

## Ground Array Installation Manual



## Contents Page

Section	Description	Page
<b>1.0</b>	<b>Introduction</b>	<b>4</b>
<b>2.0</b>	<b>Safety Information</b>	<b>5</b>
2.1	Access	5
2.2	Lighting	5
2.3	Tools an consumables	5
2.4	Handling	5
2.5	Residual hazards	5
2.6	Freezing	5
2.7	Disposal/Decommissioning	5
<b>3.0</b>	<b>General Information</b>	<b>6</b>
3.1	Types of ground array	6
3.1.1	Slinky pipe	6
3.1.2	Straight pipe	6
3.1.3	Boreholes	7
3.1.4	Water systems	7
3.2	Sizing of ground arrays	8
3.2.1	Slinky arrays	8
3.2.2	Borehole arrays	8
3.2.3	Water source arrays	8
<b>4.0</b>	<b>General Product Information</b>	<b>9</b>
4.1	Equipment delivery and handling	9
4.1.1	Factory shipment	9
4.1.2	Receipt of shipment	9
4.2	Product description	9
<b>5.0</b>	<b>Mechanical Installation of Slinky Ground Arrays</b>	<b>11</b>
5.1	Groundworks	11
5.1.1	Slinky trenches	11
5.1.2	Header trenches	11
5.1.3	Unrolling the coil	12
5.1.4	Return pipe	14
5.1.5	Unused or excess pipe	14
5.1.6	Cutting the pipe	14
5.1.7	Tips on manipulating the pipe	14
5.2	Ground arrays in lakes, ponds and rivers	14
<b>6.0</b>	<b>Ground Array Manifolds</b>	<b>15</b>
6.1	Connecting pipe to the manifold	15

## Contents Page

Section	Description	Page
6.2	Connecting the manifold to the heat pump	16
6.3	Purging procedure for multiple arrays	18
6.4	Pressurizing the system	19
6.5	Purging procedure for single arrays	20
6.6	Pressure Testing in accordance to BS805 Section 11.3.3.4	21
6.7	Backfilling Trenches	23
6.7.1	Repairing Slinky Pipe	23
6.7.2	Kinked Pipes	23
6.7.3	Backfilling	23
6.8	Straight Pipe	24
6.9	Borehole Arrays	24
<b>7.0</b>	<b>Ground Array Layout</b>	<b>26</b>

Introduction

Safety Information

General Information

General Product Information

Mechanical Installation

Ground Array Manifolds



## 1. Introduction—a message from the CEO



Kensa Heat Pumps has been manufacturing Ground Source Heat Pumps since 1999. Our mission is to enable mass decarbonisation of heat using our award-winning heat pumps.

A key part of the Kensa heat pump's design is simplifying the installation process to allow any competent plumber to perform the work rather than needing specialist skills. The purpose of this manual is to guide you through the installation process, and we've worked to ensure all the required information has been provided to allow you to connect the heat pump.

Critical instructions to ensure you do not experience any difficulties are highlighted in the 'Golden Rules' in the installation section.

Please speak to the Technical Support Team on 0345 222 4328 to receive our free-of-charge 'online commissioning' service. Opening hours are 8.00 am to 5.00 pm.

Finally, we'd love to hear from you if you have any questions, wish to consider ground source heat pumps for any future projects, or even just to share your experiences of using ground source heat

Tamsin Lishman

CEO

Kensa Group Ltd



For further information on ground source heat pumps and their application, please refer to [www.kensaheatpumps.com](http://www.kensaheatpumps.com)

## 2. Safety information

Safe operation of this unit can only be guaranteed if it is properly installed and commissioned in compliance with the manufacturer's requirements. General installation and safety instructions for pipeline and plant construction, as well as the proper use of tools and safety equipment must also be complied with.

Manufacturer:-

Kensa Heat Pumps

Mount Wellington

Chacewater

Truro

Cornwall

TR4 8RJ

Tel 01872 862140

[www.kensaheatpumps.com](http://www.kensaheatpumps.com)

The product is designed and constructed to withstand the forces encountered during normal use. Use of the product for any other purpose, or failure to install the product in accordance with these Installation and Commissioning Instructions, could damage the product, will invalidate the warranty, and may cause injury or fatality to personnel.

### 2.1 Access

Ensure safe access before attempting to work on the product. Arrange suitable lifting gear if required.

### 2.2 Lighting

Ensure adequate lighting, particularly where detailed or intricate work is required.

### 2.3 Tools and consumables

Before starting work ensure that you have suitable tools and / or consumables available.

### 2.4 Handling

Manual handling of large and /or heavy products may present a risk of injury. Lifting, pushing, pulling, carrying or supporting a load by bodily force can cause injury particularly to the back. You are advised to assess the risks taking into account the task, the individual, the load and the working environment and use the appropriate handling method depending on the circumstances of the work being done.

### 2.5 Residual hazards

Many products are not self-draining. Take due care when dismantling or removing the product from an installation.

### 2.6 Freezing

Provision must be made to protect products which are not self-draining against frost damage in environments where they may be exposed to temperatures below freezing point.

### 2.7 Disposal/Decommissioning

The slinky is recyclable and no ecological hazard is anticipated with its disposal providing due care is taken. Disposal of any antifreeze water mix should follow the disposal instructions as laid out on the COSH Safety Data Sheet available on request.



This symbol on the product indicates that this product must not be disposed of with your other household waste. Instead, it is your responsibility to dispose of your waste equipment by handing it over to a designated collection point for the recycling of waste electrical equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your household waste disposal service or the company where this product was purchased.

### 3. General information

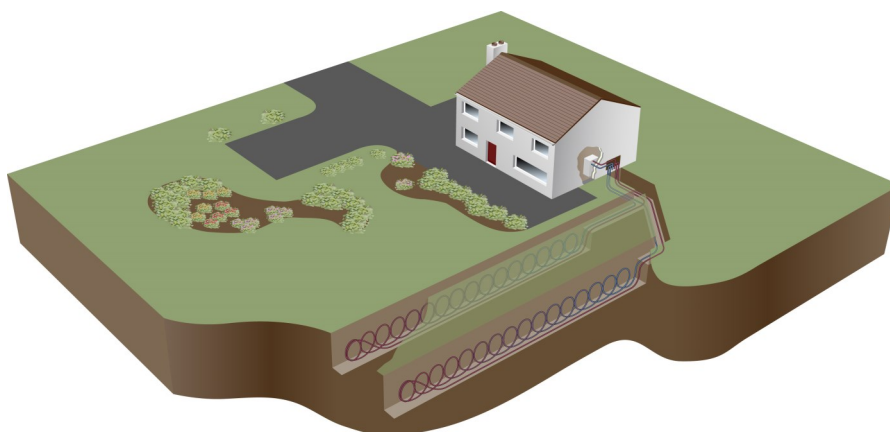
[Ground source heat pumps](#) use renewable energy from the ground to provide a low cost and low carbon form of heating for buildings. They absorb energy from the ground via buried heat exchange devices called ground arrays.

The temperature of the ground remains pretty constant all year round at around 8-12C and hence provides an ideal energy source for heat pumps. The ground absorbs low-grade solar energy by means of direct sunlight and rain. However this energy is not infinite as the ground acts as a battery and must be gradually re-charged by the sun, and rain. This means that incorrectly designed or sized closed loop ground arrays can over-cool the ground surrounding the pipe, leading to much lower outputs and efficiencies from the heat pump.

A water [antifreeze](#) mix is generally circulated around the ground arrays to provide a transfer of this energy within the ground to the heat pump.

There are a number of different designs and types of ground arrays available, which can operate with heat pumps. While there are some marginal differences in efficiencies, these are small and the heat pump's outlet temperature into the heating distribution system has a much larger affect on the units overall efficiency.

