

How to build a large (Organic) High Pressure Aeroponic system in Australia

By: Maitland Gill

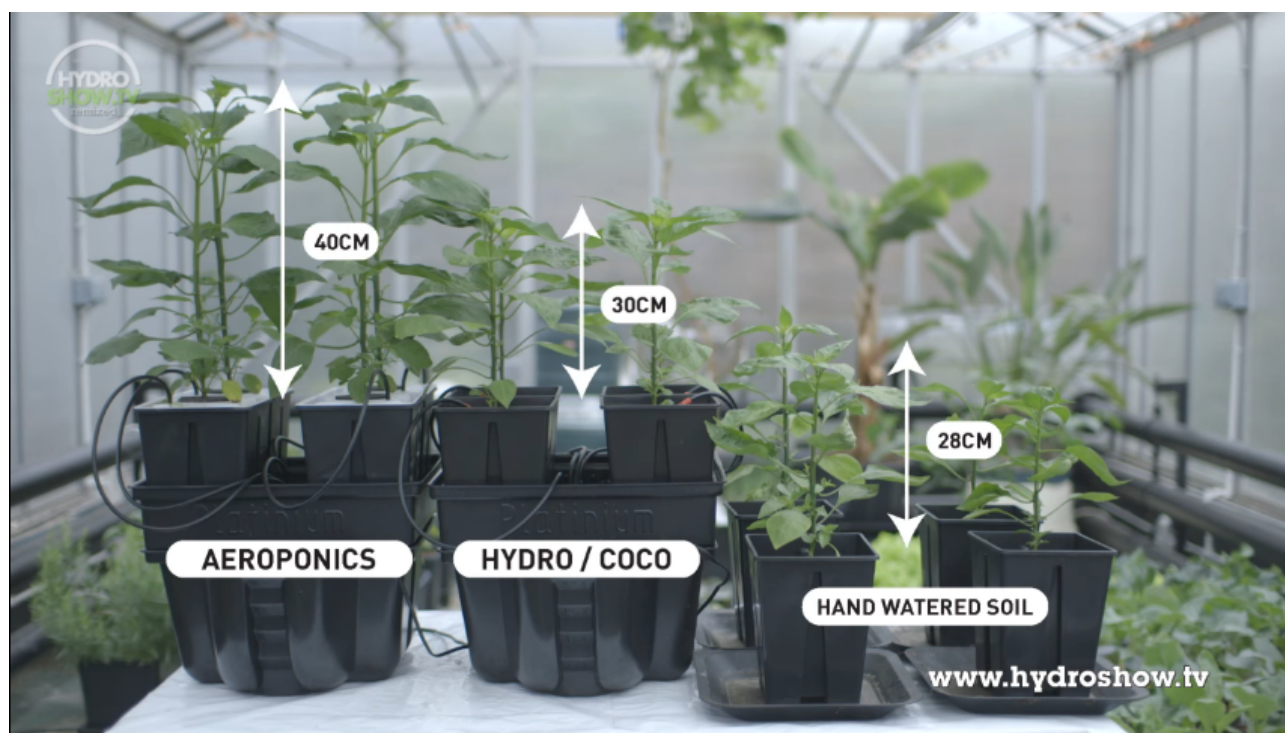
Updated: 11th of March (3) / 2019

The climate in WA is especially harsh on fruit and vegetable crops. Even a small Aeroponic or Hydroponic system will require a water chiller to keep its Reservoir temperature down.

Aeroponics (Aero-Hydroponics): Growing plants in an air or mist environment without the use of Aggregate (*Mass of fragments loosely compacted together*) mediums (*A Fluid or solid in which organic structures are placed in the middle*). Aggregate mediums are used in 'Geoponics' (Soil).

Aeroponics are conducted without the use of a growing medium, although the plants still need to be anchored. The dangling roots and lower stem of the plant hangs below and above the water-level within a reservoir or separate root container (Semi-closed environment that empties to a Reservoir).

The crown and leaves (The 'Canopy') of the upper stem extend above the Root Container.



The picture above shows a 30% increase in growth, compared to Hydroponics and Geoponics.

The nutrient-rich water solution needs to have its pH and ppm closely monitored and filtered before it enters the misting nozzles so they don't clog. The misting nozzles in 'High-pressure Aeroponics' generate 30μ to 50μ droplets in a process called '[Atomization](#)'. This is done by either forcing liquid through a small orifice with an impeller inside it, or by smashing the fluid as it exits the orifice (Impingement).

The combination of pressure and the nozzles orifice size causes the liquid to emerge as small ligaments. These then break up further into very small droplets or liquid particles.

An '*Electronic Tap Timer*' (Irrigation Controller / Timer) is attached **after** the *In-line* filtration unit and is set to open for 5 seconds in 3 minute intervals. At this rate, the Solenoid Valve will be open for 40 minutes per day.

$60 \text{ sec} \times [60 \text{ min} \times 24 \text{ h} = \mathbf{1440 \text{ min}}] = 86,400 \text{ sec}$
 $86,400 \text{ sec} / 180 \text{ secs} (\mathbf{3 \text{ min}}) = \text{switching on/off } 480 \text{ times per day}$
 $(480 \times 5 \text{ sec} = 2400 \text{ sec}) / 60 \text{ sec} (1 \text{ min}) = 40 \text{ minutes per day}$

Installing a Tap Flow Meter Gauge will allow you to see how many litres the pump must transfer. Better yet, an Electrical Cost Meter will allow you to see how many Watts the system uses each day.

An '*Accumulator Tank*' (*pre-Pressurized Well Tank* or *Bladder Tank*) is used to store an amount of water with the maximum water pressure (Head-height) of a pump, so it only needs to turn on when the pressure drops below a certain level (80% with a Torrium 2 pressure controller). The pumps '*Electronic Pressure Controller*' is a device that attaches to the outlet and provides power to the pump when the pressure drops to a certain level. Note also, that the pressurised air in the tank needs to be about 70% of the pumps max kPa.

About \$7,000 AUD will be needed to build this system, but you can start with a single drum / tote.

