of the right diameter for the pipe being used. The two parts are connected by a threaded bar cut to the desired length off the wall (Figure *12*). The shorter lengths will be stronger but note that the bottom of the pipe should oversail the planter so that drips are contained within it. This system the pipes were held parallel to the walls while being able to modify their length according to the gap between the planters and the wall. The pipe clamps are available in different diameter ranges so it is easy to adapt this system to any required downpipe diameter (See Annex 1 General product list and suppliers).

- Temporarily connect the fittings to the downpipe, the outflow of the new downpipe will determine the height of the distribution pipe's position.
- Connect the distribution pipe and set it along the planter, hold it with someone's help or as shown on Figure *13* making sure it is levelled.

Figure 12: Example of how the pipe bracket looks once assembled.

Figure 13: Temporarily connected distribution pipe and held levelled before marking the final position of the brackets.

- Measure the horizontal distance between the wall and the final position of the pipe, and cut the bracket's threaded bar to that length using a hacksaw or 4.5in angle grinder.
- Assemble a bracket together by fixing the cut threaded bar to a backplate and a clamp using two nuts in the bar to tighten both ends.
- Attach the pipe to the bracket and place it on the wall to check the position of the pipe.
- Modify the length of the bar as required.
- Mark the position where the brackets will be installed:
    - The end of the pipe will have to remain inside the planter, so measure the distance from the end of the planter to the desired position of the bracket.
    - Measure this same distance from the other end of the planter and mark the position for the first bracket. This will ensure a symmetrical position of both end brackets.
    - Avoid attempting to fix into the mortar line, fixings into brick are firmer.

Depending on the quantity of brackets deemed needed, divide the length between the mentioned brackets into equal lengths and mark them. Bigger pipes, or pipes that are extended further from the wall with longer brackets might require a higher number of brackets to support them. For example, when installing the metal trough planters, the distance off the wall was considerable, and the threaded bars were easier to bend, thus more brackets were installed to better support the pipe.

- Drill the 10 mm holes on the marks in the wall to fix the backplate of the brackets with the screws and Rawl plugs, then tighten the screws using a spanner or impact driver fitted with a hex socket.
- Hold the pipe with the newly installed bracket and before fixing the next bracket, check that the marked position is still levelled now that the pipe is fixed from one end. Modify the position of the bracket if required, and fix it.

- Proceed with the next brackets where marked.
- Correct the position of the draining holes in the pipe so that they are directed into the planter. Pour water from a bucket to confirm it flows into the planter.
- Fix the distribution pipe to the brackets, and connect it to the downpipe fittings
- Before fixing the elbows to the downpipe, pour water into the distribution pipe and check that the alignment of the holes is right and no water is spilled out of the planter (**Figure *14***).
- Connect the distribution pipe and elbows to the downpipe, this may require modifying the angles of how the fittings are attached to each other.
- Install additional brackets where deemed necessary to hold the elbows to the wall and to hold the downpipe if required, this may require modifying the length of the bracket (**Figure *14***).
- Close the end of the distribution pipe with a flexible cap end.
- Leaf filters were installed after the planters were completed, but they can be fitted while working on the downpipe connection. These are connected to the end of the existing downpipe once it has been cut, and the fittings directing the water to the raining pipe are connected to the bottom of the filter (**Figure *15***).

Figure 14: Checking the correct functioning of the distribution pipe. Note the symmetry between the brackets, and the brackets holding the cast iron down pipe and the elbow fittings.

Figure 15: Leaf filter being installed, it will make maintenance easier and reduce the risk of blockages in the raining pipe.

Connecting Planters using Water Chutes

The Holy Trinity planters were moved away from the wall to provide children access from all sides. This meant that the above 'raining' downpipe was not practical. Instead custom-made chutes were manufactured (See Annex 1). These direct the water from downpipe to planter while allowing children to walk beneath them. This will provide added interest to the planter increasing the public interest and interaction.

To install connect the planters with water chutes:

- Select a position of the arch in the planter and dig a hole big enough to fit the dimensions of the base of the arch (**Figure *16***).

Figure 16: Position of the base of the arch attached to a threaded bar.

- Cover the hole with soil and then attach the arch to the threaded bar. Firmly hit the arch on its base so it's sitting firmly and levelled.
- Tighten the threaded bar to the arch with a nut, and cut the excess bar.
- Mark the position of the bracket in the wall, then drill and insert Rawl plugs, and fix the arch using washers and screws.
- Cut the downpipe to the required height, and install the fittings (**Figure *17*** and **Figure *18***).

Figure 17: Finished installation of the water chute.

Figure 18: Finished installation of the water chute.

Connecting the Planter to the Drain

Table 3: General list of material to connect the planters to the drain.

Materials	Qty.
Flexseal 105 mm – 115 mm EPDM 90dg Flexible Rubber Drainage End Cap	2
Mechanical soil boss connector (BOSSCONN110Z-BL)	1
56 mm flexi pipe X 1-2 m	1
50-70 mm galvanised jubilee rings	2
50 mm PVC elbow	1
68 mm pvc pipe brackets	2

The installation of the outflow pipework depends on the configuration of the downpipes on site. Some pipes may be connected to a soil pipe underground, or discharging the rainwater into an open drain.

Connecting to an Open Drain

- Connect the outflow fitting to a flexi pipe, fix the flexi pipe to the wall with brackets to prevent it from being damaged by children. To give the connection more strength, the flexi pipe was glued with sealant and then held with a jubilee ring (**Figure *19***).
- Direct the outflow to the drainage with a 90 degree elbow.

Figure 19: Configuration of an outflow into an open drain.

Connecting to Underground Drain

In this case the water coming from the outflow of the planter will have to be directed back into the downpipe.

- Cut the bottom end of the downpipe to a reasonable height, and use a flexible cap to close the pipe.
- Locate the mechanical soil boss connector in the base of the downpipe and mark the correct location for drilling ensuring a slight fall from the planter. Try to locate it as low as possible to achieve a correct drainage from the planter.
- Use a 57 mm holesaw, if drilling into cast iron pipe, use a battery powered drill on a slow speed setting without applying excessive pressure on the downpipe.
- Secure the mechanical boss connector to the downpipe using pop rivets, and connect it to the outflow flexi pipe (**Figure *20***).
- Cover the open downpipe with a flexible cap end.

Figure 20: Planter outflow connected to the downpipe by a mechanical soil boss connector.

Storage Material

Two storage materials were used in this project as a learning exercise to evaluate their different volumetric capacities against their costs and installation times.

Gravel is a cheap and very accessible material and it is commonly used in building raingarden planters (void space ratio= 30%). On the other hand, geocellular crates are a specialised drainage system and are more expensive, however, they have a considerable void space percentage (90%) enabling the greatest storage volume of water. They are also designed to support heavy weights.

Geocellullar crates were found to be easier to handle on site, and the time taken to cut and install them was comparable to the one required to shovel, move, and place the gravel.

Gravel

- Introduce 20 mm gravel following the design specifications. The gravel should be uniformly spread across the planter, and introduced under the drainage pipe to support it (**Figure *21***).

Figure 21: Introduction of gravel into the planter.