**Fig 1**  
**Horizontal**  
**'slinky' ground**  
**arrays**



#### 3.1 Types of ground arrays

##### 3.1.1 Slinky pipe

[Slinkies](#) are the most cost effective way of installing ground arrays as they reduce the amount of digging required. These were developed by the University Of Oklahoma, and are one of the world's most popular heat sources for heat pumps. In simple terms, slinkies are a length of coiled plastic pipe buried in the ground using a digger. They can be installed on their vertical edge or horizontally. Due to the low cost of installation this is the type of ground array that Kensa would initially recommend.

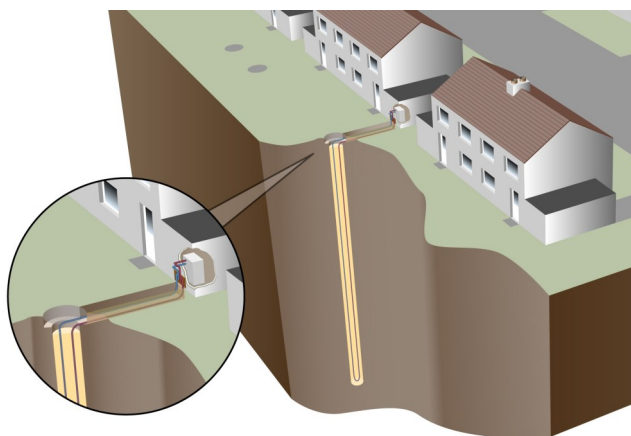
##### 3.1.2 Straight pipe

Straight pipe can also be used, however this can increase the amount of digging required by up to 5 times and hence the cost of installation. There is no difference in the amount of ground required as the energy source for slinkies or straight pipe and both have the same performance. Kensa heat pumps can work with both types of horizontal ground array and both can be supplied. However due to the advantages of slinkies Kensa would always recommend these.

##### 3.1.3 Boreholes

If there is insufficient area to install slinkies or straight pipe then an alternative is to drill vertically down. [Boreholes](#) tend to be 60-100m deep and usually consist of a single looped pipe inserted within the bore-

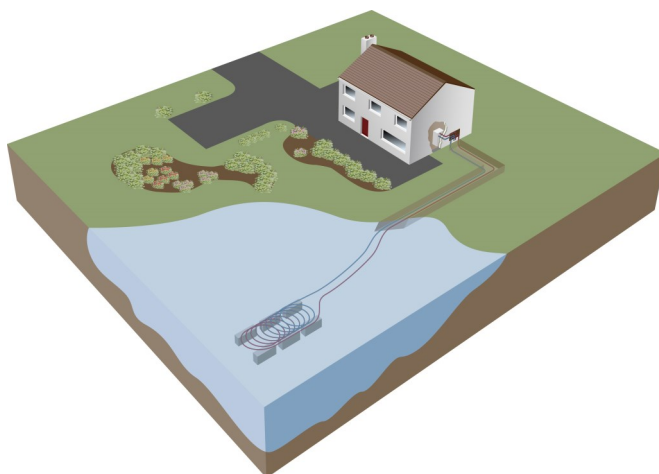
**Fig 2**  
**Vertical bore-hole ground arrays**



hole, which is then backfilled with thermal grout. The depth and number of boreholes will vary depending on the makeup of the ground the borehole is being drilled in. A specialist contractor is required to drill boreholes and hence they can tend to be an expensive alternative. Contractors generally drill the borehole and supply and fit the borehole pipe ready for connection by the installer. A geological survey should be carried out by the contractor before drilling starts.

Boreholes are economically viable on large commercial projects and any site with a heat load of above 100kW should carry out a thermal response test on a trial borehole to calculate the actual amount of heat that can be obtained from the borehole. The design of the borefield required can then be calculated accurately.

**Fig 3**  
**Closed loop water arrays**



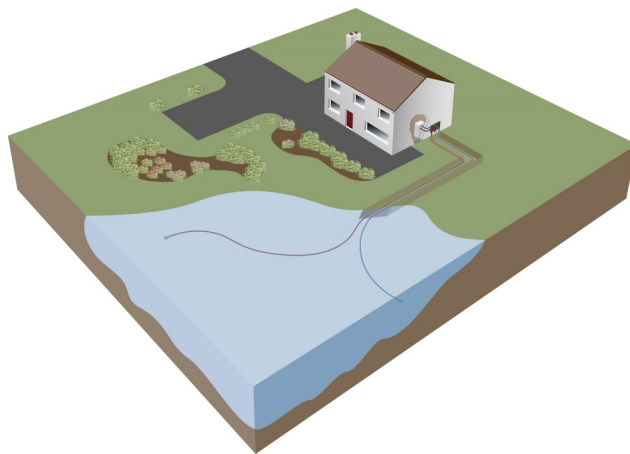
### 3.1.4 Water systems

If the property is next to a lake then it is possible to use the [lake water](#) as the energy source. This is generally the most cost effective means of installing arrays as digging is kept to a minimum. Lake systems can be either open source or closed source. Lake systems which have visible flowing water into and out of them are ideal although large still lakes can also be used as long as they have sufficient water in them.

The most popular lake system is a closed loop system and this is the preferred method. In this system a food grade glycol and water mix is circulated around the slinkies, which are sunk to the bottom of the lake. The slinkies are attached to a frame (pond mat) and will absorb energy from the surrounding water. The lake has to be sufficiently deep to avoid freezing around the slinky and to avoid any damage from passing boat traffic.

Open source systems involve water being pumped out of the lake or borehole, passing through the heat pump and then being discharged, either back to the lake or another acceptable discharge area. Consideration needs to be taken with regards to corrosion issues, filtration, extraction licenses and possible freezing within the heat exchanger. It is also important to consider the electrical energy required to pump the water to the heat pump.

**Fig 4**  
**Open loop**  
**water arrays**



### 3.2 Sizing of ground arrays.

#### 3.2.1 Slinky array

The amount of solar energy that lands per square metre is more or less the same anywhere in the UK. Therefore the amount of energy available for heat energy absorption by ground arrays is not affected greatly by different soil types. As a rule, “wetter” soil is slightly better than well-drained soil. The sizing of slinkies takes little account of soil types - although the type of soil does slightly affect heat transfer rates, other factors such as the moisture content, (which is not always easy to determine until digging has started) will make much more of a difference. However, the formula of 10 metres of trench to provide 1 kW of delivered heat from the heat pump can be more or less uniformly applied across most of the UK.

There is a difference between using the peak heating requirement of a building to size a ground array, and using the “total annual heat demand”. However, providing that the building is insulated to at least the requirements of Part L (J in Scotland) 2006 of the building regulations and, preferably, far exceed this, then the peak heating requirement alone can usually be used to size the slinkies. Provided that the recommended number and lengths of slinkies are installed correctly, and are sized to meet the full peak heating requirement of the building (ie. as the sole source of heat - without supplementary electrical backup, for example), then they will absorb sufficient energy from the ground to heat the building year-round. If too little pipe is buried then the temperature of the slinky will fall too much over the course of the winter, to below 0 deg C, and the heat pump will no longer give its rated output, and operate outside of its operating envelope. This will cause the heat pump to run continuously, and possibly freeze the slinkies.

The water temperature returning to the heat pump can be anywhere between 2 and 5 degrees below static ground temperature—in simple terms, between 3 and 7 degrees C.

#### 3.2.2 Borehole arrays

Borehole arrays generally provide a higher energy yield per metre of array than horizontal arrays. The amount of energy that a borehole can provide depends on the ground that the borehole is drilled in to. Hard rock such as granite has a better conductivity than clay or softer rock. As a rule of thumb a borehole will provide between 30W/m and 50W/m. The actual yield will depend on the geological conditions.