Index

Page 3 – Root Container (*Drums, Totes, Tubs, Containers w/ Lid*)

Page 4 – Misting Nozzles

Page 5 – Neoprene Collers & Seed Propagation

Page 5 – Pressure Tank

Page 5 – In-line Filter

Page 5 – Water Chiller

Page 6 – Circulation Pump (For Water Chiller)

Page 6 – Air Pump

Page 7 – Water Pump + “Torrium 2”

Page 8 – Electrical Connections

Page 8 – Backup Power Supply

Page 8 & 9 – Solenoid Valve + Timer

Page 9 – Reservoir (Esky)

Page 9 – Nutrients

Page 10 & 11 – Biological Control (*Insects & disease*)

Page 11 – pH and ppm Measurement / Adjustment

Page 11 – Insulation Root containers

Page 12 – Plumbing Parts + (*Tools & Accessories*)

Page 22 – Plant Seeds (*Heirloom*)

Root Container (Drums, Totes, Tubs, Containers w/ Lid)

- People In Plastic - [R200LMOHD – 200L Open Head Drum DG](#)
 - 500mm Dia, 825mm Height
- Clean Drum co. - [Plastic Drum – 210L](#)

The lid of a 200L Drum is 500 mm in Diameter, while the inside of the drum itself is 550mm. At least 4 Misting Heads are needed to cover the whole root zone, but having 6 will ensure that the lower plants will get sprayed. The misting heads will be attached to a circular loop of 3/8" tubing, fitted with Nozzle couplings and a Tee that leads out through the lid of the drum.

The loop is held up by fishing line fed through holes (1mm) drilled into the drum lid.

The length of tubing needed for each drum:

550mm (Outside Diameter below lid) – (Wall thickness: 3mm x 2 = 6mm) = 544 mm

544 mm x 3.14 = Inside circumference is 1708 mm (1.708 meters)

Length of Nylon tubing that is lost after being inserted into a Nozzle couplings *push-to-fit* hole:

.... x 12 (Number of Nozzle coupling holes) + 2 (Tee) =

(1708 mm + =) minus length of each Nozzle coupling + Tee fitting =

The of 3/8" Nylon tubing is cut into 6 segments,,,,, and mm.

One of the tube segments is cut again so that the 90° elbow can be attached.

Each one of these is cut in half so a Tee piece connector can be added between them.

Cutting holes for the PVC pipe: Alternatively, rotate the location of the holes around the drum.

If each 2" (50.8 mm) hole is spaced 25mm apart, then the distance between the centre of each hole is 75mm. With a drum height of 825mm, but the row of holes begins 16cm below that, then there will be room for 8 rows. But after every 2nd row, the PVC pipe that is to be inserted needs to have its length increased by 15mm. This reduces the number of holes that row can have.

1st and 2nd row (500mm Dia – 50mm = 450mm) x (3.14 = 1413mm)

1413mm / 75mm distance between each hole = 18 holes with 0.6mm extra spacing

3rd and 4th row (500mm Dia – 80mm = 420mm) x (3.14 = 1318.8mm)

1318.8mm / 75mm distance between each hole = 17 holes with 0.4mm extra spacing

5th and 6th row (500mm Dia – 110mm = 390mm) x (3.14 = 1224.6mm)

1224.6mm / 75mm distance between each hole = 16 holes

7th and 8th row (500mm Dia – 140mm = 360mm) x (3.14 = 1130.4mm)

1130.4mm / 75mm distance between each hole = 15 holes

Total: 132 holes (Or 152, if 19 x 2" holes are drilled into the lid, instead of a dwarf tree)

Remember to cut the pipe [at an angle](#), beginning 25mm from where it enters the drum.

This is so the water drains out of the pipe and to the bottom. The drum lid should be big enough to fit a tree trunk whose diameter does not exceed 300mm when fully grown.

Likewise, the plant stems growing through the 2" holes must not exceed that diameter when fully grown.

Misting Nozzles

There are two basic types of misting nozzles: **Impingement** and **Impellar**.

Some **Impellar** nozzles are '*cleanable*' in that the design allows for the barrel-shaped impellar to be removed and cleaned of debris. Very high pressure (6,000 kPa and above) have an anti drip-spring, which the nozzle can function without.

- Orifice sizes
 - **Small:** 0.08mm, 0.1mm, or 0.15mm
 - **Medium:** 0.2mm, 0.5mm
 - **Large:** 0.6mm, 1mm

- CoolMist Systems Australia

Normist Spray Nozzles

- 0.7mm | Thread: 10/24" | 100° spray
 - Nickel Brass NM70BH-U1
 - 303 Stainless Steel NM70SSH-U1
- 0.4mm | Thread: 10/24" | 90° spray
 - Nickel Brass NM40BH-HF-U1
 - Steel NM40SS316-U1
- 0.3mm | Thread: 10/24" | 80° spray
 - Nickel Brass NM30BH-U1
 - Steel NM30SSH-U1

Push-in Fittings

- *For 3 Root containers with 6 misting nozzles in each*
 - **18 x (Nickel plated Brass) Nozzle coupling for 3/8" tube with 10/24" female port**
Number: 0301001
 - **5 x Nickel plated Brass Tee for 3/8" tubing**
Number: 0301004
 - **1 x Nickel plated Brass Elbow 90° for 3/8" tubing**
Number: 030100
 - **18 x Misting heads**
 - **40m of 3/8" Nylon tubing (0.375" or 9.525 mm)**
 - *Rough estimate: 40m @ \$7.4547 per Meter = (\$298)*
 - **Reel of Fishing line**

Neoprene Collars & Seed Propagation

- eBay – (Pack of 65) - [EZ-CLONE 2" or 50.8mm Diameter Neoprene Cloning Collar \(Soft\)](#)
- eBay – (Pack of 65) - [EZ-CLONE 2" or 50.8mm Diameter Neoprene Cloning Collar \(Hard\)](#)
- Seedling Pot
 - Toilet ponkers, Egg Carton

Ultrasonic Foggers (Mist Maker)

Produces 1μ to 5μ droplets. Due to the displacement of available oxygen, these are best suited for propagation and early vegetative cycles. For flowering or fruit production, plants perform much better with a droplet sizes closer to 50μ (Microns).