Geocellular Crates

AcoRoofblox geocelluar crates were used because the characteristics allowed us to have a better control on the height of the storage layer to install, compared with other geocellular crates which are generally available in greater dimensions. The individual crates have a square shape measuring 500 mm per side and a 45 mm height. AcoRoofbloxx 125 is sold as a unit consisting of three layers of individual crates. The base layer is created by joining two units so that its height is 85 mm, and the consequent top layers are fixed by aligning the visual indicators in the crates adding an additional 45 mm per layer used.

An approximate amount of geocellular crates needed per planter can be obtained by dividing the internal planter area (3 m^2) by the area of the storage units (0.25 m^2), then multiplying this by six (the layers of AcoRoofbloxx needed to reach a 245 mm height). This result is now divided by three as AcoRoofbloxx 125 consists of three individual crates.

E.g. Recycled plastic planter

1 m x 3 m= 3 m^2 (internal planter area) 0.5 m x 0.5 m= 0.25 m^2 (AcoRoofblox unit area)

3 m^2 / 0.25 m^2 = 12

12 x 6 = 72 (Total Acoroofblox units needed)

72 / 3 = 24 (AcoRoofblox 125 needed)

*In practice, an estimate of 21 AcoRoofblox units were used per recycled plastic planter.

Geocellular Crates Installation

- Introduce a single layer of crates in the bottom of the planter and on top of the piping to visualise how the crates will have to be assembled and cut. Some of the crates on the first layer will have to be cut to accommodate the draining pipes.
- Measure the position of the pipe in the first crates and cut them so the pipe fits in.
- Using a circular saw for cutting the crates is recommended as this will accelerate the process, although a hand saw could be used. The crates can only be assembled in a certain orientation so be sure to follow the same orientation of the crates while cutting.
- Carefully install the rest of the crates, special care will have to be taken with the pieces that have been cut as the sharp edges can damage the impermeable membrane so position these away from the liner (Figure *22*).
- Fill the remaining gaps using crate offcuts, always bear in mind the sharp edges.
- Use 20 mm gravel to fill the gaps not covered by the previous step (**Figure *23***) and around the vertical overflow pipe to help hold it in position.

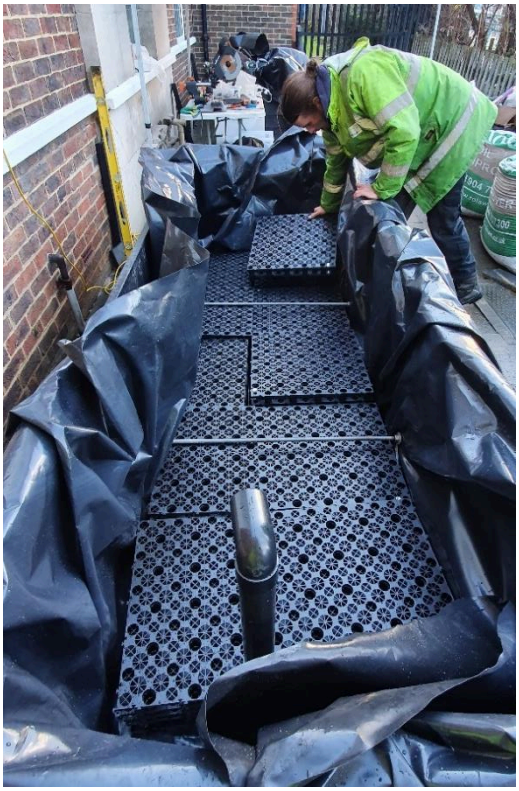

Figure 22: Installation of geocellular crates.

Figure 23: Note the offcuts used to cover the gap on the right hand side, and the gravel filling the voids close to the draining pipe.

Permeable Geotextile

This permeable layer of sheet material is located on top of the crates. Its purpose is to allow the flow of water from the soil area into the storage area beneath whilst preventing the soil from dropping down and filling the void spaces. Non-woven permeable geotextile was used. The geotextile can be ordered in different widths and lengths making it easy to install, and to adapt to different types of planters.

- Cut the geotextile to size and position it on top of the geocellular crates. It should have a minimum of 200 mm overlap up the impermeable layer which is fixed using tape. A single layer of geotextile is sufficient, adding more may prevent the water from draining efficiently.
- Make sure that the geotextile covers all of the planter and that it is positioned neatly with no excessive folds.
- Hold the geotextile using waterproof tape. The excess of membrane can be folded around the pipe leaving no gaps at the edges of the planter. Otherwise, cut a hole in the geotextile and pass it through the pipe, then seal all any gaps to prevent soil ingress into the storage area.

Substrate

When the soil and compost are delivered to site, try to locate them as close as possible to the final position of the planter. This will facilitate the movement of soil and make the installation process more efficient.

The chosen mix of substrate was 60-70% volume of top soil and a 40-30% of compost, this allows for the desired level of infiltration while containing sufficient nutrients for the plants to thrive. The soil was acquired from the same supplier to ensure uniformity, however, as the soil characteristics varied during the different installations sites, the mix had to be visually adjusted. Infiltration tests should have been undertaken to confirm the correct specifications of the substrate.

The substrate must be slightly compacted, otherwise, the soil level will reduce over time leaving the planters with not enough soil for the plants to establish.

- To achieve this ratio in practice, six to seven shovels of soil were mixed with three to four shovels of compost in a wheel barrow and then unloaded into the planter.
- Mix and compact the soil layer approx. after every 100 mm, by walking on planks of wood to spread the weight (**Figure *24***). Walking with only feet or shoes would over-compact the soil, therefore reducing infiltration rates. Alternatively, source a heavy cylinder and roll it over the surface. Use your hands to compact the corners and the edges of the planter.
- Fill the planter according to designs.

Figure 24: Soil being compacted using long wooden planks.

Planter Building Procedure: Recycled Plastic Planter

Working with Plaswood Material

All fixings are recommended to be made of galvanised metal.

It is important that all drills, tools and cutters used on Plaswood are kept very sharp. Blunt tools will accelerate generation of heat, which in turn will lead to softening, and even melting of the recycled plastic wood.

- Sawing

Circular blades with tungsten carbide tipped blades with a tooth pitch used for soft woods are the most suitable for use with recycled plastic wood. A speed between 2,000 and 4,000 rpm is suggested. The blade should cut through the profile as quickly as possible to avoid heat generation, and also to maintain a quality cut.

Sawing is best done from the presentation face (the side that will be seen) and cut through to the back face of the profile. Cutting from the back face to the presentation face can sometimes cause chipping which is difficult to dress out.

- Drilling

Twist drills are best for Plaswood but speeds and feeds must be controlled to avoid melt of the swarf and clogging problems. Cordless drills with speeds of 400 - 900 rpm are better than high-speed drills. Holes are best placed not less than 10 mm from the profile edge.

- Screwing

Twin flight, parallel thread, coarse pitch screws, similar to those used with wooden particle boards or hi-low screws, have been found to be more reliable than conventional taper thread wood screws. The greatest strength is achieved when screws are inserted at right angles to the extrusion axis. Care must be taken to avoid stripping threads when driving screws in the direction of extrusion. This risk can be overcome by using pilot holes, and torque limiting power drills and screwdrivers.

Assembling Plaswood Raised Bed Planters

Table 4: List of materials and tools to assemble recycled plastic planters.

