

Shipping Containers for Frog and Tadpole Husbandry

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Introduction

This short manual is intended to be used as a guide for the installation and fit-out of disused shipping containers for the purposes of frog and tadpole husbandry. The use of shipping containers for this purpose has been used for a considerable time at the Amphibian Research Centre in Victoria and more recently at a number of other zoos, including Taronga Zoo, Sydney. The benefits of using shipping containers are that they are totally self contained, easily portable, well insulated and readily allow for full quarantine, which is essential for frog conservation programs.

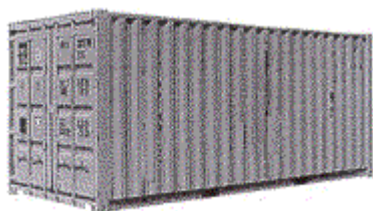
The following plan is based upon the container set-up and filtration systems that we feel would be appropriate for many Australian frogs. The internal fit-out of the container may vary depending on the species of frog being kept and the purpose of the program. Although the set-up detailed in this manual is designed to be modular and adaptable, this manual should be used as a guide only.

The Container

Dimensions and availability

Shipping containers are available in 20 and 40 foot lengths. A 20 foot container is used for the Corroboree Frog facility at Taronga Zoo, whilst Tidbinbilla Nature Reserve and the Amphibian Research Centre utilise both 20 and 40 foot containers.

STANDARD 20'



INSIDE LENGTH	19'4"	5.89 m
INSIDE WIDTH	7'8"	2.33 m
INSIDE HEIGHT	7'10"	2.38 m
DOOR WIDTH	7'8"	2.33 m
DOOR HEIGHT	7'6"	2.28 m
CAPACITY	1,172 ft ³	33.18 m ³
TARE WEIGHT	4,916 lb	2,229 kg
MAX. CARGO	47,999 lb	21,727 kg

Taronga's 20 foot container

External dimensions: Length = 6100 mm, Width = 2450mm, Height = 2430mm.

This is a 'N.O.R.' (Non-Operational Refrigerated) insulated container with stainless steel internal walls with an up-to-date CSC plate (registration for road or rail transport). It has an aluminium ribbed floor. Price about \$3000 - 4000, plus delivery.

Internal dimensions: Length = 5750mm, Width = 2290mm, Height = 2170 mm.
Length of back wall from open door edge = 4705mm.

Transport

A 20' container can either be delivered with a side-crane truck or on a standard truck with the aid of a crane. Ensure road access and sufficient unloading space are available prior to site preparation.

Footings and site preparation

Power, water and drainage should be in place prior to delivery. Footings are required on each corner only for the 20 foot container, levelled to drain to double-door end. Preferably mount the container in full shade, or at least with the viewing window side facing due south. If the container is to be a public display, reflection on the viewing window will be a problem if in direct sun. Some sort of shading will be required.

Level concrete slab; At the rear of the container, a concrete slab will need to be laid as a base for water storage tank, refrigeration condenser and water pump. The minimum dimensions for the slab are 2.4 x 1.1m, but this will vary depending on the base size of the water tank.

Installation of door and viewing windows

Door: An additional standard door is needed in back wall for ease of entry. Ours is made from the cut-out pieces (removed using a grinder with a cutting disk) and is 1940mm high, 860mm wide, 80mm thick and opens outwards. It is set 195mm from back end wall, with a 120mm step-up from floor. The four exposed edges are closed in with aluminium flashing (to keep insulation material inside), and riveted outside & inside. Two 'left handed' hinges on the outside suffice. Door also needs a single eye pad bolt (~ 150mm) and padlock for locking.

Taronga viewing windows: We have two viewing windows; a larger window to allow viewing into the entire container and smaller window viewing into an enclosure set-up for the adult Corroboree Frogs. Care should be taken when planning the placement of windows to ensure that the structural supports within the container are not compromised. The larger window is double glazed and measures 1800 X 900mm (i.e. 1975mm of container wall on each side).