- Amazing Amazon - [Pond Mist Maker](#) + [3 disk](#), [5 disk](#)

Pressure Tank

- Aquastream - [Uniflow Pure Water Pressure Storage Tank](#) (37.8L or 75.7L)
- Malcolm Thompson Pumps – [Grundfos Pressure Storage Tanks \(GT Series\)](#)

In-line Filter

- H2OshopOnline - [AMIAD Semi Auto Scanaway Filter 50mm inlet/outlet \(w/ 130μ screen\)](#)
 - [AMIAD Semi-Automatic Filters .pdf](#)
 - [Blueprints.pdf](#) (Dimensional drawings)
 - H2OshopOnline - [AMIAD Tagline Super 3" Screen Filter 100 Micron Screen Element](#)

Water Chiller

- The Aquarium Shop - [Teco TK150 Aquarium Chiller](#)
- Aquarium Products - [Teco TK150 Aquarium Chiller](#)
- Guppys Aquarium Products - [Hailea HC-130A 1/15hp Chiller Marine Aquarium to 150L](#)

People to ask:

<https://www.morleyaquariums.com.au/>

<https://www.gumtree.com.au/>

Circulation Pump

- Guppys Aquarium Products - [Hailea HX-6510 Wet/Dry](#)
 - 0.11 bar (1.2m head-height) @ 480 L/h – 1 Litre per 7.5 seconds
- Aquatuning Australia - [Watercool WCP D5](#)
 - Aquatuning Australia - [Watercool HEATKILLER® D5-TOP](#)
 - [Bridge Rectifier](#): Converts **AC** (*Alternating Current*) into **DC** (*Direct Current*).
- PLE - [EK D5 PWM G2 Barebones Liquid Cooling Pump](#) – 12V – 1.9 A
 - PLE - [EK XTOP Revo D5 Acetal Pump Top](#) – 1.35 bar (3.9m) @ 1,500 L/h
 - [Bridge Rectifier](#): Converts **AC** (*Alternating Current*) into **DC** (*Direct Current*).
- eBay - [Watercool HEATKILLER® WCP D5-VARIO pump motor with D5-TOP housing](#)
 - 1.4 bar pressure (3.7m head-height) @ 1,500 L/h – 1 Litre per 2.4 seconds
 - About the [Watercool WCP D5-VARIO pump](#)
 - [Bridge Rectifier](#): Converts **AC** (*Alternating Current*) into **DC** (*Direct Current*).

The D5 pumps can be hot-wired to a rectifier by stripping the ends and twisting them together.

It may take a few seconds, but the pump will soon run at 100% speed at the given Voltage.

If it doesn't turn on, you'll need to swap the wires. [Solder them together](#) with some lead-free Tin and wrap them in electrical tape. A Soldering iron and lead-free Tin will cost about \$50 to \$60.

Air Pump

- Guppys Aquarium Products - [Eheim Air Pump 100](#)
 - + [Check-valve](#)
- Aquarium Products - [Fluval Q2 Air Pump](#)
 - [manual.pdf](#)
- The Aquarium Shop - [Fluval Q2 Aquarium Air Pump Single Outlet /w adjustable flow](#)

Water Pump

(Needs to be at least tap pressure @ 6 bar (600 kPa) = 50m or 70m head-height)

- [Converting Pump Head to Pressure and Vice Versa](#) (Scroll down to bottom of page)
- **Note:** The Torrium 2 pump controller needs be installed regardless of pump selection.

Flojet: Duplex II Series

- [D3735-E7011](#) – High-pressure Demand Pump w/ RFI Noise Suppression
230 Volt, 0.5 Amp – Two #18 AWG wires (1.024 mm in Diameter)
EPDM Check Valve and Diaphragm
3/8" (10mm) Female **NPT** (National Pipe Thread)
 - *Note:* Because the inlet and outlet of the pump is in NPT, it will need an adaptor to fit the Torrium2 controller which has a 1" (25mm) BSP thread.
- **Tool Kwip Pumps**
- **Creative Pumps Australia**

Large, High flow pumps, if for some reason you are not able to use a FloJet

Malcolm Thompson Pumps – [Grundfos CM Booster Pump: CMB 3-6](#)

i. Cool Tech Pumps

[Davey Pump Range.pdf](#) (+ Torrium 2 Controller included)

HM60-10T – 690 kPa (6.9 bar) @ 0.94 kW (60 lpm) [\\$1,199](#)

HM90-13T – 680 kPa (6.8 bar) @ 1.4 kW (90 lpm) [\\$1,399](#)

HM160-19T – 600 kPa (6 bar) @ 1.8 kW (160 lpm) [\\$1,570](#)

HM90-11T – 585 kPa (5.8 bar) @ 1.05 kW (90 lpm) [\\$1,339](#)

HM60-08T – 575 kPa (5.7 bar) @ 0.72 kW (60 lpm) [\\$1,040](#)

ii. [Stratco Pump Range](#) (+ Torrium 2 Controller will need to be bought separately)

“Torrium 2” [Automatic Pressure Controller for Water Pump](#) – 1" (25mm) Outlet & Inlet

- Cool Tech Pumps - [Davey Torrium2 TT70/S Pressure Controller with "Plug and Play" Leads](#)
 - Pumps2You - [Davey TT70 Torrium®2 Replacement Controller](#)
 - The Farm Store - [Torrium 2 Controller](#)
-

Electrical Connections

- Power Cord (Extension Leads)
 - Bunnings - [HPM 20m 15A Caravan Extra Heavy Duty Extension Cable](#)
 - Powerboard
 - Bunnings - [Arlec Individually Switched Surge Protected 6 Outlet Powerboard](#) (Black)
 - Bunnings - [Arlec 1.8m White 6 Outlet Surge Protect Powerboard](#)
 - Protective cover
 - Bunnings - [Excalibur 6 Outlet Outdoor Safety Box](#)
 - If another extension cable is needed to reach the grow-site:
 - Bunnings - [Excalibur Red IP55 Outdoor Extension Lead Safety Box](#)
 - Bunnings - [Ampfibian X1 Weatherproof Connector Protector](#)
 - Connecting the Diaphragm Pump to the powerboard

A waterproof wire connector or Junction box is needed (*Glue opening with silicone*).

 - 2 x [IP67 Waterproof 20A Electrical Cable Wire 2 Pin Connector Plug Socket](#)
 - 1 x [AS/NZS 3112 Power cord - 2.5 m](#)
 - Connecting the D5 Pump to the Rectifier
 - 2 x [IP67 Waterproof 20A Electrical Cable Wire 2 Pin Connector Plug Socket](#)
 - Calculating power usage
 - Bunnings - [Arlec Energy Cost Electrical Meter](#)
-

Backup Power Supply

- ***Automatic Transfer Switches***

This ATS will combine two power supplies (*Primary and Back-up*)

 - Latronics - [High Speed Automatic AC Transfer Switch \(ACTS40\)](#)
-

Solenoid Valve + Timer

- General Purpose (*Normally Closed*) Differential Solenoid Valve (Brass)
 - $\frac{3}{8}$ " (10mm) Female x $\frac{3}{8}$ " (10mm) Female @ 24v – (**B35-3-10-8N**)
 - 10mm Tube x 3/8" BSPT Screw Thread St. Union – **SKU: YPC10-03**

- [Digital Timer \(0.1sec-99 hrs On/Off\) 10-28 Volts AC/DC](#)
 - [Tutorial on how to Wire a DIN plug](#)
 - [Manual.pdf](#)
- [Bridge Rectifier](#): Converts **AC** (*Alternating Current*) into **DC** (*Direct Current*).