Materials	Qty.	Tools
Plaswood planter	1	Impact driver
Planter fixings		Drill and assorted drill bits
Stainless steel screws (M5 x 65mm)	50	Hex sockets
3 x 13mm galvanised felt nails	25	Hammer
Sand 25kg bag	3	Spirit level
		Square
		Crowbar
		Spade
		Wood saw
		Chop saw (optional)
		Bevel

It is important to note that the installation of these planters produce considerable quantities of microplastics. When working with this material follow procedures that reduce the possibilities of particles being dispersed (**Figure *41***) and constantly clean the working area.

For most of the planters installed in this project, a standard 3000 mm x 1000 m x 750 mm raised bed (no bottom) made of recycled plastic was used. This model is not designed for a raingarden purpose, so they had to be modified in order to retain water. Additional corner posts, rims, and planks were ordered to give the planters a more aesthetic finish. Two 3 m pieces of panel planks, and 4 extra 1.5 m corner posts where sufficient for every planter installed. Rims have to be order considering the dimension of the planter, in this case 2 x 3 m long rim planks and 2 x 1 m rim pieces where ordered for every planter. An extra 3 m long rim piece was ordered as spare if any mistakes occurred when cutting and installing the rims, this added piece was enough for every 2 planters installed.

The recycled plastic raised beds are delivered as a flat-pack arrangement (**Figure *25***), and the items can be unloaded and transported by hand if needed, therefore no machinery or plant is required.

Figure 25: Recycled planter as delivered on site.

- Check the area where the planter is to be installed, always bear in mind the location of the downpipe and the outflow it will be connected to, the general context of the site, and details agreed with the team or with the schools (**Figure *26***).

- Start by separating the required pieces for each planter in case more than one is being installed, identify the ends and the side panels. Some panels have more precise cuts and once assembled they present a more aesthetic look with no gaps between them, it is therefore important to select these for the panels that will be facing the most viewed direction. Use a square or a level to select the panels that are cut in a straighter angle.

- Follow the manufacturer's provided diagram to assemble the planter, making sure all panels are square and that you follow a straight line at the front and back of the planter. If there is a visible line or mark in the floor this can be used as a guide but it should also be checked. When assembling the panels, a small crowbar is very useful to correct the height of the panels so they are all levelled and aligned. Use a hammer to introduce the fixings into the joints, and when it is required to take them off, utilise an old drill bit to aid. Handle the fixings with care as the thread can get damaged and the installation process will be delayed.

- Tighten the fixings with the correct sized hex socket and an impact driver, or alternatively using a spanner or ratchet. Note that due to irregular cuts in the panels a perfect alignment might not be achieved. Introducing washers in the gaps on the centre posts (**Figure *31***) was found to help at correcting this, however, as these joints will have to be disassembled on future steps, it is easier to do so when tightening for the final time.

- Once the planter is tightly fixed, check that all of the panels are correctly aligned. Check the corners with a square, and measure the inside length from different sides of the planter so they are all equal. Alternatively, a wooden plank can be cut to the desire length (1 m) to make this process faster.

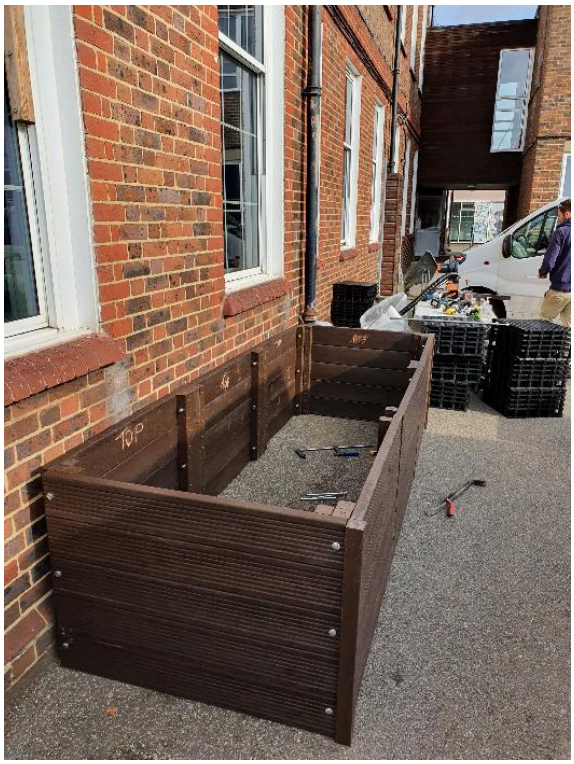

Figure 26: Chosen position of the planter after considering the position of the downpipe, the ground levels, and the visual symmetry in relation with the architecture.

Levelling the Planter

The type of planters installed have 4 corners and 4 centre joints (**Figure *27***). If the site where the planter is to be located is significantly uneven, the structure should be modified so every joint sits level on the ground.

Figure 27: Structure of the planter showing the position of the joints.

- Once the planter is assembled, temporarily introduce wedges underneath the joints that are not grounded until the structure reaches the desired level (Figure 28).
- Measure the gaps between planter and ground surface with the temporarily wedges, then cut chocks to the required length and insert them.
- Note that some corner posts will need to be longer to compensate for uneven ground levels, so avoid cutting the posts too short as there will be a limited number available on site, and this may affect the installation of the top rims.
- Check the level of the planter with a spirit level and proceed with modifications if required.

Figure 28: The planter is being temporarily supported so the gap can be measured and a chock can be cut and fixed.

Fixing Extended Legs

- Using a 4 mm drill bit, predrill a diagonal pilot hole at an angle that allows the screw to reach the chock (**Figure *29***). Then, use a countersink drill bit so that the head of the screw will remain hidden and won't damage the permeable membrane.
- Introduce the screws with an impact driver. Always proceed with caution as high speeds or excessive pressure can melt the material and impede the screws from being fixed tightly.
- Repeat the above where required.

Figure 29: Fixing the chocks to the planter structure. Note the angle in which the screws were inserted.

In order to give the planter more stability and strength, an extra piece of plastic timber was installed to brace the chocks to the corner posts of the planter (**Figure *30***).

- Locate the new piece on the floor and insert two screws from each side, one holding it to the planter structure and one securing the leg extension.
- Be aware of other fixings in the area where new screws are being fixed.

Figure 30: Installed piece securing the leg extensions to increase the planter stability.

Fixing supporting pieces into the centre joints

- Insert and fix chocks into the centre joints if needed. Only fix the leg extension or chocks into the panel structures and not into the centre posts as these will be removed in further steps. Please refer to **Figure *31***.

Figure 31: Fixed chocks in the centre joints.

Once the planter is levelled, there will be a gap beneath some of the panels that will have to be filled for aesthetic reasons (See **Figure *40*** in the “New side panels” section). This piece will have the same thickness of the panel planks so it is important to make sure that the supporting pieces remain in the inside of the planter and do not go underneath the side panels (**Figure *32***).

Figure 32: Note the gaps left when fixing the supporting blocks so a covering strip can be installed.

Installing Corner Posts

The planters are not supplied with corner posts; these were order separately in order to give the planters a better final look.

Cut corner posts to the required length and fix with screws positioning them as shown in

- **Figure *33***.
- When inserting screws, always drill a pilot hole and use a countersunk drill bit.

Figure 33: Screw positions on corner posts.

Sand Layer Protection

A skirt protection made of spare impermeable membrane was installed in the bottom of the planter to contain the sand layer protecting the impermeable membrane (**Figure *34***).