A smaller double glazed viewing window is 850 x 700mm and mounted to the left of the larger viewing window. The lower edge of both windows are 860 mm from the outside base of the container and public walkway, which allows small children to look inside. Like the door above, windows are cut out using a grinder with a cutting disk and exposed container edges closed in with aluminium flashing (to keep insulation material inside), and riveted outside.

This particular container came with a circular **ventilation hole** high in the end wall (opposite end to double doors), and is 250mm diameter. Utilising fine wire mesh to cover this hole will permit ventilation, yet not have a large impact on the insulating properties of the container.



Figure 1 & 2. The positioning of the windows on the Corroboree Frog container at Taronga Zoo as viewed from the outside and inside of the container.

Water Supply

Water from most sources will need to be treated prior to use with amphibians. The quality of the source water will vary greatly depending on whether it is municipal water, bore water, rainwater or water taken directly from a creek line. Due to the variable water sources, the level of filtration needed will also vary between zoos. Institutions wishing to keep amphibians should have their source water analysed for total metals and pH to determine what level of filtration is necessary.

Those institutions in areas with a supply of good quality water may only need to allow the water to age before use or use simple carbon filtration. At the other extreme, those using water from a local stream, which may contain pathogens, including chytrid, will require a more intensive filtration system, such as a reverse-osmosis filter with a reconstitution barrel to replenish essential elements in the water supply.

Taronga Filtration System

The system below is used for all amphibian water used in the Reptile Building. However, the Corroboree frog container has its own Reverse Osmosis water system, which would not be suitable for most species. The recirculating filtration system passes through the following stages: Incoming tap water → Mechanical filtration → Chemical filtration → UV sterilisation → Storage for recirculation or use in amphibian enclosures.

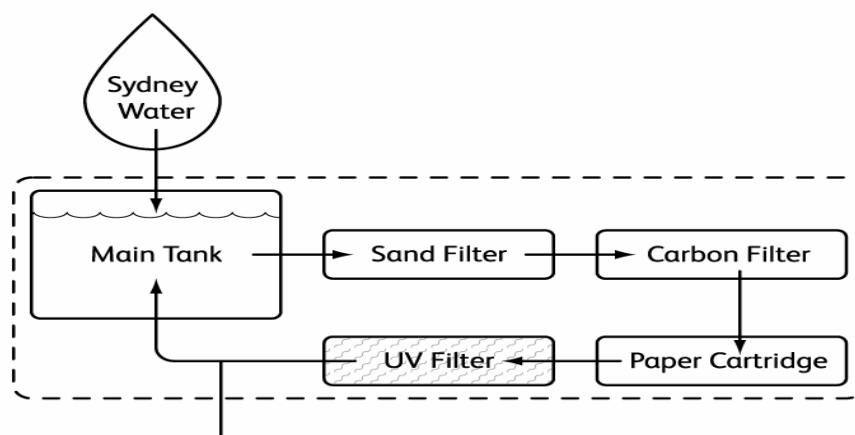


Diagram 1. A flow diagram detailing the movement of water through the filtration system to be used for frogs in the Reptile House at Taronga Zoo.

Sydney water enters the system via an on-demand float valve into a 1200 L water storage tank which is located outside the container. Water is recirculated from this through a 'Rainbow Lifeguard' model M-6 modular mechanical filter, which can take up to 17 033 L/h. The M-6 filter has six ~ 70 cm tower compartments, the first three chambers have pleated paper filter cartridges which filter down to 5 micron size particles, which provides “Mechanical Filtration”. The next three are filled with up to 680g activated aquarium filter carbon (Aquasonic) which provides “Chemical Filtration”. The water is forced through this under pressure of around 150 psi. After leaving the filters all water is passed through a 'Rainbow Lifeguard' UV filter model QL – 80, at up to 11350 L/h. This comprises of two ~ 70 cm towers, each containing a 40 watt UV tube, i.e. 80 watts of sterilization.