About Solenoid Valves and their Cable and Plug types

DIN Connector cables plug into an interface to connect devices together.

The **DIN 43650** (*EN 175301-803*) (*a.k.a* **MPM** or **Sugercube** connectors) are the plugs used with Solenoid valves. They are 3-pin electrical plugs with earth-contacts. These are available in three versions, the main difference being the pin spacing.

- **Form A**: Blocky U-shaped pins facing upwards towards the centre. Separated by 18mm spacing.
- **Form B**: These have two different sizes, ranging from 11mm which have 3 flat (Blades) pins and 10mm with 1 flat pin and 2 U-shaped pins on the bottom, their top-ends facing outwards.
- **Form C**: Has flat bladed pins that are either 8mm or 9.4mm apart.

M12 and M8 Cable Connectors

Used for **(I)** Industrial, **(C)** Control, and **(S)** Systems or **ICS** for short. These 8 cable types were first introduced at the Hannover Fair in 1985. They come in 3, 4, 5, 8, and 12 pin variations, with the 4-pin being the most common (Note that the **M8** only has the 3, 4, 8 pin varieties).

The A-code **M12** connectors are **Micro DC** 'Micro Direct Current' (**MDC**) or 'Micro-change' for short, are used for sensors, transmitters, and powering instruments.

An **MDC receptacle** is a 'Field Wireable Bulkhead' (No soldering required for connecting wires) that provides a mating point for **M12** cables.

The **M12** wires may be connected to the **DIN 43650** connectors / sockets.

- Example: [ProductsForAutomation - DIN 43650 to MDC](#)

Reservoir (Esky)

- Bunnings - [Esky Arctic Pro Cooler – 120L](#)

Note: Be sure to brake off the locks

Nutrients

- GrowRoom - [Canna Bio Vega 1L](#)
- GrowRoom - [Canna Bio Flores 1L](#)

Biological Control (*Insects & disease*)

- **Slime and mould within a Nutrient Reservoir**
 - Fishpond.com.au - [API Stress Zyme 240ml](https://www.fishpond.com.au/products/api-stress-zyne-240ml) (\$31.34)
- **Treating Mildew**
 - Spray full-cream milk from a bottle onto the effected areas.
- **Spider-mite** (This occurs when clumps of fruit are growing too close to each other)
- **Fungus**
 - Chamomile-tea and Cinnamon powder are both fungicides.
- **Slugs**
 - DO NOT use Iron Phosphate if growing in soil. It will poison the earthworms as well.
 - Slugs and Snails are attracted to beer and will drown themselves in a bowl of it.
- **Protection against Insects** (Unlike Glyphosate, these should be easy to remove from fruit)
 - The Pyrethrum Daisy

These may smell nice, but they're deadly if ingested. Very common in WA gardens.
Can also be bought from most gardening stores in pre-made solutions.



If your growing them in your garden,
pick the flowers by their stalks.

They need to be long enough to tie together to dry, finely grind, and then store within a freezer bag. Sprinkle the powder or mix a solution of 2 tbsp (35ml) per 3 Litres of water and strain it with tea-bag paper for use in a water-bottle.

Add some soap and its ready to spray. But take care as to not get into your eyes and be sure to wash you hands afterwards.

- Garlic Fire Spray
 - If pyrethrum isn't enough, here's a detailed recipe for an effective insect deterrent:
 - I. 2-3 Garlic bulbs (6 Clovers each)
 - II. 6 large or 12 small hot chilli peppers (Or 2 tbsp / 35ml of chilli powder)
 - III. 1 tbsp (17ml) of Vegetable oil
 - IV. 3 squirts of detergent (*Dish-washing liquid*) – preferably Plant Based Formula
 - V. 7 cups (1.6 Litres) of water
 - **Note:** Blend in the first 700ml and then add the rest.
 - If giving to others or if you yourself or others within your family are pregnant, you should **NOT** use Neem oil. Unless the produce is very thoroughly washed, it should be avoided.
-

pH and ppm Measurement / Adjustment

- pH Meter
 - [HM Digital PH-200](#)
 - [manual.pdf](#)
 - TDS (Total Dissolved Solids) Digital Meter
 - [HM Digital COM-100](#)
 - [manual.pdf](#)
 - Calibration and Storage Solutions
 - Hydroponic Solutions - [HY-GEN](#)
 - HydroponicXpress – [HY-GEN pH Electrode Storage Solution \(250mL\)](#)
 - ibrew - [pH 7.01 Buffer sachet \(20mL\)](#)
 - ibrew - [Hanna pH probe Storage Solution](#)
 - Dosing pump to automatically adjust pH
 - Aquarium Online Supplies - [EHEIM Autoliquid Liquid Doser](#)
-

Insulating Root Containers

- Bunnings – [Aluminium Tape \(15mm wide – 50m long\)](#)
 - Foil Insulation
 - <https://www.bunnings.com.au/our-range/building-hardware/building-construction/insulation/foil>
-

Plumbing Parts + (Tools & Accessories)

Be warned that **BSP** "[British Standard Pipe](#)" (a.k.a. "Whitworth 55°" thread form) can mean either a **BSPT** "[British Standard Pipe Taper](#)" or a **BSPP** "British Standard Pipe Parallel" thread type. The difference is that a BSPT thread (*The spiral-like pattern*) is angled slightly inward, giving it a subtle cone shape. This gives the thread a better seal against high pressures, but it shouldn't be joined with a BSPP or NPT fitting (*Cross-threading*). The reason is that, while it may appear to be tight, only a couple of threads will be engaging.

NPT "[National Pipe Thread](#)" is another thread type that's good for high pressure seals (*Mainly gas*). It also has a cone-like thread, but unlike BSPT which has a **crest** of 55° (*The width and height of each tooth*), the **NPT** thread has a crest of 60°. It requires less sealant than BSPT (*Two turns of plumbers tape*) but any more than that and there is the risk of leakage.

BSPP is the most popular type of thread in Australia and when paired with a 'Bonded Seal Ring' or 'O-ring', no thread sealant is required.