- Cut spare sections of the impermeable membrane and fix it along the internal edges of the planter with felt nails.
- Introduce a c.10mm deep layer of sand at the bottom of the planter (**Figure *27***).
- For a 3x1 m planter, three 20kg bags of builder's sand was sufficient.
- level the sand using a long wooden piece or float.

Figure 34: Pond liner skirt installed to keep the protective layer of sand inside the planter.

Impermeable Layer and Cross Braces

Table 5: List of material and tools needed to install the impermeable membrane and cross braces.

Materials	Qty.	Tools
HDPE (high density polyethylene) membrane 5.5 m x 4 m	1	Angle grinder
1 metre M16 galvanised threaded bar	2	Hacksaw
M16 galvanised nuts	8	Ratchet spanner
M16 galvanised washers	20	Hex sockets
M16 galvanised penny washers	4	Drill

M16 rubber penny washers	4	Drill bits
Geocel The Works Pro Sealant and Adhesive Clear 290 ml with gun	1	Adjustable auger bit

- Set the impermeable membrane into a position so that it covers all of the edges and corners of the planter. Try to fold the membrane in the neatest possible way to minimise the quantity of bulky edges and folds. This is important so that the planters have a good final look, and to avoid difficulties when installing the rims.
- Cross braces were fixed into the two central joints of the planters to give them more durability and strength. Galvanised metal fixings were used as this material is cheap and will withstand corrosion and humidity over time. The galvanised threaded bars can be purchased in different lengths and cut to measure, however, the companies may charge extra if they have to be cut or if longer pieces have to be delivered.
- Remove one pair of the central posts on either side of the planter and mark the desired centre for the hole to be made. The height at which the bar will be located depends on the height of the storage material to be used in the planters. If geocellular crates are used, it is recommended to position a layer in front of the central post to accurately measure and mark the correct position of the bars (**Figure *35***). Make sure there is not a big gap left between the bar and the storage material because the permeable layer will be installed on top of the bars.

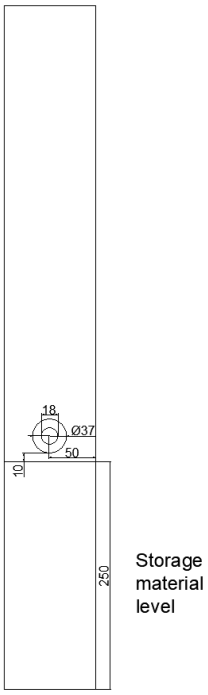

Figure 35: Position and dimensions of the holes to attach the threaded bars to the central posts.

- There has to be a gap wide enough for a socket to fit in order for the nuts to be tightened and the bar can exert the desired force in the planters (**Figure *37***).
- An aperture of 37 mm in the adjustable auger bit was enough to accommodate the correct socket size for M16 fixings. If another size of fixings is used, make sure that the hole is wide enough to fit the matching socket. The auger bit is not designed to perforate material, it has a sharp point that needs to be fixed so that the flat-bottom hole it makes is precise and straight.
- Measure the dimension of the washer and the nut to get an idea of how deep to drill with the auger bit. Pay attention not to drill too deep. Leave enough room for the washer and the nut to fit in while staying flush with the surface of the post (**Figure *36***).

Figure 36: Testing the depth of the drilled hole for the washer and nut.

- Only proceed to drill the bar hole after the countersink hole (made with the adjustable auger bit) is finished, otherwise the auger bit has nowhere to locate its centre and the hole won't be precise. Use an 18 mm drill bit for an M16 bar.
- Proceed with the next post ensuring the hole is drilled in the correct position mirroring the previous one.
- Cut the threaded bars into 990-995 mm lengths and insert the fixings in the right order (**Figure *37***). Cut the bar carefully so the thread is not damaged, file a chamfer on the edge to prevent cross threading the nuts.

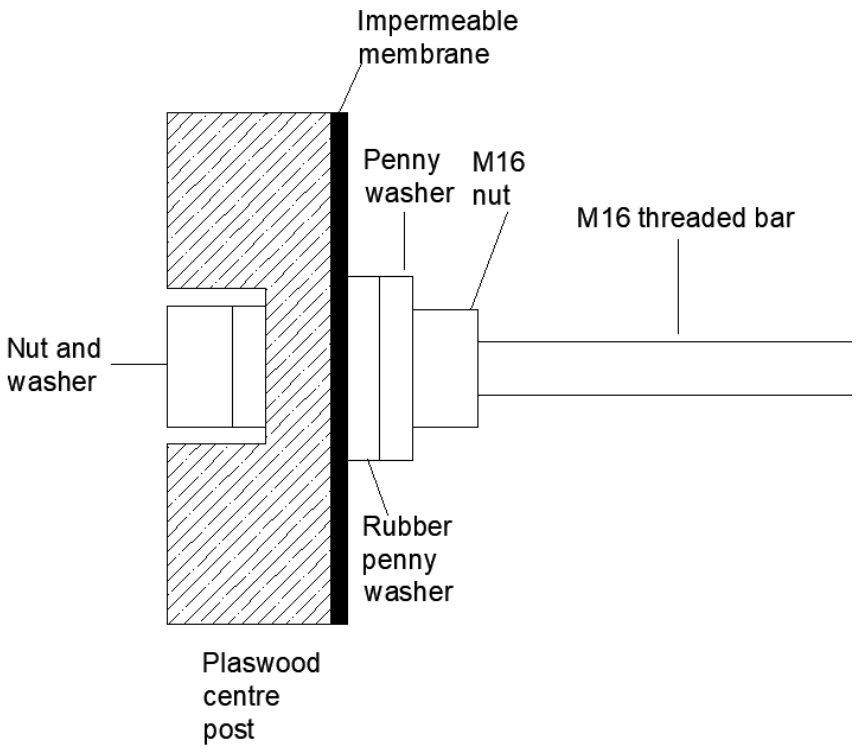

Figure 37: Cross sectional diagram of the threaded bar components. Note the gap around the external nut and washer where the socket will be used for tightening them.

- Insert a nut, a penny washer and a rubber washer in this order into both ends. The rubber washer will create a watertight seal once it is tightened. Measure the internal width of the planter and adjust the nuts on both ends in order to maintain this internal dimension (Figure 38).

Figure 38: Bar fixings being located in a position corresponding with the internal width of the planter.

- After drilling the holes in the central posts, insert them back into their place. They will have to be lifted again to insert the threaded bars, so enough slack on the membrane has to be left to allow this movement.
- Mark in the membrane the position of the holes and do a small x shaped incision with a sharp knife.
- Simultaneously lift both posts and the membrane, and introduce the sides of the bar in the holes.
- Attach the outside fixings and tighten the outside nuts.
- Carefully return the now attached posts into their place without disturbing the sand layer or the protective skirt.
- Repeat the previous step with the second bar. Lifting the other bar will help when fixing the bar into the posts. Then lower both bars together so that the membrane position is not changed.
- Once the panels are cranked tight, some of them kick out resulting in a kinked alignment. Before tightening the panel fixings, as mentioned in the Assembling Section, introduce washers on the side gaps (**Figure *31***) to correct the alignment of the panels once they are tightened.
- Tighten the internal nuts, sealant can be added between the membrane and the rubber washer to ensure a complete seal (**Figure *39***).
- Repeat the previous steps with the other central posts of the planter (**Figure *39***).
- Check again the internal dimensions of the planter and the correct alignment of all the side panels.