Water is then sent back into the storage tank, or removed at this point for piping to frog tanks. We use a Lowarra 4HM7 pressure pump connected to a Lowara Dominator pressure switch, to transfer water to all areas required.

Note that all water passes through the entire filtration system above (including UV) before it goes to any frog tank. When water is being removed for use, new town water automatically enters the on-demand float valve, so a small percentage of this water may have only been filtered once. The total water volume in the storage tank is being recirculated at approximately 11 times per hour, or 264 times per day by a Waterco Supastream 075 pump which can pump up to 260l/min 15,600 l/hr (For particular specifications, see www.waterco.com).



Figures 3 & 4. The incoming water filtration system used at Taronga Zoo as described above.

Temperature Control

Taronga refrigeration system and control unit.

Refrigeration System

A refrigeration system is recommended if the temperature within the containers needs to be lowered significantly below ambient. In situations where this is not required, a powerful air conditioning system may be used. Due to the insulation properties of the shipping containers and the lights used above the frog cages during daylight hours, the temperature within the container can rise at up to 2 degrees Celsius an hour, making it necessary to have a powerful cooling device installed.

In most situations, we would recommend a split refrigeration system. The split system consists of the Condensing unit being mounted outside of the container whilst the Evaporating unit is mounted to the ceiling within the container. The condenser should be mounted to a concrete slab outside of the container. It should also not be in contact with the container as this will permit vibrations. In most situations, a condensing unit powered at 1-1.25 horsepower would be sufficient. The Heatcraft Fridgebox model PP100HM-3 or PP125HM-5 is an example of a recommended condensing unit.

The evaporator should be mounted in the centre of the ceiling within the container. This will permit an even temperature distribution within the container. An example of a recommended low profile standard evaporator is the Realcold Rondo 900 Evaporator Model W4012. This should be installed with fan speed control to minimise wind chill.



Figure 5 & 6. The split system refrigeration system utilised in Corroboree container at Taronga Zoo, displaying the condenser (Figure 5) mounted outside of the container and the evaporator (Figure 6), mounted inside the middle of the ceiling in the container.

Climate control software

Sophisticated climate control technology is available that can accurately control the climate within the container in addition to a number of functions. The Control Unit used on the Corroboree Frog container at Taronga Zoo is an Emerson Climate Technologies E2 RX 100 Refrigeration Controller (from CPC Computer Process Controls, Kennesaw, GA, USA). This software has a number of features including:

- The ability to set variable temperatures during the day using different schedules (i.e. different day and night temperatures).
- Hi and Lo case alarms to be triggered if the temperature falls outside of the desired range.
- The ability to view temperature graphs for the most recent 48hr period on the unit screen.
- Connectivity to a working computer. With installation of the appropriate software, the control unit can be accessed via the user's PC. From the PC, this allows for full control of the unit, ability to graph temperatures over a 6 month period and alarm warning to be viewed should the temperature fall out of the desired range.

To supply and install the CPC Einstein controller is \$2650 + GST. Additionally to supply and install a flashing alarm light to the roof of the container and wire to alarm relay is \$370.