Inside Dia. (ID)	BSP	Decimal	Outside Dia. (OD) BSPT	Outside Dia. (OD) BSPP
6mm	1/8"	0.125"	9.728 mm	8.6 mm
8mm	1/4"	0.250"	13.157 mm	11.9 mm
10mm	3/8"	0.375"	16.662 mm	14.7 mm
15mm	1/2"	0.5"	20.995 mm	18.3 mm
15.8mm	5/8"	0.625"	22.5 mm	20.6 mm
20mm	3/4"	0.750"	26.441 mm	23.9 mm
25mm	1"	1"	33.249 mm	29.7 mm
32mm	1 1/4"	1.25"	41.91 mm	38.6 mm
40mm	1 1/2"	1.5"	47.0 mm	44.5 mm

Tools & Accessories

- 1 x [Hose Cutter](#)
- 1 x [Stanley 250mm Adjustable Wrench](#)
- 1 x [Stanley 380mm Adjustable Wrench](#)
- 1 x [Flat-head Screwdriver](#) (*For tightening the hose-clamps*)
- 5 x [Plumbers-Tape](#)
- [Nylex 18mm x 18m Heavyweight Garden Hose](#)

Draining Root Containers to Nutrient Reservoir
(Connecting the pipe that drains each Drum)

- Garden Hose for Draining Root Containers to Nutrient Reservoir
- **per container** x Tank Fittings ($\frac{3}{4}$ ") 20mm (*a.k.a Skin or Bulkhead Fitting*)
These are placed on the hole that was drilled on the bottom of these Root Containers
 - Bunnings - [Holman 20mm Female Tank Fitting](#)
 - Hills Irrigation - [HANSEN 20mm Female Tank Fitting](#)
- **per container** x Nipple (20mm – $\frac{3}{4}$ ") for attaching the Union fitting
(*The flat-side of the Tank Fitting is on the outside of the Drum, so a Nipple is needed*)
 - Bunnings - [Garden Rain 0.75" Poly Irrigation Nipple](#)
 - Hills Irrigation - [HANSEN 20mm Poly Nipple](#)
- **per container** x [Hills Irrigation - HANSEN 20mm BARREL UNION](#)
This is to disconnect the Root Containers if the Drain hose is buried underground.
- **per container** x 19mm barb with a 20mm Male thread
 - Bunnings - [Pope 19mm Tail x 20mm BSP Male Director - 5 Pack](#)
 - Hills Irrigation – [19mm x 20mm BSP Poly Director](#)

Draining Root Containers to Nutrient Reservoir
(Attaching the Drain Hoses to the Nutrient Reservoir)

Sections of Nylex 18mm hose are cut to length and attached to the barbs on each Drum.

- **1** x 19mm barb Tail to 20mm BSP Male thread (20mm – $\frac{3}{4}$ " in decimal is [0.75"](#)) Director
 - Bunnings - [Pope 19mm Tail x 20mm BSP Male Director](#)
 - Hills Irrigation – [19mm Barb x 20mm BSP Male POLY DIRECTOR](#)

Dividing the number of Drums into groups of 2, plus 1 if there is an odd number of Drums. This tells you how many Tees will be needed. If there is an uneven number of Drums, an extra Tee is connected to both the Drum and with one of the other Tees.

- **(No. of Drums \div 2) + 1** (*If the number of Drums are Odd*) x [19mm Barbed Tee](#)
 - Bunnings – [Pope 19mm Barbed Tee](#)

The hole in the reservoir in which the Drums drain into need to be positioned lower than the bottom of the Drums and their draining hoses. So if the draining hoses are buried underground, then so must the Reservoir. The hole and Tank fitting must also not be below it's max water level.

For this, a 90° Elbow attached before the Union joint will allow for more leeway, since this allows for a length of hose to be moved around the sides of the Reservoir withing the hole. Otherwise the tunnel where the hose enters the hole (Made for the Reservoir) would need to be perfectly aligned with the Tank Fitting.

- 1 x 90° Elbow M/F 20mm ($\frac{3}{4}$ " Male – $\frac{3}{4}$ " Female)
 - Bunnings - [Philmac \$\frac{3}{4}\$ " M x \$\frac{3}{4}\$ " F Threaded BSPT Pipe Elbow \(Tapered\)](#)
 - Hills Irrigation - [HANSEN 20mm M/F ELBOW](#)
- 1 x Hills Irrigation - [HANSEN 20mm BARREL UNION](#)
- 1 x 20mm Nipple ($\frac{3}{4}$ " or 0.75")
 - Bunnings - [Garden Rain 0.75" Poly Irrigation Nipple](#)
 - Hills Irrigation - [HANSEN 20mm POLY NIPPLE](#)
- 1 x Tank Fitting 20mm
 - Bunnings - [Holman 20mm Female Tank Fitting](#)
 - Hills Irrigation - [HANSEN 20mm FEMALE TANK FITTING](#)

Note: As with the Root Drums, the Flat-Side faces inward.

The extra length can be sawed off, but be sure to leave enough for the Union to be attached.

Reservoir Inlet Strainer and Tank Fitting

- 1 x [Stainless Steel Intake Strainer](#) – 20 mm Male thread (1.2 mm Diameter punched holes)
- 1 x [Nut and Tail](#) – 20mm Female BSP thread with clamp screw (Nut) and a 20mm barb tail

Note: A length of hose is placed in-between the Strainer and Tank Fitting so it can be pulled up above the water to check for blockages and to make it easier to clean if necessary.

- 1 x Tail (Director) 19mm Barb to 20mm ($\frac{3}{4}$ ") Male BSP Thread
 - Bunnings - [Pope 19mm Tail x 20mm BSP Male Director](#)
 - Hills Irrigation – [19mm Barb x 20mm BSP Male POLY DIRECTOR](#)
- 1 x Tank Fitting 20mm ($\frac{3}{4}$ ")

Note: An extra long Tank fitting will be needed due to the Thickness of the Reservoir.

- Bunnings – [Garden Rain 20mm Female Tank Access Outlet](#)
- Hills Irrigation – [HANSEN 20mm Female Tank Fitting](#)

Connecting the Nutrient Reservoir to the Water Pump Inlet

The hole from where the pump will draw water from within the Reservoir can either be on the Lid or on the side. If the hole is drilled into the side, then another 90° Elbow will be needed.