Figure 39: Installed cross bar with added sealant for creating a waterproof seal, and completed installation of cross bars in a planter.

New Side Panels

If the gap created at the bottom of the panels after levelling is unsatisfactorily too obvious, a piece (a rip) will have to be cut and fitted to create a cleaner finish (Figure 40).

- Measure the height at both ends of the gap, and translate those measurements onto a long section of specifically ordered plastic timber for this purpose.
- Mark a straight line between the marks, use a chalk line if it's a long length needing to be cut.
- Cut the piece with a hand saw or circular saw. Bear in mind the orientation of the material and the face that will be showing as this panels come with two different textures on the sides.
- Introduce the new section in the gap using a lump hammer (if required).
- This piece will be fixed with screws, so observe and mark the location of each of the posts so it can be fixed.
- Fix the screws in the marked locations, remember to predrill and use a countersink drill bit.

Figure 40: Final look of the planter. Note how the bottom section is covering the gap created when modifying the planter's height.

Adding Storage and Drainage

Drilling the Outflow Hole

Regular tank connectors cannot be used with these Plaswood planters as the material is too thick and the tank connector is not long enough. To solve this, two PVC Adapter Female Threaded Socket 50 mm x 2" were joined together with a 2" threaded nipple (**Figure *42***).

- Measure the outside diameter of the tank connector fitting to be used at the outflow of the planter, and drill the hole using an adjustable auger bit. It is recommended to do a trial hole on a spare piece of material to evaluate how tight the fitting will be using that specific aperture.
- Always drill from the outside to the inside of the planter, this will avoid any damage on the front face of the planter.

The auger bit is not designed to create holes, it has a sharp point that needs to be centrally located so that the hole it makes is precise and straight. For this reason, a piece of plastic timber has to be temporarily fixed in the inside of the planter in the position where the outflow will be located (**Figure *41***).

Figure 41: Temporarily fixed timber piece to allow the use of the adjustable auger bit. Note how the small pieces of plastic are collected and disposed of.

Internal Piping

Table 6: *List of material to install the internal pipes.*

Materials	Qty.
32 mm PVC Pipe PN16 (3 m length)	1
32 mm PVC Pipe PN16 (3 m length)	1
PVC socket 32 mm	2
50 mm PVC Pipe (3 m length)	1
50 mm PVC socket	1
32 mm PVC cap	2
PVC reducing bush 50 mm x 32 mm	2
50 mm PVC tee	1
50 mm PVC cap	1
PVC Adapter Female Threaded Socket 50 mm x 2" (tank connector)	2
PVC Threaded nipple 2" (tank connector)	1
Solvent cement	1

Different pipe brands were used in the first planters installed, a brand purchased at eeziflo.com was found to be of the best quality and were available with a wide range of fittings and tank connectors which were a notable benefit for this project.

- Drill the 32 mm draining pipe to the desired length. Connect it to the 50 mm pipe using the 32 x 50 mm adapter, then join this to the tee connector with the overflow pipe and the outflow section.

Figure 42: Inner section of the tank connector composed of a threaded nipple and two female adapters.

- Make an X shaped incision in the membrane where the outflow hole is located, this cut should be as small as possible so the membrane is held tight on the fixing to reduce the risk of leaking.
- Join one threaded socket adaptor to the nipple using Teflon tape to create a good seal; introduce them then into the outflow hole from the outside of the planter. Use a lump hammer and a spare piece of timber to avoid damaging the fitting (**Figure *44***).
- Thread in the second adaptor to complete assembling the tank connector (**Figure *42***), and connect the rest of the pipes to it.

Planters were reported to be leaking some time after their installation, and the problem was found to be in the outflow fittings. An extra piece of rigid plastic was added to increase the contact area between the female threaded adaptor and the membrane to create a waterproof seal (**Figure *43***, yellow material). An extra piece of membrane was glued to the rigid plastic to further reduce the chances of leaking. The female adapter was attached to the threaded nipple, the bespoke cut rigid plastic was inserted into the nipple, and finally, a small cut was done in the membrane and the nipple was pressed into it so the membrane was tightly pressed into the fitting.

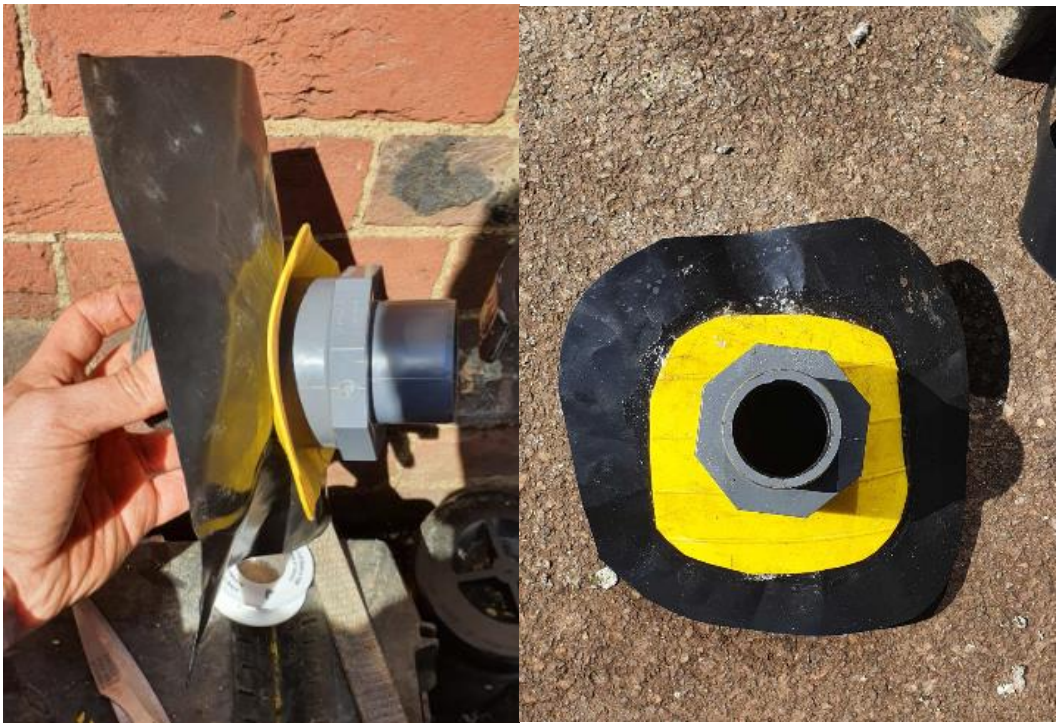

Figure 43: Improved method used to create a waterproof seal in the outflow.

- The piece was then inserted into the outflow hole from inside the planter, and sealed with mastic. A lump hammer and a spare plastic piece were used to help at inserting the fitting into the hole (**Figure *44***).
- Connect the other adapter on the outside of the planter using Teflon tape, and tighten to resistance.
- Connect the rest of the internal piping checking that every joint is in the correct position and angle (overflow pipe), proceed with gluing the pieces together with solvent cement once being certain of their correct position. Use a big piece of spare membrane or cardboard under the pieces being cemented as this substance may damage the membrane.
- Leave the overflow pipe long for the time being. It will be cut once the soil level is defined.

