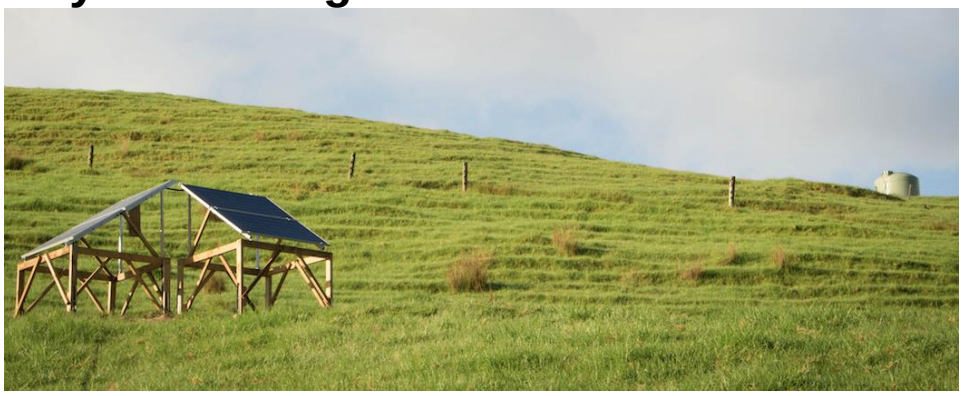
React Pump Mark 2 (RP2)
System Design and Installation Manual



1080W of PV on movable frames (540W per frame)

RP2 pontoon mounted

Please read this manual carefully before beginning the installation.


4 panel (showing RP1) ground mounted adjacent to a farm pond

2 panel (RP1 shown) ground mounted above a shallow farm well

Please read this manual carefully before beginning the installation.

Note that some solar PV images in this document are based on smaller panels. Today (2023) much larger 400W (nominal) panels are more common & cost effective.

For RP2 pumps all solar PV panels with a Voc < 45V at the lowest expected temperature are approved. As the panels are connected in pairs the maximum voltage (at the lowest expected temperature) must not exceed 90V per panel pair.

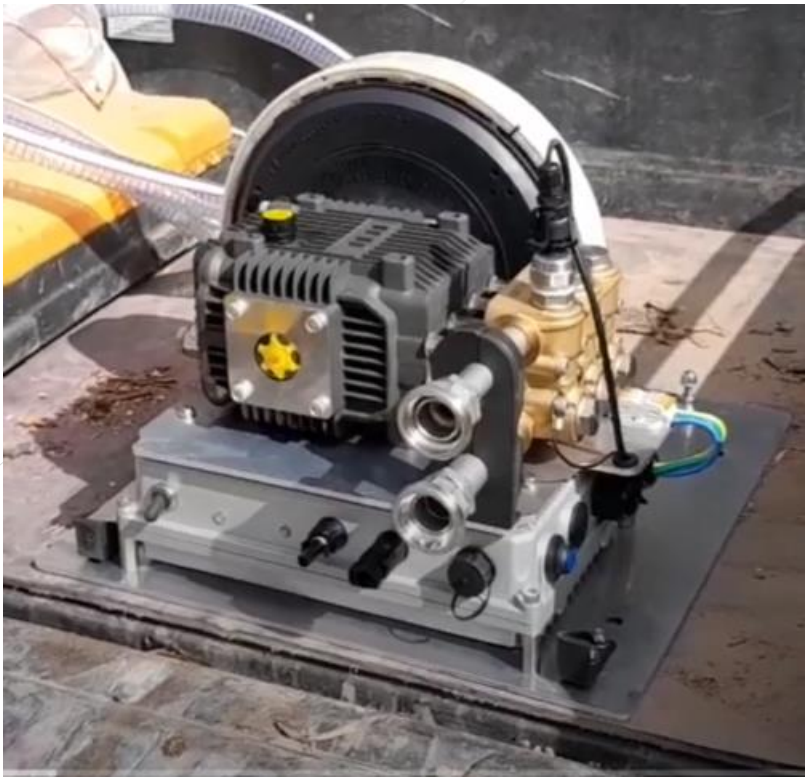
Please note that 4 panels is the maximum that can be connected to an RP2.