- 90° Elbow M/F 20mm ($\frac{3}{4}$ " Male – $\frac{3}{4}$ " Female)

- Bunnings - [Philmac \$\frac{3}{4}\$ " M x \$\frac{3}{4}\$ " F Threaded BSPT Pipe Elbow \(Tapered\)](#)
- Hills Irrigation - [HANSEN 20mm M/F ELBOW](#)

- 1 x Threaded Union Fitting to disconnect the Nutrient Reservoir for cleaning
 - Hills Irrigation - [HANSEN 20mm BARREL UNION](#)
- 1 x Tail (Director) 19mm Barb to 20mm (1") Male BSP Thread
 - Bunnings - [Pope 19mm Tail x 20mm BSP Male Director](#)
 - Hills Irrigation – [19mm Barb x 20mm BSP Male POLY DIRECTOR](#)

- 1 x **Model No. 01740-000**: In-line Suction Strainer (*With 20mm barb*) – [40 Mesh](#) (841µ)

- 1 x 19mm barb Tail with a 20mm BSP **Female** thread (20mm – $\frac{3}{4}$ " in decimal is 0.75")
 - Hills Irrigation – [ANTELCO 19MM X 20MM BSP NUT AND TAIL](#)

- 2 x 20mm ($\frac{3}{4}$ ") to 15mm ($\frac{1}{2}$ ") Reducing Bush
 - Hills Irrigation – [HANSEN 20mm x 15mm POLY BUSH](#)

- 2 x 15mm ($\frac{1}{2}$ ") to 10mm ($\frac{3}{8}$ ") reducing Bush
 - Hills Irrigation – [TEFEN \$\frac{3}{8}\$ " \(10mm\) x \$\frac{1}{2}\$ " \(15mm\) Bush](#)

- 2 x NPT to BSP adaptor $\frac{3}{8}$ " (10mm) Nipple – (*Attached to Pump Inlet & Outlet*)
 - [Stattin Stainless Shop: Stainless Steel NPT/BSP 3000lbs Crossover Hex Nipples](#)

- 2 x Tail (*Director*) 19mm Barb to 20mm ($\frac{3}{4}$ ") Male BSP Thread

Warning: From here on out, the pressure will be about 7 bar (100 psi) or 700 Kpa

 - Bunnings - [Pope 19mm Tail x 20mm BSP Male Director](#)
 - Hills Irrigation – [19mm Barb x 20mm BSP Male POLY DIRECTOR](#)

Connecting the Diaphragm Pump's Outlet to the Torrium2 Pressure Controller

- 2 x Reducing Socket F/F – 25mm (1") to 20mm ($\frac{3}{4}$ ")
 - Bunnings – [Garden Rain 1.0 x 0.75" Poly Irrigation Reduce Socket](#)
 - Hills Irrigation – [HANSEN 25mm x 20mm Reducing Socket](#)

These are attached to the Inlet and Outlet of the **Torrium2** Pump Controller. Because the high pressure, hose clamps will be needed.

Connecting the “Torrium2” Pump Controller to the Tap-Manifold

- 1 x Tail (*Director*) 19mm Barb to 20mm ($\frac{3}{4}$ ") Male BSP Thread
 - Bunnings – [Pope 19mm Tail x 20mm BSP Male Director](#)
 - Hills Irrigation – [19mm Barb x 20mm BSP Male POLY DIRECTOR](#)
- 1 x Tail (*Director*) 19mm Barb to 25mm Male BSP Thread
 - Bunnings – [Pope 19mm Tail x 25mm BSP Male Director](#)
 - Hills Irrigation – [19mm x 25mm BSP Male POLY DIRECTOR](#)

Tap Manifold

- 1 x Manifold with 4 outlets – (1) Pump (2) Pressure Tank (3) In-Line Filter (4) Drain
 - Bunnings – [Holman 25mm 2-Way Manifold](#) (3 Female & 1 Male)
 - Hills Irrigation – [TAVLIT 25mm 2 Swivel Outlet Manifolds](#) (3 Female & 1 Male)
- 3 x Tail (*Director*) 19mm Barb to 25mm Male BSP Thread
 - Bunnings - [Pope 19mm Tail x 25mm BSP Male Director](#)
 - Hills Irrigation – [19mm Barb x 25mm BSP Male POLY DIRECTOR](#)
 - x 1 (*In-Line Filter – Inlet*)
 - x 1 (*Pump – Torrium2*)
 - x 1 (*Drain*)
- 8 x Hose Clamps
 - Bunnings - [Kinetic 11mm x 25mm Steel Hose Clamps](#)
 - [Hardy Spicer](#)
 - x 2 (*Connecting Diaphragm Pump Outlet to the **Torrium2** Inlet*)
 - x 2 (*Connecting the “Torrium2” Pump Controller to the Tap-Manifold*)
 - x 2 (*Connecting the In-Line Filter Inlet to the Tap-Manifold*)
 - x 2 (*Connecting the In-Line Filter flushing valve to the Nutrient Reservoir*)

Attaching the Tap Manifold onto the Pressure Tank

- **1 x Female To Female 1" (25mm) Socket**
 - Bunnings - [Garden Rain 25mm Female To Female Rural Poly Irrigation Coupling](#)
 - Hills Irrigation – [HANSEN 25mm Poly Socket](#)
- **1 x Riser**
 - Bunnings – [Garden Rain 25mm Male Threaded x 300mm long Poly Irrigation Riser](#)
 - Hills Irrigation – [25mm Male Thread x 300mm Long Poly Riser](#)
- **1 x Reducing Bush – 32mm (1-1/4" or 1.25") to 25mm (1")**
 - Bunnings - [Garden Rain 1 1/4 x 1" Poly Irrigation Reducer Bush](#)
 - Hills Irrigation – [HANSEN 32mm x 25mm Reducing Bush](#)

Connecting the In-Line Filter to the Tap-Manifold

- **1 x Socket (F/F) – 50.8mm (2")**
 - Bunnings – [Garden Rain 2" Poly Irrigation Socket](#)
 - Hills Irrigation – [HANSEN 50mm Socket](#)
- **1 x 50.8mm (2") to 25mm (1") reducing bush**
 - Bunnings – [Philmac 2 x 1" BSP Pipe Bush](#)
 - Hills Irrigation – [HANSEN 50mm x 25mm REDUCING BUSH](#)
- **1 x Nipple (25mm – 1") for attaching the Union fitting**
 - Bunnings – [Garden Rain 1" Poly Irrigation Nipple](#)
 - Hills Irrigation – [HANSEN 25mm Poly Nipple](#)
- **1 x Threaded Union Fitting to disconnect the In-line Filter from the Manifold**
 - Hills Irrigation – [HANSEN 25mm BARREL UNION](#)
- **2 x 19mm barb tail to 25mm Male BSP Thread (Connecting to the manifold)**
 - Bunnings – [Pope 19mm Tail x 25mm BSP Male Director](#)
 - Hills Irrigation – [19mm x 25mm BSP Male POLY DIRECTOR](#)