Figure 44: Introducing the tank connector on the planter. This process has to be done carefully to avoid any damage in the fitting.

Membrane wrapping

- Correct any fold or bulky edges in the membrane if possible, try to correct them (**Figure *45*:** In this image, excessive folds and HDPM material in the corner have been removed.) so that the rims sit correctly in the edges of the planter.

Figure 45: In this image, excessive folds and HDPM material in the corner have been removed.

Rims

The installation of the rims is one of the final stages of building the planters, because they will hold the pond liner In its place.

- Measure the length of one planter's sides extending to the outer point of the corner posts. This is the 'long length'.
- With the chop saw, cut the rim at 45 degree angles with the outside lengths forming the 'long length'.
- Locate the rim into its final position. Screws (16 x 6 mm x 75 mm stainless steel) will be secured through the rim into the planter beneath. These will be positioned alternatively off the centre line to help prevent the rim from rocking.
- Mark the location of the screws that will fix it in place. Make sure that the screws will penetrate the planter's panels, and bear in mind that they will be symmetrically positioned in the other rims (**Figure *46***).
- Use smaller pilot holes (4mm) so the screws are fixed tightly, then use a countersink drill bit.
- Do not use high speeds on the impact driver as this melts the material and prevents a good fixing.
- Locate the rim piece into its position, pulling the membrane towards the outside of the planter to tension it in order to achieve a better looking result with fewer folds (**Figure *47***).
- Proceed with the back side of the planter following the previous steps.
- As the planter is unlikely to be exactly square, the side rims will probably require a slight variation to a 45 degree cut. Use a sliding bevel to translate the angle of the adjacent rim to the one to cut.
- Follow this procedure so that the rim pieces fit nicely into one another (**Figure *48***). Modifications might have to be done on the cuts until they fit together in the most aesthetically looking way.

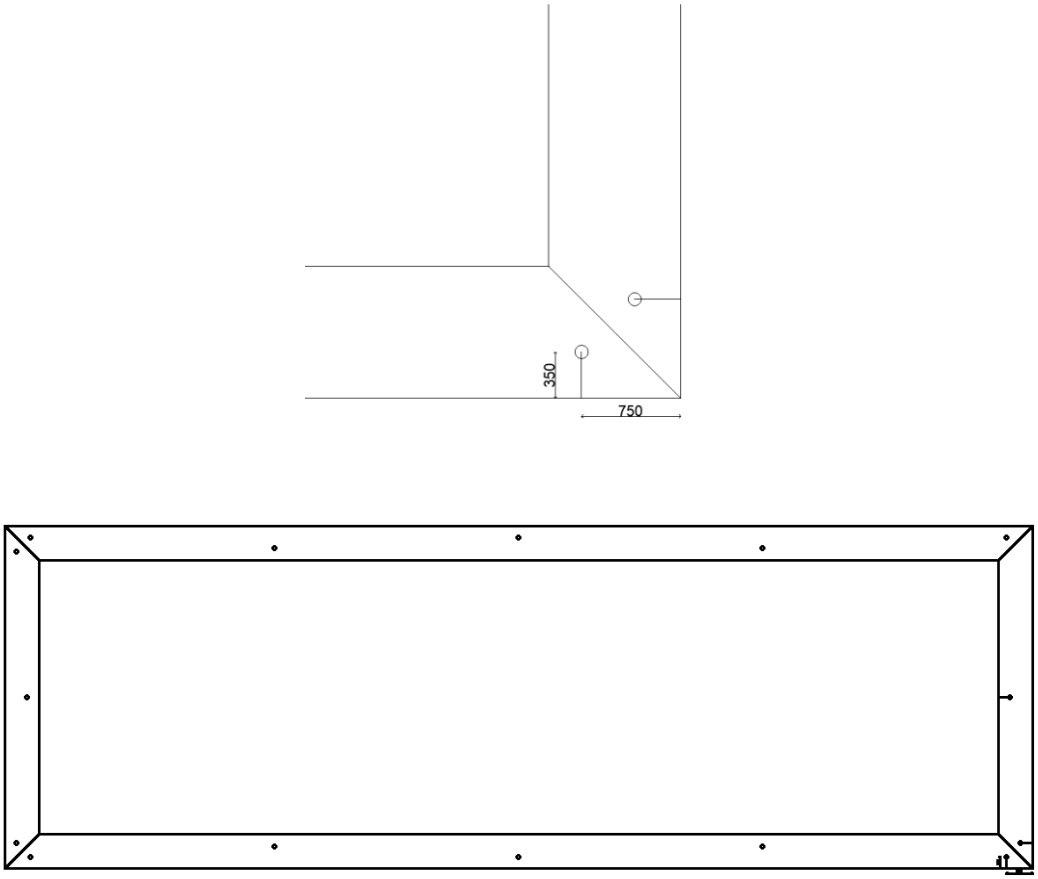

Figure 46: Position of the rim screws in the corner and general overlay of the screws around the planter's rims. Note the symmetrical position of all the screws.

Figure 47: Rim installation, note how the membrane is being pulled while the rim is being fixed into place.

Figure 48: Example of the joints between the rim sections. Note the symmetrical positions of the screws in the rims.

- Once the rims are installed, cut the overflow pipe to a height higher than the soil level, but below the rims. This will allow the water to flow down the drainage system before spilling out of the planter in extreme events.
- Connect an elbow on the overflow pipe so that its inlet is parallel to the soil level, and insert a previously drilled cap (**Figure *49***). In extreme rain events, this will allow the water to flow out into the draining pipe and not spilling over the planter. The drilled holes will prevent the overflow pipe from being blocked by vegetation or other debris.

Figure 49: Elbow attachment in the overflow pipe to reduce the risk of blockages.

Installing Planters with Benches

The installation of planters with benches was meant to give the planters an added value and increase the interaction and acceptance from the pupils. These planters are delivered assembled, and they require a special delivery method including a forklift vehicle. Make sure that the site dimensions are suitable for this type of the delivery.

If the planters cannot be delivered to their exact final position, they will have to be moved with two tonne hydraulic trolleys.

- It is best to find a level ground to locate these planters as modifying their structure as done with the raised bed Plaswood planters will involve extra difficulties.
- The installing procedures are almost the same as when installing the raised bed Plaswood planters. However, these benched planters come with a base that requires a different method of cutting and introducing the geocellular crates (**Figure *50***).
- The rims will have to be removed so that the impermeable membrane can be fixed.

Figure 50: Installing the geocelluar crates in the benched planters, note the different cutting and positioning of the crates.

Figure 51: Final look of the planter with bench.

Lessons Learned

- It is crucial to understand the position of the planter in its general context. The configuration of the downpipes, ground levels, and the site access will all have an impact on what type of planter is better to install, the materials that will be needed, and the organisation of delivery logistics.

- Make sure you plan carefully before purchasing the materials needed, every planter is different and its configuration and connections will vary. It is always useful to talk to a seller if you need advice on how to connect different pipe types, diameters, and fittings.

- If a pond liner is needed to waterproof the planter, make sure a good quality one is used. The effects of UV rays, humidity, etc. can easily damage the impermeable membrane which could be very hard to repair. Hozelock pond liners were used in this project as they have a 15-year guarantee.

- We installed “raining” distribution pipes for increasing the aesthetic value of the planters, however, the water can be fed into the planter using only the diverted downpipe with an attached elbow. Make sure the surface of the planter where the water falls is protected.