Please note that the intended application of this solar pump is for high country farm stock water pumping from Spring to Autumn.

Operation in winter (or when freezing temperatures may occur) is only permitted if protection from freezing is implemented. Damage caused by freezing temperatures is not covered by warranty.

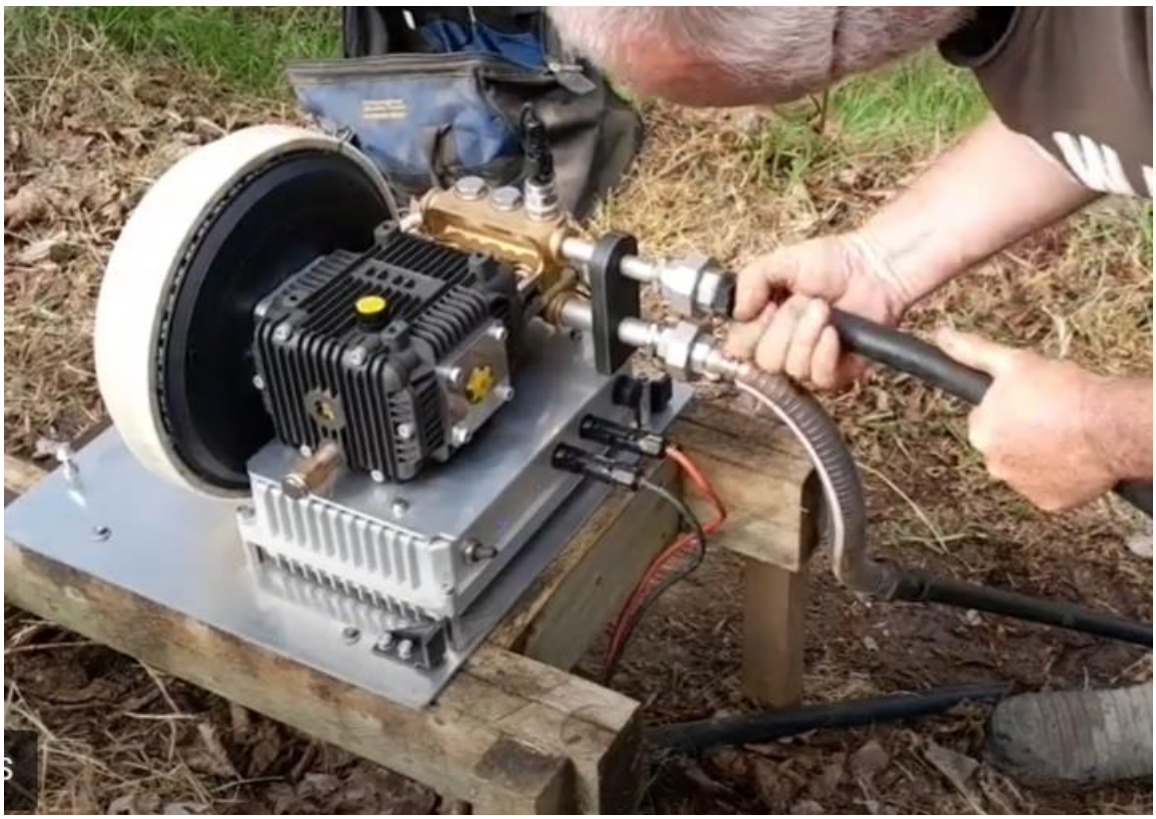
Please note that some images and videos linked in this document show our earlier RP1 product. These older images/videos may not be accurate but are indicative of good practices. Where there is any conflict this manual is the correct procedure to follow.