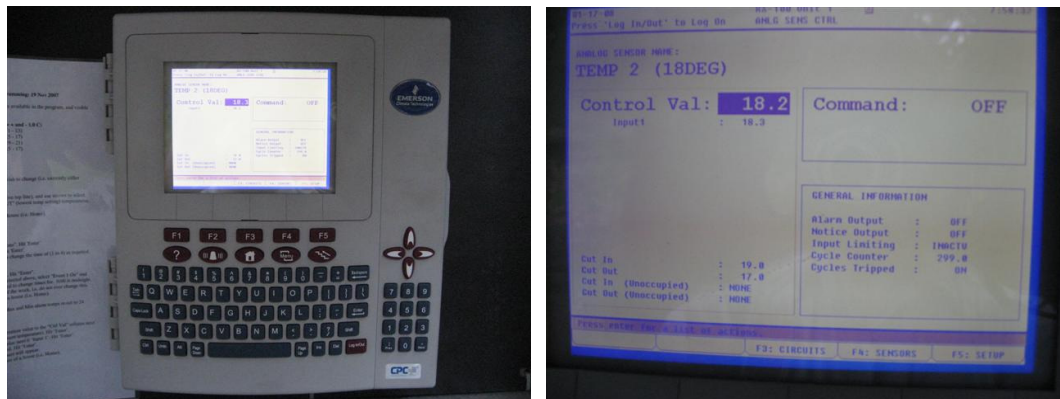


Figure 7 & 8. The Emerson climate control panel, secured outside of the container (Figure 7). A close-up of the panel screen, displaying information on current temperatures in the facility (Figure 8).

Day length variability option and temperature alarm

Lighting

The lighting above cages within the container can be either set by a timer or, preferably, with a photo-electric (PE) cell, also known as a Light Sensitive Switch. A PE cell is able to regulate the lighting within the container to replicate natural photoperiod. As PE cells are programmed to turn lights on upon dark, a relay must be wired in to achieve the alternate affect, with lights on during daylight hours. Within the container, a twin fluorescent light, weatherproof batten fixed to the roof of the container can be hard-wired in to the lighting circuit. All lighting above cage banks should be powered via red general power outlets (GPO), or a colour other than white (see Electrical connections and power requirements below).

Temperature alarm lighting cut-off

As a protection measure, a relay should be installed to allow for an automatic cut-off of power to the enclosure lighting circuit should the temperature alarm be generated. This ensures the turning off of heat generating devices in the container should the refrigeration fail. Fluorescent lighting alone in the container will permit the temperature to rise at least 2 degree Celsius an hour without refrigeration. If unchecked, this can rise to fatal levels in a number of hours

Container Internal Fit Out

Shelving and Shelf lighting

The two options for installing shelving within the container are welded, solid shelves or adjustable cold room shelving. We prefer the latter option due to the flexibility to alter the set up of the enclosures should the purpose of the captive program change over time.

We use adjustable cold room shelving, which can be ordered in stainless steel, Bright Zinc (galvanized) or powder coated, with standard or 50mm x 50mm angle beams (to carry extra weight). One company (BDS Pty Ltd) supplies in the following specifications:

Height	Lengths	Widths
1350mm	600mm	300mm
1800mm	750mm	375mm
2000mm	900mm	450mm
	1050mm	525mm
	1200mm	600mm
	1350mm	
	1500mm	
	1650mm	
	1800mm	
	1950mm	
	2100mm	
	2250mm	
	2400mm	

Lights:

Lighting is required above cages to provide dial cycles and UV lights to the frogs and tadpoles. To suit this purpose in a container, the optimal way to do this through fluorescent lighting.

In most situations, the use of 4' fluorescent tubes is applicable. These can be set up in twin 36W weatherproof battens. The external dimension of the batten are 1290mm in length and 100mm deep (including tubes). These cost approximately \$70 each.

For the back wall of a 20' container, four 4' lights will fit per shelf. Each batten can be attached to the shelf above with “jack-chain”, which will allow the height above each tray/tank to be adjusted. For both tadpoles and frogs, we recommend using one ordinary daylight tube and one 'NEC 'Blacklight' (or alternate UV) tube mounted in each batten. The distance between UV tubes and animals should be minimised if possible. We position the tubes 150mm above the tadpole water when using the tray techniques (See Tadpole Trays below). Remove clear plastic cover if UV lights are being used.



Figure 9 and 10. Twin fluorescent light battens being supported by jack chain above tadpole trays (Figure 9) and frog holding tanks (Figure 10).

Enclosures and Watering Systems

Automatic Watering Systems

Both tadpole trays and frog enclosures installed in the container may require water sprayers to allow for water changes and to flush waste. To minimise keeping time, an automatic watering system can be easily installed. Water plumbed into the container can be connected to a manual or automatic controller. The simplest and most effective way of doing this is through use of a basic two-channel irrigation timers (eg. Pope 'Simple Set Duo Dial' two channel timer), which allow the user to control the frequency and time-length of spraying.