For large commercial heating loads it is advisable that a Thermal Response Test (TRT) is carried out to determine an accurate energy yield from a representative trial borehole.

#### 3.2.3 Water source arrays

Water has a very high conductivity and is an ideal source of energy for a heat pump. For a pond mat, due to this high conductivity, the energy extraction rate is approximately 7kW per pond mat. For any water source arrays Kensa should be contacted for additional sizing information.

Open loop systems are more difficult to size and in these situations Kensa should be contacted.



## 4. General Product Information

This manual explains how to install slinky ground arrays suitable for a Kensa heat pump and connection of ground array manifolds for use with slinkies, straight pipe or boreholes.

The Kensa range of heat pumps and slinky ground arrays are designed for straightforward installation and require no specialist training to install. However the installation must conform to all relevant construction and electrical codes and comply with the requirements of the Microgeneration Certification Scheme (MCS) MIS3005 'Requirements for Contractors undertaking the Supply, Design, Installation, Set to Work Commissioning and Handover of Microgeneration Heat Pump Systems'

### 4.1 Equipment delivery and handling.

#### 4.1.1 Factory shipment

Prior to shipment, the Kensa slinky horizontal ground array and manifolds are tested, and inspected to ensure proper operation.

#### 4.1.2 Receipt of shipment

Each pallet should be inspected at the time of delivery for possible external damage. Any visible damage should be recorded immediately on the carrier's copy of the delivery slip.

Each pallet should be unpacked carefully and its contents checked for damage.

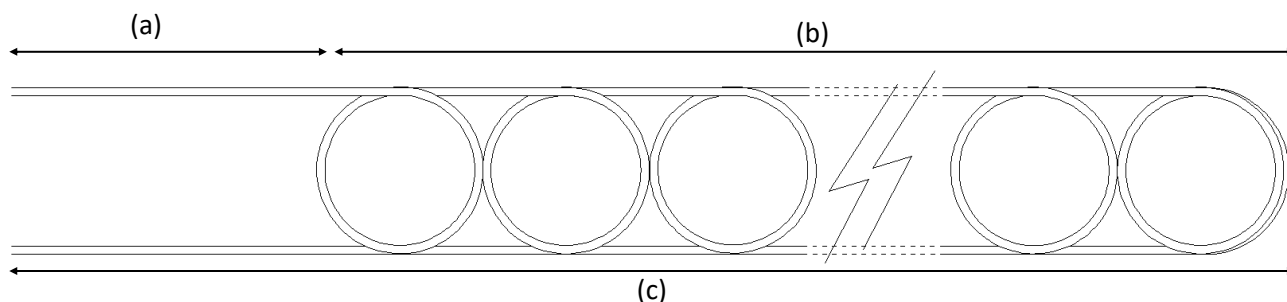
If it is found that some items have been damaged or are missing, notify Kensa immediately and provide full details. In addition, damage must be reported to the carrier with a request for their on-site inspection of the damaged item and its shipping pallet.

### 4.2 Product description.

Kensa heat pumps will operate with all types of ground arrays. However Kensa generally recommend the slinky type of ground array.

Slinkies are generally the most cost effective way of installing a ground array as due to their 'looped' design approximately every 1m of trench contains 5m of pipe.

Kensa manufacture 3 different lengths of slinkies, specified as 30, 40 or 50m slinkies. Please note the length specified is the trench length that the slinky fits in and not the amount of pipe within the slinky. Each slinky length is made from a straight header pipe, a coiled section (which is the energy absorbing part of the slinky) and a straight return pipe.



**Fig 5 Slinky Construction**

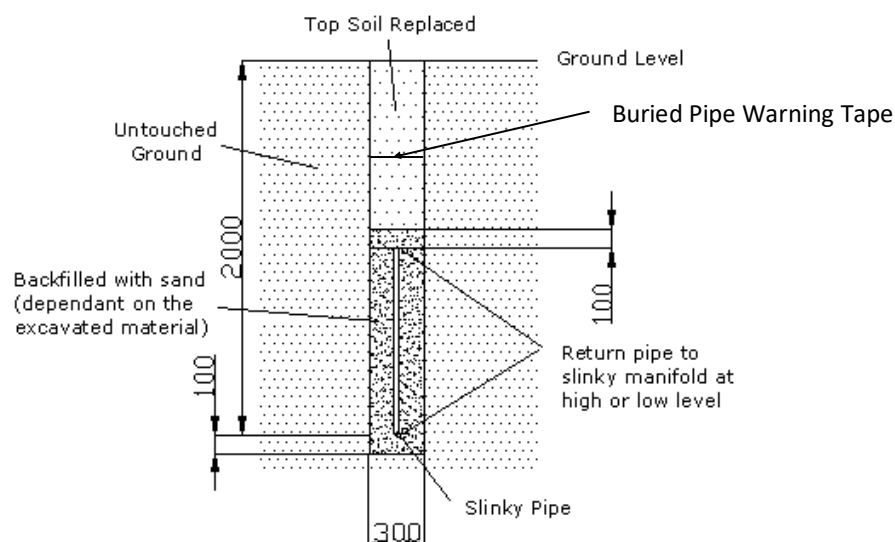
Slinky m	Pipe OD mm	Length of header m (a)	Length of coiled section m (b)	Length of return pipe m (c)	Total amount of pipe m
30	32	25	30	55	200
40	32	25	40	65	250
50	32	25	50	75	300

Slinkies are manufactured using black HDPE (High Density Polyethylene) pipe, with a pressure rating of PE100+. Blue pipe is not acceptable, as under Water Resources Council guidelines, this denotes that it contains only fresh water, which would be unacceptable as ground arrays contain antifreeze.

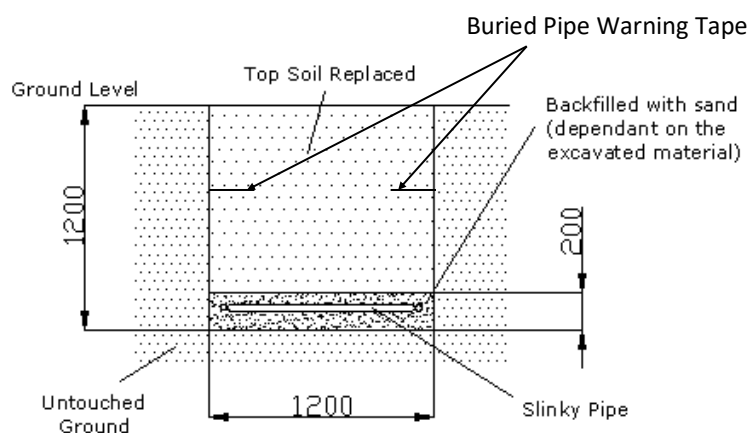
All slinkies are leak tested before they leave the factory and this is indicated by the coloured cable tie on the return pipe.

Yellow—50m Slinky  
Green—40m Slinky  
Purple—30m Slinky

**Fig 6 Slinky  
Installed Vertically**



**Fig 7 Slinky  
Installed Horizontally**



## 5. Mechanical Installation of Slinky Ground Arrays.

### 5.1 Groundworks

When digging and working in trenches all current Health and Safety measures should be adhered to, appropriate to the depth of trench work being carried out. Any unstable trench sides will need to be supported.



**Fig 8 1.2 x 1.2m slinky installation**



**Fig 9 2m deep slinky installation**

#### 5.1.1 Slinky trenches

With Slinky installation there are two choices of installation, a narrow 2m deep trench, 300-400mm wide (Fig 6) or a 1.2m by 1.2m deep trench (recommended) (Fig 7). Before trenching begins consideration should be given to which trenching method is more suitable for the available ground. If the ground contains sharp flints or large clods of clay the trench may well require to be back filled with sand to provide a close contact between the pipe and ground, in this case a 1.2m x 1.2m trench would be more suitable due to the reduction in sand required. A minimum distance of 5 metres between trench centres should be maintained. The edge of any trench should be at least 2.5 metres inside any property line and 1.5m away from any buildings.