- Roof runoff may contain large amounts of moss and leaves, installing leaf filters in the downpipes will prevent them from blocking and will facilitate its maintenance.

- Be meticulous when installing and sealing your tank connector, it could be very difficult to repair once the planter is complete. Pour water into the planter once the tank connector is in so that you are completely sure there are no leaks and the water is going where it is meant to.

- Don’t feel daunted to use geocellular crates as a storage system, they are very easy to install and to cut so that they fit in your planter. They are also easier to handle and transport, and they won’t represent a bigger cost compared with gravel.

- Make sure you use an adequate mix of soil and do infiltration tests with it (see Design Report), this is critical for the purpose of the planter and the establishment of plants.

Pros and Cons of the Types of Planters.

Table 7: Pros and cons of the three different types of planters installed.

Metal water troughs		Recycled plastic raised bed		Recycled plastic with benches	
Pros	**Cons**	**Pros**	**Cons**	**Pros**	**Cons**
Reduced installation and labour times.	Heavy and difficult to handle on site, therefore hard to adapt to site specific configurations.	No special considerations are required for its delivery.	Considerable amount of micro plastics produced.	Delivered already assembled.	More expensive unitary cost.
No need for installing impermeable membrane.	Requires lifting trolleys if there is no access for the delivery truck to the final site.	Parts are easy to handle and can be moved manually which facilitates their installation at the selected location.	Require more installation time and resources.	Reduced installation and labour times.	Expensive delivery.
No required modifications on the structure of the planter.	The final position has to be carefully assessed, planters cannot be modified so the site has to be levelled or easy to modify.	Durable and long-lasting material.	More materials and fixings required compared with metal troughs.	Durable and long-lasting material.	Special delivery considerations involved. Access for forklift vehicle is required.
Less quantity of materials required.	Availability – troughs this large were difficult to source	More attractive with customisable colours.	As the material is cut and modified in different ways, a lot of timber leftovers and rubbish are produced.	Benches increase their value as amenity inside schools.	Hydraulic trolleys may be needed to locate the planter on its final position.
Resistant material and strong structure.		The colourful rim creates a useful surface area around the edge of the planter		More attractive with customisable colours.	

Appendix 1.- General Product List and Suppliers

Item	Supplier (link)
Planter	Plaswood
Water troughs	Mc Veigh Parker
Geocellular crates	https://www.aco.co.uk/products/roofbloxx
Sub base 20mm gravel	https://www.wickes.co.uk/Tarmac-20mm-Gravel---Major-Bag/p/133795
Sand base	https://www.wickes.co.uk/Tarmac-Building-Sand---Major-Bag/p/132008
Topsoil 2 bulk bags	https://londontopsoilcompany.co.uk/product/premium-grade-topsoil-bulk-bag/
Compost	https://londontopsoilcompany.co.uk/product/compost-bulk-bag/
Permeable geotextile 2x25m	https://www.plasticdrainage.co.uk/draintex-white-non-woven-geotextile.html
Impermeable membrane	https://www.wickes.co.uk/Wickes-1000-Gauge-Black-Damp-Proof-Membrane---4-x-12-5m/p/152859
Stainless steel M16 Threaded bar and washers	Orbital Fasteners
Pipe fittings and tank connectors	www.eeziflo.com
General piping products	www.drainagecentral.co.uk
Hilcon Jumbo Flexible Conduit Size	https://www.hilltop-products.co.uk/hilcon-uw-56-0-cls.html#.X7Tp1cj7RPZ
Backplates for brackets	https://www.jtmplumbing.co.uk/malleable-galvanised-pipe-fittings-brackets-c545/galvanised-pipe-brackets-c834/jtm-bracketry-galvanised-back-plates-p11674
M10 (8.8-High Tensile) Galvanised Threaded Rod and hex screws	Orbital fasteners
Pipe clamps	https://www.hilti.co.uk/c/CLS_INSTALLATION_SYS_7134/CLS_GALVANIZED_PRODUCTS_7134/CLS_VENTILATION_SOLUTIONS_7134/r5509
Galvanised water chutes	de Havilland Engineering Group http://www.dehavillandfabrication.co.uk/

Appendix 2.- Approximate Costs per Planter

The following tables show the costs for every type of planter installed, note that no labour costs are taken in account in these tables.

CHSG - Recycled Plastic Raised Bed Planters

What was purchased?	Qty.	Where was it purchase? (include link if you can)	Total costs (incl. VAT and delivery)
3 m x 1 m x 750 mm brown planters with rim	3	Plaswood	
Additional lumber for planter	1	Plaswood	
Extra rim	1	Plaswood	1,742.14
Geocelullar crates	47	Aco Roofblox	705.25
Sand base	9	Wickes	30.75
Gravel bulk bag 20 mm Trent Valley	1	Aggregates Direct	107.22
Gravel bags 20 mm major bag	20	Wickes	50
Gravel bags 20 mm major bag	13	Wickes	32.5
Premium topsoil bulk bags	3	London Topsoils	516.6
Compost bulk bags	2	London Topsoils	
35 lt westland topsoil	6	Dobbies Garden Centre	59.94
Permeable geotextile 2x20 m	1	geotextilemembranes.co.uk	66.2
Impermeable membrane 4.5 x 4 m	3	Wickes	120
Galvanised M16 full nuts, washers and six 1 m threaded bars		Orbital fasteners	59.11
Saw hire 24 h		Brandon hire	50
Chop saw		Screwfix	119.99
Flexi pipe 50 mm OD x 2 m		Amazon	14.72
Resin for rim			13.47
No.10 x 3" (5 x 75) A2 Stainless Steel Pozi Countersunk Wood Screws Csk			13.5
M16 Stainless steel washers		Amazon Celtic Sustainables	6.61
PVC sement solvent glue	1		7.03
Geocel sealant	1		4.99
New BOSCH drill bits	1		14.43
Galvanised clout nails 20 x 3.0	1		4.63
Leaf filter	1		22.5
Flexseal 100 mm to 11 5mm	1		414.76
Rubber Flexible Drainage Drain Pipe Coupling		Drainage superstore	
Cascade cast iron style 110 mm 92.5 dg single socket bend	3	Drainage superstore Mark Fisher	414.76 23.9

Cascade cast iron sty 110 mm 2.5 m single socket pipe	2		
Cascade cast iron style double socket pipe connector	1		
100 mm Cast iron push and fit soil blank end	1		
Mechanical soil boss connector BOSSCONN110Z-BL	1		
Flexseal 10 5mm – 115 mm EPDM 90dg Flexible Rubber Drainage End Cap	1		
Waste Pipe Solvent Weld 3m MuPVC Pipe 32 mm - Black	3		
Hunter 50 mm x 32 mm Reducer Solvent Weld - White	3		
Hunter 32 mm Plastic Waste Pipe Socket Plug - Grey			
Hunter 50 mm Solvent Plastic Waste Pipe 92.5dg Tee - Black	3		
Hunter 50 mm Solvent Plastic Waste Pipe Access Cap - Black	3		
Hunter 50 mm Solvent Plastic Waste Pipe Straight Coupling - Black	6		
Plastic Guttering Round Style Downpipe 2.5 m Length 68 mm - Black	3		
Marley 68 mm Circular Loose Pipe Socket - Black	4		
Plastic Guttering Round Style Downpipe 92.5 Degree Bend 68mm - Black	6		
Flexseal 60 mm – 68 mm EPDM 90dg Flexible Rubber Drainage End Cap	4		
2 x 4 m 68 mm downpipe	2		
3X 3 m 32 mm pipe, 3m 50mm pipe, 2 blank ends, 2 adaptors		Mark Fisher	57
3x 32 mm straight couplings		Toolstation	2.34
McAlpine BOSSCONN110Z-BL 2" Pipe Mechanical Soil Pipe Boss Connector	1	Bellabathrooms	18.09
Starrett FCH0214 Bi Metal Fast Cut Hole Saw, 57 mm	1	Amazon	16.31