From the timer, Low Density Polyethylene Pipe (LDPE, otherwise known as polypipe) can be used to connect water to the enclosures as required. Other LDPE fittings that may be required include elbows, tee, end plugs, ratchet clamps and shut-off valves. Additionally, installation of “rigid risers” with 360° sprayers directly into the polypipe will permit spraying into the enclosures.



Figure 11 and 12. A basic two-channel irrigation timer which can be used to control tadpole water changes or automatic water systems (Figure 11). Simple polypipe irrigation fittings, including a rigid riser, tee piece, elbow piece, connecting piece, shut off valve and length of polypipe (Figure 12).

Frog Tanks

The type and design of frog tanks can be quite variable depending on the species being held and the purpose of the tank. For example, a holding or maintenance tank may be much simpler than a breeding tank. For flexible, general purpose frog holding, we recommend front opening Exo-Terra 18 x 18 x 18' glass tanks, plumbed with a drainage hole in the base draining to the waste water system. These fit onto the shelving and can be removed when not required. Regular water changes can easily be supplied via an automatic watering system as described above.



Figure 13 and 14. Six Exo-Terra glass tanks on an adjustable cold-room shelving (Figure 13). Drainage below the tanks is very important to remove waste and allow for efficient cleaning (Figure 14).

For smaller species, the use of plastic containers (such as Hagen Pal Pens), may be more suitable. In this situation, we recommend setting up a glass tray on the shelving with drainage plumbed into one end. Drainage holes can be drilled into the lower front side of the container to allow for drainage into the tray. Note that the drainage holes must always remain above the water level in the glass tray to avoid quarantine problems.



Figure 15 and 16. Plastic Pal Pen containers being housed to house Corroboree Frogs on glass trays (Figure 15) and Booroolong Frogs on adjustable cool room shelving (Figure 16).

Tadpole Trays

Tadpoles can be raised in various ways. The two recommended methods of rearing tadpoles are utilising larger tanks or shallow trays. The use of these will depend on the species being housed, with trays typically good for stream species inhabiting shallow water whilst tanks may be better for deeper, pond-dwelling species. Tanks are best constructed from glass with a drainage fitting in one corner. A PVC pipe can be inserted into the drainage fitting, with the length of the pipe determining the depth of the water. Please note, that a suitable strainer should be attached to the top of the pipe to prevent tadpoles being flushed during water changes.

At Taronga Zoo, we now grow our tadpoles in shallow trays for most purposes. Currently we use plastic 23 L opaque crates (external dimensions 610 X 410 X 130mm deep), and plumb them with a waste water overflow at the front so that water in the tray is 30mm (or 40mm) deep. Water from our filtration system enters at the back of each tray via commercial irrigation piping, controlled by a manual (eg. Pope 'Simple Set Duo Dial' two channel timer) or automatic timer.

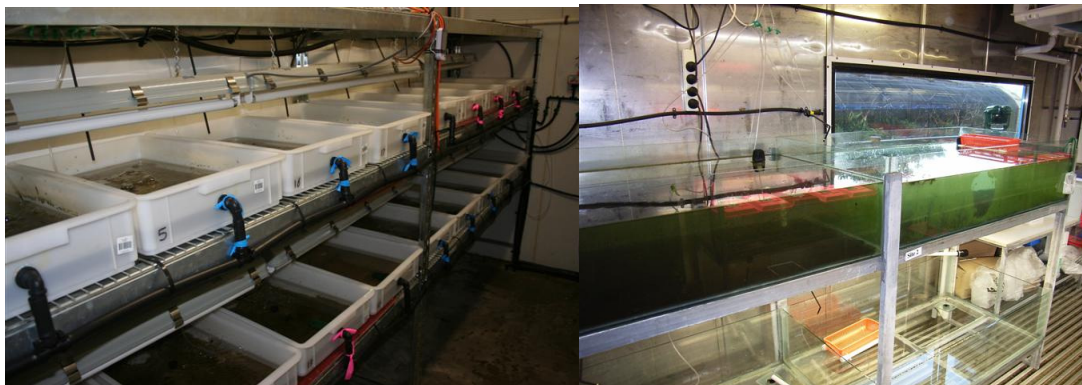


Figure 17 and 18. The use of shallow plastic trays (Figure 17) and deeper glass tanks (Figure 18) to house tadpoles.