Connecting the In-Line Filter (Exhaust / Flushing valve) to the Nutrient Reservoir

- **1 x 40mm (1½" or 1 – 8/16") Male thread to 1" (25mm) Female reducing bush**
 - Bunnings - [Philmac 1½" to 1" Threaded BSP Pipe Bush](#)
 - Hills Irrigation - [HANSEN 40mm x 25mm Reducing Bush](#)
- **1 x Nipple 25mm (1") for attaching the Union fitting**
 - Bunnings – [Garden Rain 1" Poly Irrigation Nipple](#)
 - Hills Irrigation – [HANSEN 25mm Poly Nipple](#)
- **1 x Threaded Union Fitting to disconnect the Nutrient Reservoir for cleaning (1" or 25mm)**
 - Hills Irrigation - [HANSEN 25mm BARREL UNION](#)
- **1 x 19mm barb tail to 25mm Male BSP Thread**
 - Bunnings – [Pope 19mm Tail x 25mm BSP Male Director](#)
 - Hills Irrigation – [19mm x 25mm BSP Male POLY DIRECTOR](#)
- **1 x Tail (Director) 19mm Barb to 20mm (¾") Male BSP Thread**
 - Bunnings – [Pope 19mm Tail x 20mm BSP Male Director](#)
 - Hills Irrigation – [19mm Barb x 20mm BSP Male POLY DIRECTOR](#)
- **1 x Female To Female ¾" (20mm) Socket**
 - Bunnings – [Garden Rain 20mm Female To Female Rural Poly Irrigation Coupling](#)
 - Hills Irrigation – [HANSEN 20mm Poly Socket](#)
- **1 x Tank Fitting 20mm (¾")**
 - Bunnings – [Garden Rain 20mm Female Tank Access Outlet](#)
 - Hills Irrigation – [HANSEN 20mm Female Tank Fitting](#)

Connecting the Solenoid Valve onto the In-Line Filter

- **1 x Socket (F/F) – 50.8mm (2")**
 - Bunnings - [Garden Rain 2" Poly Irrigation Socket](#)
 - Hills Irrigation – [HANSEN 50mm Socket](#)
- **1 x 50.8mm (2") to 25mm (1") reducing Bush**
 - Bunnings - [Philmac 2 x 1" BSP Pipe Bush](#)
 - Hills Irrigation - [HANSEN 50mm x 25mm REDUCING BUSH](#)
- **1 x 25mm (1") to 15mm (½") reducing Bush**
 - Bunnings - [Garden Rain 1.0 x 0.5" Poly Irrigation Reducer Bush](#)
 - Hills Irrigation – [25mm \(1"\) to ½" \(15mm\) reducing Bush](#)

- 1 x 15mm ($\frac{1}{2}$ ") to 10mm ($\frac{3}{8}$ ") reducing Bush
 - Hills Irrigation – [TEFEN 3/8" \(10mm\) x 1/2" \(15mm\) Bush](#)
 - [Hardy Spicer](#)

Note: Make sure that the Solenoid is facing the correct direction

Connecting the Nylon Tubing to Solenoid Valve

The 40m of Nylon tubing is shown in the “*Misting Nozzles*” section (Page 4) of this list.

PVC pipes for inserting into the Holes of each Drum / Tote

- [PVC pipe](#) (2" or 50.8mm) for putting into the holes.
 - 37m = \$261.96
 - [Caulking Gun](#) to use with Silicone sealant to fix the PVC pipes in place

Connecting Nutrient Reservoir to Water Chiller

- 1 x 3m of Copper Tube – $\frac{1}{2}$ " (15mm) – (Annealed)

Note that, while it says 15mm (*Refers to pipe fitting*), the pipe is actually 12.7mm OD

 - Bunnings - [Kembla 1/2" x 3m Annealed Copper Tube](#)
- 2 x Push-to-Fit (Compression fitting) for $\frac{1}{2}$ " Copper with a $\frac{3}{4}$ " (20mm) Male BSP thread

Cover the Pex fittings with Liquid Silicone to prevent rust and Lead leeching out.

 - Bunnings - [SmarteX P 16mm x 3 / 4" Push Fit Brass Pex Male Connector](#)
 - [Hardy Spicer](#)

Even if a filter was placed between the Reservoir and Water chiller, bio-mass would still build up and erode the internals of the chiller. It's for this reason that clean or distilled water is passed through a copper tube in a closed-loop. This allows the chiller to draw heat from the reservoir while keeping its own clean water separate.

- 2 x Tank Fitting 20mm
 - Bunnings – [Holman 20mm Female Tank Fitting](#)
 - Hills Irrigation – [HANSEN 20mm FEMALE TANK FITTING](#)
- 2 x Barrel Union
 - Hills Irrigation – [HANSEN 20mm BARREL UNION](#)
- 2 x 90° Elbow (20mm Male to 20mm Female)
 - Bunnings – [Garden Rain 0.75" Poly Irrigation M/F Elbow](#)

- Hills Irrigation – [HANSEN 20mm Poly Threaded Male and Female Elbow](#)
- 2 x 19mm barb Tail to 20mm Male BSP Thread
 - Bunnings - [Pope 19mm Tail x 20mm BSP Male Director](#)
 - Hills Irrigation – [19mm Barb x 20mm BSP Male POLY DIRECTOR](#)