	3		40.83
56 mm flexi hose 3 m		Hiltop Products	
Galvanised Backplates		JTM Plumbing	30.24
M10 (8.8-High Tensile)	20		30.36
Galvanised Threaded Rod - 150mm		Speedy Fixings	
	50		15.6
Galvanised Full Nut - M10		Speedy Fixings Hilti	
110mm brackets	10		72.36
70 mm brackets	10	Hilti	72.36
M6x50 Hex Coach screw galv.	70	Orbital fasteners	13.76
Tools to deliver SiSS		Melvyn Clark	26.85
Tools to deliver SiSS		Melvyn Clark	10.5
50/70mm hose clips	1	Toolstation	3.31
Plastic storage boxes	3	B&Q	19.25
Straight compression coupling	1	Mark fisher	7.45
Hole saw screws and rawl plugs		Crown Tools	27.31
Tools to deliver SiSS		Melvyn clark	2.95
Tools to deliver SiSS		Melvyn clark	4.95
9.5mm countersunk drill bit	1	Toolstation	3.19
Adjustable auger bit	1		16.99
			£
		Total Cost	**2,834.11**
		Cost per planter	**£ 944.70**

CHSG Recycled Plastic Planter with Benches

What was purchased?	Quantity	Where was it purchase? (include link if you can)	Total costs (incl. VAT and delivery)
Planters	2	Plaswood	2818.66
Geocelullar crates	47	Aco Roofblox	525
Building sand major bag	8	Wickes	20
Gravel 20 mm major bag	3	Wickes	6
Premium grade topsoil bulk bags	2	London Topsoils	515.76
Topsoil small bags	12	London Topsoils	
Compost bulk bags	2	London Topsoils	
Impermeable membrane	2	Wickes	90
M16 x 1 Metre Long Studding (Threaded Rod) High Tensile 8.8 Steel Galvanised DIN 975	6		77.46
M16 Hexagon Full Nut Grade 8 Galvanised DIN 934 (Tapped Oversize)	30	Orbital fasteners	

M16 (48x4 mm) Form G Mild Steel, Heavy Duty Penny Mudguard Repair Timber Galvanised Washer, DIN 9021	10		
M16 x 48 x 4.0 mm Black Rubber Mudguard Penny Washers	10		
M16 x 30 x 3.0 Mild Steel Form A Flat Washers Galvanised, DIN 125	15		
M10 x 1 Metre Long Studding (Threaded Rod) High Tensile 8.8 Steel Galvanised DIN 975	3		
M10 Hexagon Full Nut Grade 8 Galvanised DIN 934 (Tapped Oversize)	35		
M6 x 50 Mild Steel Hexagon Head Coach Screw Galvanised, DIN 571	20		
Brackets			
Resid. pipe ring MP-H101-110 M8/M10 pack of 10	1	Hilti products	
No.10 x 3" (5 x 75) A2 Stainless Steel Pozi Countersunk Wood Screws Csk		Amazon	
Flexseal 100 mm to 115 mm Rubber Flexible Drainage Drain Pipe Coupling	2		347.89
Cascade cast iron style 110 mm 92.5 dg single socket bend	6		
Cascade cast iron styl 110 mm 2.5 m single socket pipe	2		
Cascade cast iron style double socket pipe connector	1	Drainage Central	
Flexseal 105 mm – 115 mm EPDM 90dg Flexible Rubber Drainage End Cap	4		
110 mm Cast Iron Style PVCu Push Fit Soil 500 mm Long Offsett Pipe BS500CI	2		
Mechanical soil boss connector BOSSCONN110Z-BL	2		
32 mm PVC Pipe PN16 (3m length)	2		47.08
PVC socket 32mm SKU: 022.011.032P	2	Eeziflo	

50 mm PVC Pipe PN10 (3 m length) SKU: 022.P.05010PE	1		
50 mm PVC socket SKU: 022.011.050P	8		
32 mm pvc cap 022.221.032P	2		
PVC reducing bush 50mm x 32 mm SKU: 022.091.050032P	2		
50 mm PVC tee SKU: 022.061.050P	2		
50 mm pvc cap SKU: 022.221.050P	2		
PVC Adapter Female Threaded Socket 50 mm x 2" SKU: 023.212.05007	4		
PVC Threaded nipple 2" SKU: 021.253.07	2		
		Total cost	**£ 4,447.85**
		Cost per planter	**£ 2,223.93**

Wandle Valley- Water Trough Planters

What was purchased?	Quantity	Where was it purchase? (include link if you can)	Total costs (incl. VAT and delivery)
Water troughs	2	McVeigh Parker	1004.38
1 x SKOOTS PAIR - 2000KG	1	HSS Hire	211.2
Geocellular crates	40	Aco Roofblox	600
Topsoil bulk bags	2		530.4
Compost bulk bags	2	London Topsoils	
PVC Tank Connector BSP Male Thread 50 mm X 63 mm X 2"	2		42.98
PVC Reducing Bush 50x32 mm	4		41.2
PVC cap 32 mm	4		2
PVC cap 50 mm	2		2.24
PVC socket 32 mm	6		2.82
PVC socket 50 mm	4		3.6
PVC Reducing Bush 50 X 32	4		4.12
PVC Pipe PN10 (3 m length) 50 mm	1		5.09
PVC Pipe PN16 (3 m length) 32 mm	2		7.54
pvc tee joint 50 mm	4		8.48
Griffon WDF-05 PVC Cement, 250 ml	1		6.28
PVC 90 Degree Elbow 50 mm	2		3.22
PVC Adapter Socket 50 mm to 2"	2	Eeziflo	6.26

PVC Socket 75 mm	2		6.72
PVC 90 Degree Elbow 75 mm	4		22.96
PVC Pipe PN10 (3 m length) 75 mm	3		33.33
Flexseal 85 mm to 75 mm PVC Plumbing Straight Coupling E085-085BL	2	Drainage Central	20.9
McAlpine BOSSCONN82Z-BL 2" Pipe Mechanical Soil Pipe Boss Connector	2	Bella Bathrooms	22.54
Brackets			50.14
M10 galvanised rod 500mm	15		
M10 galvanised nut	30		
8 mm galv hex screws	15	Orbital Fasteners	
Galvanised Back Plates	12	JTM Plumbing	11.52
Galvanised pipe bracket MV-P 80 M8/M10 #2048126	1	Hilti	36.96
Flexible caps for cut downpipe Fernco Stop End Cap (90-75 mm)	2	Drainage Shop	17
82 mm tee joint		Eco-Filtration	10.78
		Total cost	**£2714.66**
		Cost per planter	**£1357.33**

Acknowledgements

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