Care should be taken while trenching around mature trees to avoid excessive damage to roots. Trenches do not have to be straight as long as the 5m separation distance is maintained.

If rock or large boulders are found, it is possible to change from one type of trench to the other, for some or the entire trench. Slinky trenches can be used as soakaways providing that the trenches are at least half backfilled with good quality spoil before pea gravel is used. Pea gravel should only be used in soakaways. For backfilling see section 6.7. Backfilling should only be done after leak testing.

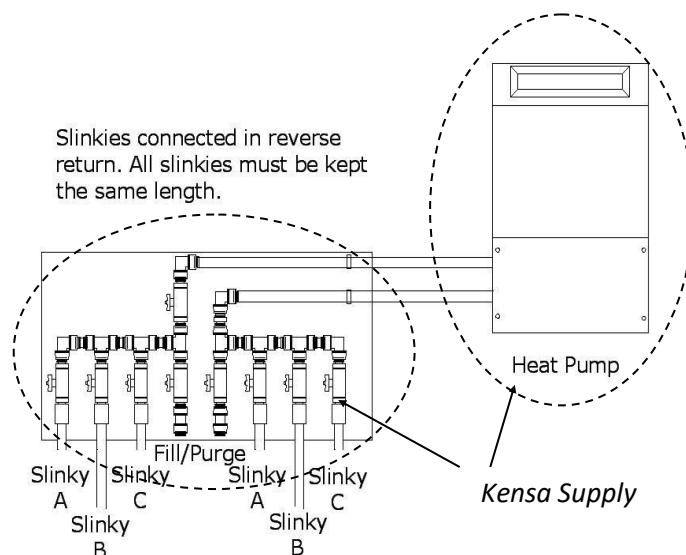
#### 5.1.2 Header Trenches

The slinkies are supplied with a header pipe, which is usually about 25 metres. This allows the slinky trench to be terminated a little way from the building. The header pipes from all the slinkies can join together into a single 1.2 m deep header trench. It is advisable that all the flows are placed on one side of the trench and the returns the other. This also allows the header pipes to exit the soil vertically, directly under the Slinky Manifold, which is generally fixed to the outside of the building.

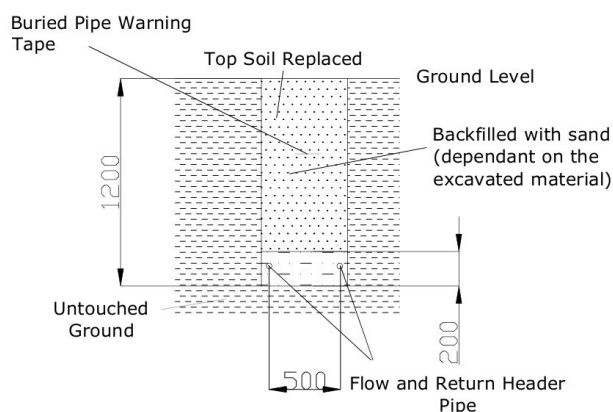
If a header pipe needs to cross a service pipe or drain, it is advisable that the header pipe is insulated at the crossing point. Buried pipe within 1m of a buildings foundation should also be insulated.

The distance between the slinkies and the manifold is fixed (i.e. approximately 25m, the header length). Distances greater than this can be achieved by un-coiling coils in the coiled section of the slinky. It is important that there is a minimum separation distance of 1 metre between adjacent pipes for uncoiled sections.

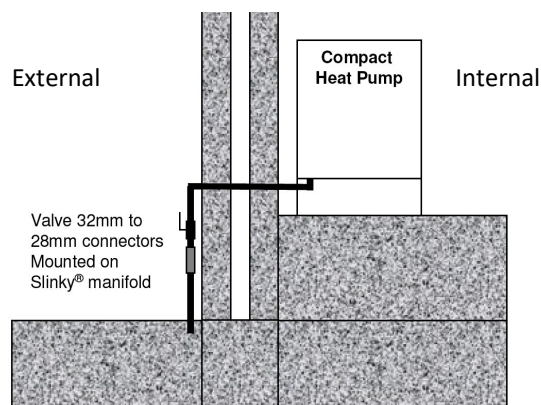
Ideally an expansion vessel should be fitted on the ground array to maintain pressure within the system as the pipe relaxes. A suitably sized vessel would be 4l (225 x 195mm) and is available from plumber suppliers or Kensa.



**Fig 10 Manifold Slinky connections**



**Fig 11 Header Trench**



**Fig 12 Positioning of Heat Pump and Manifold**

Please note if one coil is unrolled at the front of the slinky's coiled section then one coil needs to be uncoiled from the rear of the coiled section to provide enough return pipe.

Uncoiling coils can also be used to enable slinkies to be placed within pinch point areas (i.e. where there is not enough area to maintain the required 5m separation distance, for example between two buildings). It is important to note that by uncoiling slinky coils the overall trench length will be increased and that the corresponding number of coils will need to be uncoiled from the end of the coil section to provide enough return pipe.

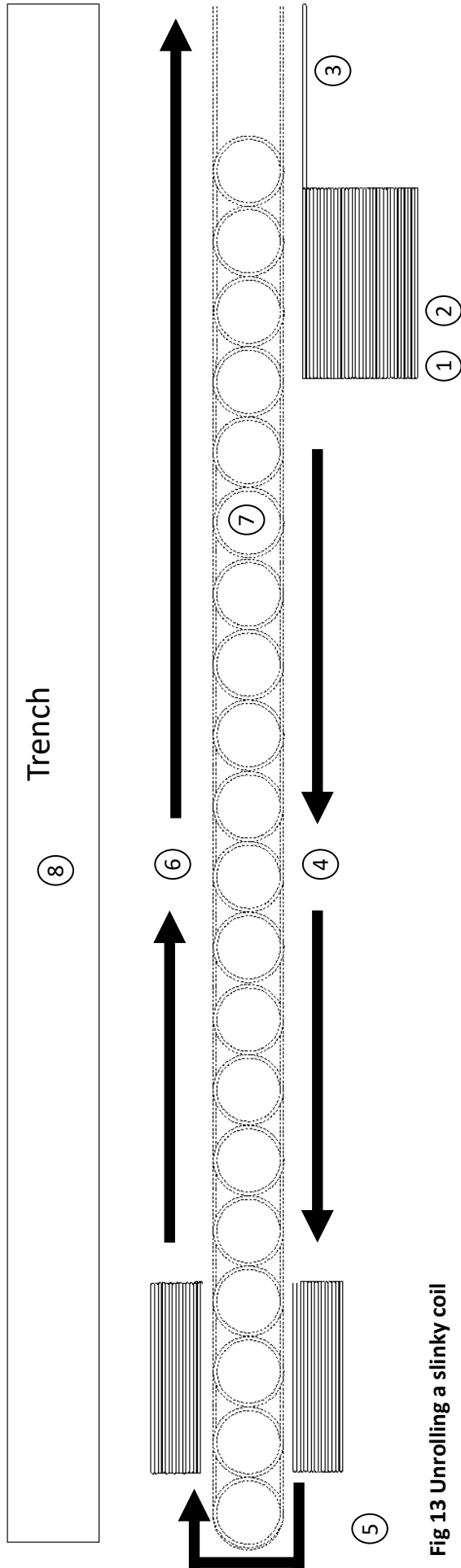
### 5.1.3 Unrolling the coil.

The slinkies are formed and held together using plastic zip ties. When formed into a coil for transport, the slinkies are held together with black strapping.