Attaching the Circulation Pump in between the Reservoir and water chiller

- **From the Reservoir straight to the Water Chiller**
 - The 18mm ID Nylex hose should fit onto the Water Chiller's $\frac{3}{4}$ " barbed outlet and connect to the other Director on the Reservoir.
- **Attaching the hose from the Reservoir to the Circulation Pump's Outlet**
 - 1 x 19mm barb tail to 15mm Male BSP Thread Director
 - Bunnings – [Pope 19mm Tail x 15mm BSP Male Director](#)
 - Hills Irrigation – [19mm x 15mm BSPM POLY DIRECTOR](#)
 - 1 x Hills Irrigation – [HANSEN 15mm BARREL UNION](#)
 - 1 x Hills Irrigation – [TEFEN \$\frac{1}{4}\$ " \(6mm\) x \$\frac{1}{2}\$ " \(15mm\) Bush](#)
 - 1 x Hills Irrigation – [TEFEN \$\frac{1}{4}\$ " \(6mm\) Nipple](#)
- **Connecting the hose from the Water Chiller to the Circulation Pump Inlet**
 - 1 x Hills Irrigation – [TEFEN \$\frac{1}{4}\$ " \(6mm\) Nipple](#)
 - 1 x Hills Irrigation – [TEFEN \$\frac{1}{4}\$ " \(6mm\) x \$\frac{1}{2}\$ " \(15mm\) Bush](#)
 - 1 x Socket (F/F) – 15mm ($\frac{1}{2}$ ")
 - Bunnings - [Garden Rain 15mm Female To Female Rural Poly Irrigation Coupling](#)
 - Hills Irrigation – [HANSEN 15mm Poly Socket](#)
 - 3 x 19mm barb tail to 15mm ($\frac{1}{2}$ ") Male BSP Thread Director
 - Bunnings – [Pope 19mm Tail x 15mm BSP Male Director](#)
 - Hills Irrigation – [19mm x 15mm BSPM POLY DIRECTOR](#)
 - 1 x Hills Irrigation – [HANSEN 15mm BARREL UNION](#)
 - One of the two hoses from the copper pipes (Reservoir) is connected directly to the water chiller while the other is secured to the pump outlet (*Hole on the side*).

The hose from the Pump Inlet (*Hole in the middle*) is cut after 15cm or 20cm, so a Barrel Union can be placed in between them.

This is to remove the bubbles by submerging it underwater and disconnecting it while the pump is running. For this, an additional two 15mm Directors are needed.

Once all the parts are connected, the two hoses that attach to the chiller are held up above the pump and reservoir while water is poured into either one of the hoses.

When the water-level reaches the top, connect the hoses to the water-chiller.

Submerge the Barrel Union in front of the pump's inlet, into a clean bucket of water. Turn on the circulation pump and disconnect the Barrel Union. The water chiller should fill up with water and any bubbles should be removed. Reconnect once done.

Connecting Air Pump to Nutrient Reservoir

This will help prevent the water from going stagnate

- **1 x Push-to-fit (*Compression fitting*) for ¼" (8mm) pipe to ¼" (8mm) BSP thread**
 - [Hardy Spicer](#)
 - Truwater – John Guest ¼" Tube x ¼" BSP Male Straight Adaptor (**PI010812S**)
 - Aquastream – [1/4" Tube x 1/4" BSPM Straight Adaptor](#)
 - WaterFiltersAustralia – [Adaptor - Straight BSP ¼" to ¼"OD](#)
- **1 x Hills Irrigation – TEFEN ¼" (6mm) x ½" (15mm) Bush**
- **1 x Tank Fitting ½" (15mm)**
 - Bunnings – [Holman 15mm Female Tank Fitting](#)
 - Hills Irrigation – [HANSEN 15mm Female Tank Fitting](#)
- **1 x Socket (F/F) – 15mm (½")**
 - Bunnings – [Garden Rain 15mm Female To Female Rural Poly Irrigation Coupling](#)
 - Hills Irrigation – [HANSEN 15mm Poly Socket](#)
- **1 x Hills Irrigation – TEFEN ¼" (6mm) x ½" (15mm) Bush**
- **1 x Push-to-fit (*Compression fitting*) for ¼" (8mm) pipe to ¼" (8mm) BSP thread**
 - [Hardy Spicer](#)
 - Truwater – [John Guest ¼" Tube x ¼" BSP Male Straight Adaptor](#) (**PI010812S**)
 - Aquastream – [1/4" Tube x 1/4" BSPM Straight Adaptor](#)
 - WaterFiltersAustralia – [Adaptor - Straight BSP ¼" to ¼"OD](#)

Insulating Pipes

- Bunnings - [K-Flex 9 x 19mm x 1m Elastomeric Pipe Insulation - Suits 3/4" Pipe](#)
 - (Tubes from Nutrient Reservoir to Water Chiller)
 - (Tubes Between Root containers to Nutrient Reservoir)
 - (Tube from Nutrient Reservoir to Pump Inlet)
 - (Tube from Pump Outlet to Manifold)
 - (Tube from Manifold to In-line Filter)
 - Bunnings – [K-Flex 13 x 13mm x 1m Elastomeric Pipe Insulation - Suits 1/2" Pipe](#)
 - 1/4" Tube from Air Pump to Nutrient Reservoir

Plant Seeds (*Heirloom*)

- [Heirloom Seeds](#): The seed of a plant that has been carefully cultivated and passed down through many generations. [Heirloom](#): A valuable object that has belonged to a family for several generations.
 - [The Diggers Club](#) (*Heritage Nursery Seed Shop* – Canberra, New South Wales)

Watermelon	MOON AND STARS Red	25 Seeds	\$4.95
Tomato	COSTOLUTO GENOVESE	25 Seeds	\$4.95
Tomato	CHRISTMAS GRAPES	25 Seeds	\$3.95
Tomato	TOMATO TEN COLOUR HEIRLOOM MIX	40 Seeds	\$6.95
Strawberry	BUSH ALPINE	300 Seeds	\$4.25
Berry	TAYBERRY	In pot	\$12.95
Dwarf Tree	DWARF APPLE DUKE OF CLARENCE	In pot	\$29.95
Cucumber	CUCUMBER LEMON	40 Seeds	\$4.95
Cucumber	CUCUMBER CRYSTAL APPLE	30 Seeds	\$4.95
Cucumber	CUCUMBER JAPANESE CLIMBING ORGANIC	30 Seeds	\$4.95
Passionfruit	PASSIONFRUIT PURPLE	30 Seeds	\$4.95

- Other Suppliers of Heirloom Seeds
 - [Green Harvest](#) (Sunshine Coast Hinterland, Queensland, Australia)
 - [Reimer Seeds](#) (Mount Holly – North Carolina, America)
 - [Attitude Seed Bank](#) (Products will need to be shipped with random items, such as Mugs, Wallets, and bags, ect to remain undetected)

World of Seeds AUTO Pakistan Ryder	3 Seeds	\$50.84
World of Seeds Landraces Ketama	3 Seeds	\$38.12

‘Plant Blankets’ to protect them from sunlight and frostbite.

Shade-cloth to lay beneath the plants so they don’t get burned by the hot-tin.

PVC piping for putting into the holes for plants.

Building the Housing for the electrical equipment (+ Soundproofing)