Plumbing required for frog tanks and tadpole trays

All plumbing consists of either black plastic irrigation polypipe (Low Density Polyethylene Pipe) and fittings, or PVC piping used for general pressure plumbing. Please note that under no circumstances should metal pipe be used in the container or leading from the filtration system. Metal pipes have the capacity leach metals into the water supply, causing toxicity and potentially death to frogs and tadpoles.

Electrical Connections and Power Requirements

The following power recommendations should be applicable to most shipping container designed for amphibian conservation purposes:

- Power supply to container requires a 6mm sub-mains cable.
- The electrical board within the container is a 63A, 12 pole weatherproof board (IP54 Dust resistant splash proof). A 12 pole board is recommended to allow for the various circuits required.
- Switches- The switches for the following circuits are required :
 - Mains switch – 60A
 - Red GPO's (lights) + PE Cell – 20A
 - White GPO's (pumps and internal UV filters) – 20A
 - Refrigeration – 20A
 - External water filtration – 20A

The major power needs associated with the container are listed below:

- Refrigeration
- Climate control computer
- External water filtration (Pressure pump, re-circ pump, 2 x UV sterilisers)
- Internal water filtration (Water pumps x 9, UV filters x 9)
- 36W lights x 13



Figure 19 and 20. A weatherproof switchboard being utilised in the Corroboree Frog container at Taronga Zoo (Figure 19). The use of red GPO's (Figure 20) on the day circuit as opposed to white GPO's which remain powered at all times.

Powerpoints required

The suggested number of powerpoints are based on a shipping container with the internal set up designed to house frog in Exo-terra type tanks with recirculating filtered water. The number of powerpoints utilised will vary depending on the type of enclosures used in the container. We have suggested the use of two different coloured general power outlets (GPO). The white GPO's are to be in use at all times. These may be used for applications such as filters, UV sterilisers or water aerators. The red GPO's are to be connected to the photo-electric switch so will only be on during daylight hours. Generally, only the lighting should be connected to the red GPO's.

Internal

Front wall – 2 Red double GPO's – one above each bank to control lighting dictated by the photo-electric cell.
 – 3 White double GPO's – One above each bank and one above the working area. These have power supply 24hrs and will supply power to pumps and UV filters.

Rear wall – 2 Red double GPO's – one above each bank to control lighting dictated by the photo-electric cell.
 – 2 White double GPO's – One above each bank. These have power supply 24hrs and will supply power to pumps and UV filters.

External

8 Weatherproof powerpoints are required in a secured box. The use for these powerpoints is listed below. Please note, the refrigeration and computer software may alternatively be hard-wired.

- 1 x Refrigeration
- 1 x Climate control computer
- 1 x Pressure pump
- 1 x Water Re-circ pump
- 2 x UV Sterilisers
- 2 x Spare

APPENDIX

Some Costs and Suppliers of items mentioned in the text

The Container

Royal Wolf
Ph: 139653
info@royalwolf.com.au

Port Container Services
Newcastle, Sydney, Brisbane, Perth, Melbourne, Central Coast
Ph: 1300 793 668

Container Options Pty Ltd
77c Governor Macquarie Drive
Chipping Norton NSW 2170
PO Box 1011
Fairfield NSW 1860
Ph: 02-98922822

Viewing Windows and Door.

Double glazed window filled with argon gas 1800mm x 900mm x 100mm approximately \$1200. Price varies on size, size made to order. This is just one supplier, price may vary from others. Precision Installations (Ph. 0418605831).