Remove the coil or coils from the pallet. There are generally two coils per pallet. You are advised to assess the risks taking into account the task, the individual, the load and the working environment and use the appropriate handling method depending on the circumstances of the work being done

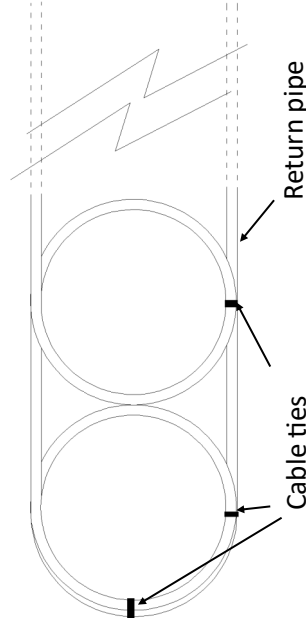
To unroll the coil please see the procedure over.





**Fig 13 Unrolling a slinky coil**

1. Position the slinky at the top of the header trench, (the end nearest the manifold).
2. Turn the slinky coil on its edge and cut the black strapping, which will allow the coil to be unwound. (The end of the coil without the colored cable tie is the short header pipe which runs into the looped section).
3. Peg down the end of the short header pipe to ensure that it does not move.
4. Carefully roll the coil along the trench allowing each loop to separate from the coil and lie next to the trench
5. At the end of the trench, carefully turn the coil through 180 degree to allow the coil to be rolled back along the trench. Separate the last loop from the coil and cable tie this to the return pipe. (This is to reduce the possibility of the pipe kinking at this point).
6. Slowly roll the coil along the side of the trench allowing the return pipe to separate from the coil and lie next to the trench and loops.
7. Once the coil is fully unrolled it is advisable that the loops are cable tied to the return pipe to improve rigidity of the slinky. The slinky can then be moved easily.
8. Place the slinky in the trench.



**Fig 14 Advisable additional cable tie positions**

#### 5.1.4 Return pipe

The return pipe should be in the same trench as the slinky and as described above ideally cable tied to the bottom of the slinky coil.

#### 5.1.5 Unused or excess pipe

To avoid balancing issues with flows all slinky pipes need to be kept to the same length.

Allow enough pipe above ground (usually 1.5m) to cut down and connect into the slinky manifold. Any excess header pipe can be coiled back into the trench. Alternatively, it can be cut, however the same amount needs to be cut off each slinky pipe.

#### 5.1.6 Cutting the pipe

The pipe can be cut with a plastic pipe cutter which is available from plumbers' merchants. Do not reduce the total length of one slinky without reducing the length of all of them by the same amount. This is because the lengths of the slinkies must be identical to ensure that there is an equal flow rate throughout.

#### 5.1.7 Tips on manipulating the pipe

The flexibility of the pipe at 5 deg C (an average winter's day) and 20 deg C (an average summer's day) will vary. However, even on the coldest days, the pipe can still be bent into a 1 metre diameter circle.

### 5.2 Ground arrays in lakes, ponds and rivers

Since plastic pipe is buoyant even when filled, the arrays and their headers must be kept in place using weights. The arrays should be assembled on a stainless steel mesh and held down using plastic zip ties. The dimensions of the mat are generally 2.5m long by 1m wide and with a height of approx 500mm. The mats should be placed with sufficient water above them and this amount of water depends on whether the water is flowing, boat traffic, etc. The arrays should be filled with air, not water, and floated into place with any weights attached. When in the proper location, the arrays can be filled with water using a hose (providing that there is sufficient mains water pressure) and sunk into position. Additional weights may then also need to be carefully placed on the arrays.



Fig 15 Slinkies mounted on a pond mat



Fig 16 Floating the pond mats out

Please note:-

- Any antifreeze used in water sourced arrays needs to be environmentally friendly and food quality.
- Silting of the lake can cause a reduction in performance in pond mats unless regular maintenance (i.e. removal and cleaning) takes place.

## 6. Ground Array Manifolds

Manifolds for the ground arrays can either be above ground or below ground.

### Above Ground

The manifold for the slinkies should be placed on the outside wall of the building, ideally with the heat pump on the other side of the wall. This is to avoid having to insulate the manifold with vapour barrier insulation to prevent condensation. It also reduces the number of entry/exit holes in the buildings fabric. Once installed an enclosure can be built around the unit if required.

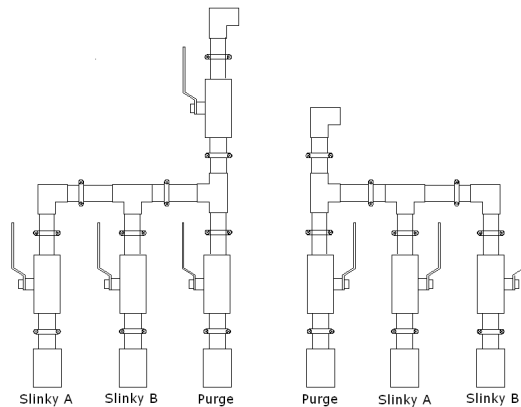


Fig 17 - Two way universal manifold  
(configured for right handed)

On the slinky manifold, each end of each slinky connection is terminated in a 32 mm to 28 mm reducer, which is connected to a 28 mm compression valve. Each of these valves is connected to either a "feed header" or "return header". It is important that the effective length of each slinky is the same, to ensure even flow rate across them all.

### Underground Manifolds

The underground manifold chambers are pre-fabricated and designed specifically for use with ground source heat pump installations.

They provide security and a central position to connect the heat pump's ground array pipes together.

Manufactured from tough, resistant polyethylene they are available in a range of sizes and with differing numbers of inlets and outlets with control valves, flow meters and fill and bleed ports.

### 6.1 Connecting ground array pipe to the manifold

#### Above Ground

The array pipe must be cut squarely and neatly, and any burrs inside or outside removed. An appropriate plastic pipe cutter should be used. Each ground array manifold is supplied with copper ferules, one of which must be inserted into the end of each array pipe. This avoids the plastic pipe from being crushed by the compression fitting. It is essential that the ground array circuits are the same length to ensure even water flow. The ground arrays are all supplied from Kensa as identical lengths - **do not** cut them to different lengths exceeding +/-1m.

The pipe must be pushed all the way into the reducers, before tightening. Two spanners must be used to tighten the reducers - one to hold the body of the reducer, and one to turn the nut. As the nut is tightened, the copper or brass olive is compressed onto the plastic pipe, sealing the joint. A jointing compound such as "Fernox LSX" may be used on the joints, and it must be spread onto the pipe before it is inserted into the reducer so that it will be underneath the olive.

## **Underground Manifolds**

DC3—Loop connections include PVC ball valves as a method of isolation, and 8-38 flowmeters for balancing the system. All DC3 units are supplied with 1" ball valves on the flow and return for filling and bleeding the system. The use of a 90 degree bend within the chamber allows the addition of DN50 PVC ball valves to the heat pump lines allowing isolation to the main flow & return. This also allows the manifold to be completely isolated and removed from the chamber. The manifold comes with 40mm—32mm electrofusion reducers and as the chamber is buried electrofusion joints should only be used. For further information on the process of electrofusion please contact Kensa Heat Pumps

DC4—Moulded from tough, 11mm thick, solid walled resistant polyethylene, DC4 are available in various sizes and numbers of inlets and outlets together with an assortment of accessories. It has a removable lid which is rated to 600kg (ISO 15398) and is suitable for installation within driveways or areas of occasional light slow-moving traffic. 8-38 flowmeters for balancing the system are included and the manifold comes with 40mm—32mm electrofusion reducers. Addition of PVC ball valves to the heat pump lines allows for isolation to the main flow & return. As the chamber is buried electrofusion joints should only be used. For further information on the process of electrofusion please contact Kensa Heat Pumps.

DC5—Moulded from tough, 11mm thick, solid walled resistant polyethylene, DC5 are available in 12 way versions. It has a removable lid which is rated to 600kg (ISO 15398) and is suitable for installation within driveways or areas of occasional light slow-moving traffic.

8-38 flowmeters for balancing the system are included and the manifold comes with 40mm—32mm electrofusion reducers. Addition of PVC ball valves to the heat pump lines allows for isolation to the main flow & return. As the chamber is buried electrofusion joints should only be used. For further information on the process of electrofusion please contact Kensa Heat Pumps.

## **6.2 Connecting the manifold to the heat pump**

### **Above Ground**

All 1, 2 and 3 way Compact Heat Pump ground array manifolds are supplied with 28 mm 'Speedfit' push-fit connectors and are universal, i.e. can be configured on-site as right or left-handed. Other Compact Heat Pump manifold sizes are supplied with 50mm connectors and need to be specified as right or left handed at the time of ordering. Plantroom system manifolds can be larger sizes.

### **Below Ground**

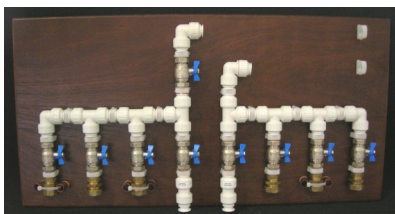
DC3 and DC4 come with 63mm electrofusion stubs for connection to the heat pump. As the chamber is buried electrofusion joints should only be used. For further information on the process of electrofusion please contact Kensa Heat Pumps.

DC5 manifolds come with 2 x 110-90mm electrofusion joints for connection to the heat pump. As the chamber is buried electrofusion joints should only be used. For further information on the process of electrofusion please contact Kensa Heat Pumps.



Connection to a Compact Heat Pump should be via 28mm 'Speedfit', 50mm MDPE/HDPE or similar plastic pipe systems. This pipe can be purchased from any plumbers' merchants.

Any ground pipes inside the building should be insulated using a vapour barrier insulation, such as "Armaflex" to prevent dripping from condensation. Any pipe outside the building need not be insulated since the circulating fluid contains anti-freeze.



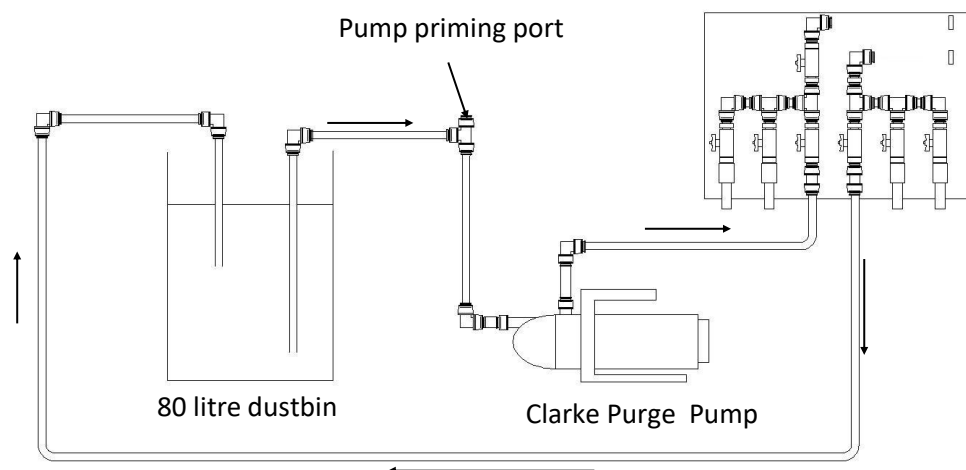
**Fig 18 3-Way  
universal manifold**



**Fig 19  
4-Way  
manifold  
(left handed)**

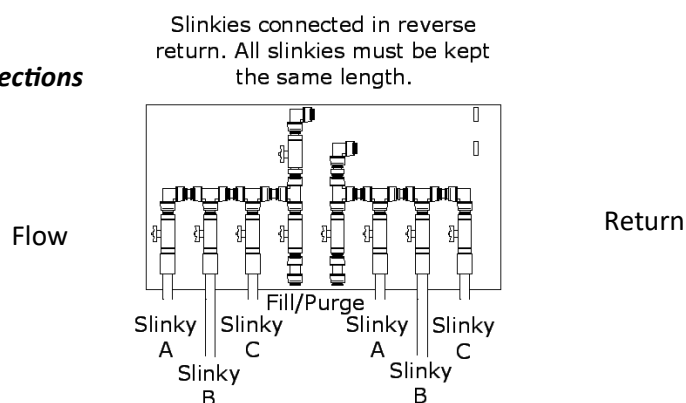
### 6.3 Purging procedure for multiple ground arrays (for single ground arrays, see section 6.8)

**Fig 20 Slinky purging  
kit connected to a  
manifold**



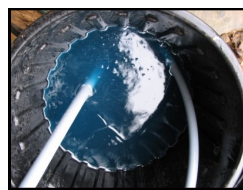
- i. Remove the plastic purging connection blanking plugs, and connect the purge pump to the fill and purge ports on the Slinky manifold, see figure 18. The purge ports can be connected either way round.
- ii. Connect the purge pump to draw from an 80 litre dustbin half filled with clean water. This pump must be capable of circulating 60 litres per minute against a pressure of 1 bar. If the pump's electrical rating is less than 1 kW, then it is unlikely to be suitable. Kensa only recommend the use of the Clarke SPE1200SS pump as above. The water level in the dustbin will need to be topped up constantly during the following process. The pump may need priming by pouring water into its priming port until it overflows.
- iii. Place a filter such as a kitchen sieve over the pipe returning water to the dustbin so any debris will be captured. Ensure all valves are closed. Open the valves on the manifold in the following order (refer to above diagram Fig 18) :-
  - a. Open  $A_{\text{return}}$
  - b. Open  $A_{\text{flow}}$
  - c. Open both purge valves

Start the purge pump, being careful that the water pipe returning water to the dustbin is secure.

**Fig 21 Slinky manifold connections**

- iv. If the water level in the dustbin does not start to drop, then repeat the pump priming. No water should be flowing through the other slinkies. The flow rate should be in excess of 30 litres per minute. This can be checked simply by holding a 10 litre bucket to collect water returning from the slinky, and ensuring that it fills in less than 20 seconds. If the flow is less than this, sufficient velocity is not being achieved to displace the air at the tops of the slinky coils.
- v. After water has circulated for about ten minutes, and no more debris has collected in the sieve, place the return pipe below the water level in the dustbin to ensure all the air has also been expelled (Fig 20). Stop the purge pump and then the valves on the first slinky can then be closed, again ensure that the return pipe into the dustbin is secure. At this stage, the valve to the heat pump should still be closed.
  - a. Close  $A_{\text{flow}}$
  - b. Close  $A_{\text{return}}$

Repeat the above procedure (steps iii to v) for the next slinky (i.e. slinky B on the diagram).