Water Supply

Taronga filtration system

Bushman's 1200L water tank
Bushman NSW 02 6361 8750, (www.bushmantanks.com)

Water co pump and Water co Supastream 075 pump (www.waterco.com)

Rainbow lifeguard modular filter M-6 Mechanica life filter \$999.00 plus GST
Rainbow life guard UV filters QL – 80 \$695 plus GST.
Aqua sonic Ph 02 65 86 4933 (www.aquasonic.com.au)

Temperature Control

Taronga refrigeration system and control unit.

E2 RX 100 Refrigeration Controller
Supplied and fitted for \$2650 + GST by Knights Refrigeration.
Emerson Climates Technologies Inc.

Condensing Unit

Heatcraft Fridgebox
Model : PP100HM-3 or PP125HM-5
Supplier: Heatcraft Australia

http://www.heatcraft.com.au/products/capital/capital_equipment.pdf

Evaporating Unit

Realcold Rondo 900 Evaporator Model W4012

<http://www.coolparts.co.nz/pdf/capitalplant/Realcold%20Evaporator%20Units.pdf>

Container Internal Fit Out

Shelving and Shelf lighting

Cold Room shelving: Try BDS Pty Ltd, 5/59 Pine Rd, Yennora NSW, 2161.

ph: 02 -9632 4677, fax: 02 - 9632 5066 (see web site:

<http://www.bdsptyltd.com.au/Shiva.html>). Available sizes below; can be ordered in stainless steel, Bright Zinc (galvanized) or powder coated, with standard or 50mm x 50mm angle beams (to carry extra weight)

Some prices (Nov 07)

1 Bay 2000H x 2250L x 600W with 3 wire shelves.....\$538.82

1 Bay 2000H x 2100L x 600W with 3 wire shelves.....\$510.05

1 Bay 2000H x 1650L x 600W with 3 wire shelves.....\$362.36

1 Bay 2000H x 1500L x 600W with 3 wire shelves.....\$346.61

1 Bay 2000H x 900L X 600W with 3 wire shelves.....\$259.94

Quotes above (Nov 2007) are for shelves with 50 x 50 angle beams to carry extra weight, with Bright Zinc finish. Delivery is extra & 3 weeks from receipt of order.

1 Bay 1800H x 1500L X 375W with 4 wire shelves & standard angle beams & Bright Zinc finish is \$408.00.

Shelf lighting : Twin 36W weatherproof batten (fluorescent tube holders) for above-tank/tray fixtures: eg; Thorn THN WFP 236 (~ \$80.00 each). These need to be wired by an electrician.

Automatic watering systems

All internal and external plumbing and irrigation supplied through Reece. Cost varies depending on location and set up. Use pressure PVC pipe fittings for filters. Can use any brand.

Lowara4HM7 with Dominator pressure switch

Reece Irrigation plumbing centre, Waterloo Sydney 96997777

www.reece.com.au

Frog Tanks

Frog tanks: Exo-Terra 18 x 18 x 18' glass tanks, plumbed with drainage hole (tank \$93.50 + GST, plus \$20 for hole per tank).

Pet Pacific head office 02 47286000

www.petpacific.com.au

(This is one option for a ready made tank, you can use any type this is just one we use).

Tadpole Trays

Plastic tadpole trays: we use Ki-Tab 23 L opaque crates with lids; External dimensions 610 X 410 X 130 mm deep (crates \$14.50, lids \$6.00 + GST)

From: Dexion Liverpool (NSW), 2/33 Heathcote Rd, Moorebank, NSW, 2170. ph: 02 - 9600 8443, Fax: 02 - 9602 5347.

Electrical connections and power requirements

Electrical connections – These are generic electrical connections including conduit, double GPO's, building wires, breakers, surface mount enclosure, contactor, surface switches and sunset switch (photo-electric cell). Quote - \$1600.

From: Quote from Ritera Electrical Gladesville, Unit 22, 43 College St, Gladesville, NSW, 2111. ph: (02) 9879 5444, Fax: (02) 9879 5544