**Fig 22 Purging the Slinkies of Air****Fig 23 Slinkies Purged of Air**

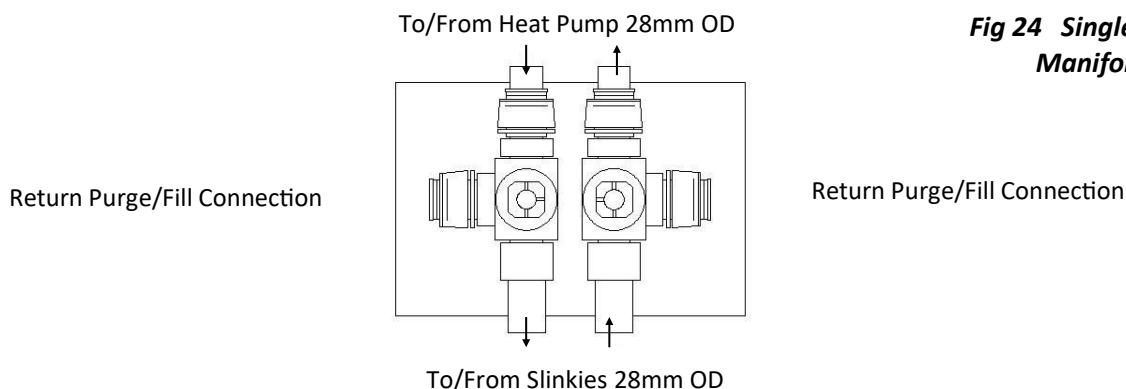
- vi. When the slinkies have been purged, change the connections around and re-purge in the opposite direction as per MCS guidelines.

#### 6.4 Pressurizing the system.

- i. Open all valves EXCEPT THE DISCHARGE PURGE CONNECTION. Keep a close eye on the level of water in the dustbin and start the purge pump. This should pressurise the whole system. If the level of water drops significantly this indicates the system hasn't been correctly purged of air and needs to be re-purged.
- ii. Close the fill purge valve on the slinky manifold with the pump running, so that the ground array is left under pressure.
- iii. Most purge pumps will attain around 5 bar, and the circuit should be left at this pressure for a minimum of 15 mins, as any leaks will become immediately apparent. The pressure will slowly fall as the pipes in the ground arrays slowly expand in the coming months, and may need topping up using the cold fill system provided.
- iv. Remove the purging equipment. Replace the plastic blanking plugs in the slinky manifold purge connections.
- v. Leak test the ground array in accordance with BS805 section 11.3.3.4 (Section 6.6)

## 6.5 Purging procedure for single ground arrays

The single slinky manifold consists of two three port diverting valves, one for flow and one for the return. The manifold allows the slinky to be filled and purged.



**Fig 24 Single Slinky Manifold**

The sequence of valve operation for a single manifold is slightly different from larger manifolds. Each slinky is connected to a three port diverting valve as above. The slots machined on the front of each valve indicate which connection is open. The previous drawing (Fig 21) is set for normal operation, i.e. both purge connections are closed and the flow and return from the slinky to the heat pump are open.

- i. Remove the plastic blanking plugs, and connect the purge pump to the fill and purge ports on the Slinky manifold, see Fig 21. The purge ports can be connected either way round.
- ii. Connect the purge pump to draw from an 80 litre dustbin half filled with clean water. This pump must be capable of circulating 60 litres per minute against a pressure of 1 bar. If the pump's electrical rating is less than 1 kW, then it is unlikely to be suitable. Kensa only recommend the use of the Clarke SPE1200SS pump for this. The water level in the dustbin will need to be topped up constantly during the following process. The pump may need priming by pouring water into its priming port until it overflows.
- iii. Place a filter such as a kitchen sieve over the pipe returning water to the dustbin so any debris will be captured. To move the position of the valve an adjustable spanner can be used. Open the valves on the manifold to the following position:-



*Both purge connections are now open to ground array*

Start the purge pump, being careful that the return pipe to the dustbin is secure.

- iv. If the water level in the dustbin does not start to drop, then you need to repeat the pump priming. The flow rate should be in excess of 30 litres per minute. This can be checked simply by holding a 10 litre bucket to collect water returning from the slinky, and ensuring that it fills in less than 20 seconds. If the flow is less than this, sufficient velocity is not being achieved to displace the air at the tops of the slinky coils.



**Fig 25 Purging the Slinky of Air**

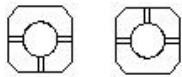


**Fig 26 Slinky Purged of Air**

- v. After water has circulated for about ten minutes, and no more debris has collected in the sieve, place the return pipe below the water level in the dustbin to ensure all the air has also been expelled.



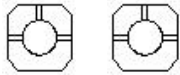
Move the valves on the manifold to the positions below, again ensure that the return pipe into the dustbin is secure.



*Slinky connection is now closed, purge pump connection open to the slinky*

- vi. When the slinky has been purged, change the connections around and re-purge in the opposite direction as per MCS guidelines.

- vi. The system should then be pressurised and left under pressure, with the connections left as shown below and the purge pump turned off.



*Both slinky connections are now closed.*

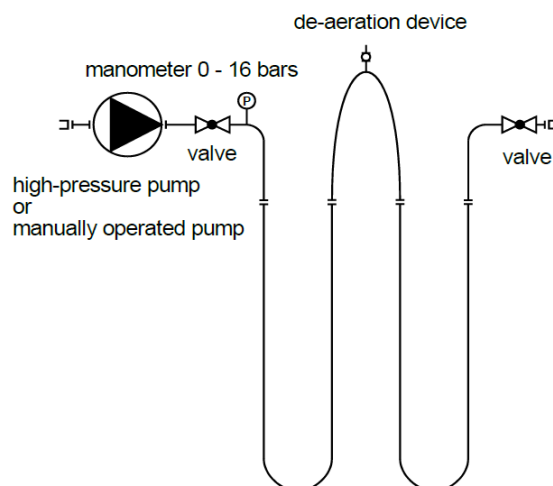
- vii. Most purge pumps will attain around 5 bar, and the circuit should be left at this pressure for a minimum of 15 mins, as any leaks will become immediately apparent. The pressure will slowly fall as the pipes in the ground arrays slowly expand in the coming months, and may need topping up using the cold fill system provided.
- viii. Remove the purging equipment. Replace the plastic blanking plugs in the slinky manifold purge connections.
- ix. Leak test the ground array in accordance with BS805 section 11.3.3.4 (Section 6.6)

#### 6.6 Pressure Testing in accordance to BS805 Section 11.3.3.4

In accordance with MCS Guidelines, leak tightness (pressure) testing has to follow the EN 805 prescriptions in section 11.3.3.4. This test should be carried out after the ground arrays have been purged but before the antifreeze is added. For polyethylene (PE) tubes, the pressure testing has to be carried out as a 'compression test'. An overpressure (inside-outside) is applied to the pipe over the whole length. This step inflates slightly the PE pipe over its whole length. Then a sudden pressure drop of around 10% of the testing pressure is applied. This pressure drop allows the pipe to compress again. If the pipe is tight, a pressure increase is measured. This test should only be carried out on the ground arrays with the heat pump isolated from the test.

To perform such a test, the following equipment is needed:

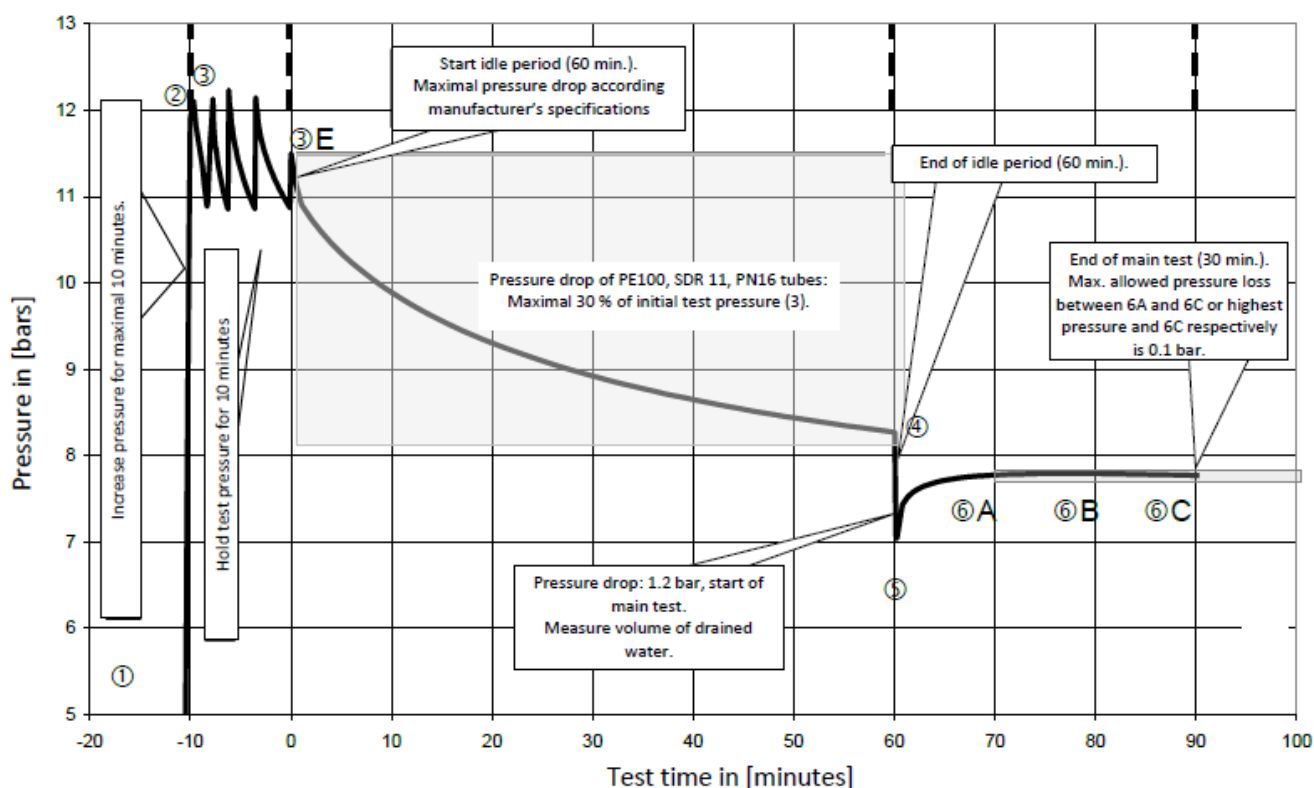
- A high-pressure pump or a manually operated pump
- 2 stop valves
- 1 manometer 0 -16 bar
- A de-aeration device (if any point of the ground array is at a high point where air can collect)



**Fig 27 Leak Tightness Configuration**

Test procedure in detail (Fig. 28):

- 1 h Idle period. No overpressure is applied to the tube . ①
- Apply the test pressure. For PE100/PN16/SDR11 ground arrays this should be > 7.5 barg. If the heat pump is within the pressure test this should be less than 10 barg. For other materials follow the manufacturer's specification ②
- 10 min Keep up pressure test ③
- 1 h Idle period. The tube is going to expand over the whole length
- Pressure measurement. The pressure drop may not exceed the manufacturer's specifications ④
- Sudden pressure drop of at least 10% of the test pressure ⑤
- 10 mins. First pressure measurement ⑥ A
- 20 mins. Second pressure measurement ⑥ B
- 30 mins. Third and final pressure measurement ⑥ C



**Fig 28 Graphical Test Procedure**

The ground array has passed the test if the pressure difference (pressure drop) between (6)C and (6)A does not exceed 0.1 bar.

The test should not be conducted in cold weather, when there is a risk of freezing.

## 6.7 Backfilling Trenches

It is important that the slinkies are visually inspected for damage and kinks before the trench is backfilled.

### 6.7.1 Repairing Slinky Pipe

If damage or leaks are found then a repair joint may be required. Ideally this should be an electrofusion joint. Alternatively it is possible to use an 'O' seal connectors, however electrofusion will provide a stronger joint.

If the repaired joint is above ground a compression fitting can also be used. It is important that the correct size of internal pipe support inserts are used. The procedure for repairing a ground array pipe is no different from repairing a water pipe. The edges of the pipe should be cut square, with no burr, and there should be no scratches in the pipe.

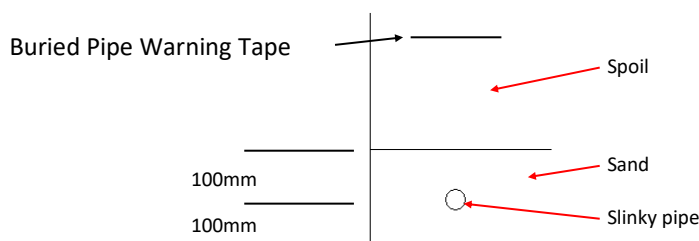
After the joint is made, the entire ground array should be pressure-tested, preferably witnessed by the client or Main Contractor, before it is back-filled.

### 6.7.2 Kinked Pipes

If the plastic pipe is bent through too tight a diameter, then it can kink, so this should be avoided. If this does happen, it is possible to simply straighten out the pipe. If the kink is severe, then the pipe will have to be cut and joined.

### 6.7.3 Backfilling

If the soil removed from the trench contains flints or contains large clods of clay, it is advisable that the bottom of the trench is initially covered with approximately 100mm of sand, to prevent damage and provide good contact with the surrounding ground. The slinky is installed on this sand base and is then covered by approximately another 100mm of sand.



**Fig 29 Backfilling With Sand**

If back filling with sand is required then it is advisable that a 1.2m by 1.2m trench is dug as this significantly reduces the amount of sand required.

Pea gravel should only be used in slinky trenches which are being used as soakaways and only after the slinky trench has been approximately half filled. Soils containing sharp flints and rocks should not be used as backfill. Since slinkies are a "closed loop" system any leaks will allow the water pressure to fall below that at which the circulating pump can operate.

The backfilling procedure is critical because it is the time when damage to the slinkies is most likely to occur. Heat transfer depends on good contact between the pipe loop and the ground. Clay soils must be carefully prepared before returning the material to the trench, since larger clods of clay will leave sizeable air pockets around the slinky.

The earth pile should be shovelled sideways so that it falls gradually into the trench. Break up or discard any clods or lumps of earth.

Buried pipe warning tape should be buried above the slinky pipe to provide warning that pipes are buried below.

Over a period of time due to the settlement of the soil the level of the top of the trench might slightly drop. Due to this settlement the pressure within the ground array may also decrease. The disturbed ground surrounding the newly installed ground array will not make perfect contact with the pipe initially. After several years the effects of rain and natural compaction of the soil will result in improved conduction. Essentially, if the building is heated successfully over the first winter, performance in later winters will generally improve.

## 6.8 Straight pipe

Straight pipe can be used with Kensa heat pumps, however pipe lengths of each circuit should not exceed 300m.

Pipes should be buried at 1.2m and should be separated by 1m between centres.

Due to the large amount of pipe being buried, many sites will completely remove 1.2m of topsoil from the area, lay the pipe, secure it and then recover with the 1.2m of topsoil after it has been graded to remove any large or sharp stones.

Connection to the manifold is the same as for slinkies. (See section 6)

## 6.9 Borehole arrays

Drilling of boreholes is a specialist procedure and would need to involve the services of a borehole driller.

The driller as well as providing the borehole will also usually take responsibility for providing the borehole pipe, testing the pipe and backfilling the borehole with a thermal grout.

Boreholes should not be any closer than 5m between centres and for large borefield sites it is important that tests are carried out ( thermal response tests) to obtain an accurate output for a representative borehole so that an accurate borefield design can be obtained.

Connection to the manifold and heat pump are the same as for slinkies. (see section 6)



Intentionally left blank



## 7. Ground Array Layout

The following section should be used to indicate the position of the ground arrays as installed. It is vital that this is completed to enable future reference of the position of the arrays and avoid damage due to future works.

Please provide below an outline sketch of where and how the ground arrays are installed with dimensions.