Screw to remove fairing on RP2



Fairing removed

Typical East/West Truss mounted array remote from the RP2 location



RP2 being installed (with fairing removed). Note this is in Northland NZ where frost is unlikely, the RP2 is supplied via pond water that is just above the pump location - so we have positive head on the inlet side, positive feed head is the best and most reliable option.

Typical small farm dam install video
These videos are a must view

Click on image above to view an RP2 solar pump installation

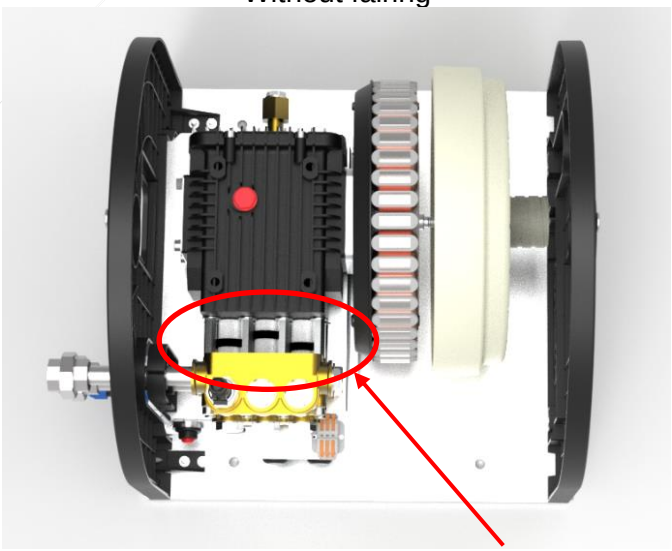
Click on image above to view an RP1 replacement with an RP2

Click on image above to view an older RP1 being removed

Some renders of the new RP2

Complete with fairing

Without fairing



Plan view – part fairing – note the new packed head design on the RP2

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If English is not your language, click here for instructions on how to translate this PDF to your desired language.

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Revisions history
2.0 New release for RP2 Version December by ML (all version 1 documents are for the earlier RP1 design sold prior to January 2023)
2.1 Corrections after review from staff and dealers.

Ensure you are reading the latest version.
The most recent release of all our product's documentation is located in our INDEX.

EcoInnovation (the NZ company who manufactures PowerSpout and React pump products)

Web:

- www.powerspout.com
- www.reactpump.com

If you cannot find the answers to your questions about our products, renewable energy systems, or your site's potential in this document or on our website at www.powerspout.com, please submit a question via email to any of the dealers listed on our websites. Our dealers will answer your query as quickly as possible. If our dealers fail to reply promptly, then please feel free to contact us directly via our web site contact page.

PowerSpout is a product proudly designed and manufactured by:

EcoInnovation Ltd
671 Kent Road
New Plymouth R.D.1
New Zealand 4371

- Web: www.powerspout.com or www.reactpump.com

1. Scope of Application and Safety

This document is **part of the product.** It refers to the PowerSpout React Pump mark 2 (RP2) sold from January 2023.

If you have an earlier version of our RP2 (Production dates from April 2019 to September 2022) then refer to this earlier document.

Failure to fully comply with the installation advice in this document may void your warranty. Please take the time to fully read it.

1.1. Introduction

The RP2 is based on 3.5 years of experience in selling the earlier RP1 design in the New Zealand market. The RP2 is a significantly improved product and exports sales of the RP2 will begin in the 1st quarter 2023.

These are the main improvements to the RP2:

- Stronger base - 4mm grade 5 aluminium.
- Fully enclosed BLDC and Nano PCB in aluminium enclosure that is also the pump base.
- Stronger injection molded fairing that is larger, easier to remove and fire resistant.
- Side water connections (easy to access) with quick connect stainless fittings.
- Packed head - the pump can keep running if you get a small water side seal leak without the risk of water ingress to the oil side.
- Spare parts kit for 2 services – up to 3 years operation assuming clean water and correct installation.
- Improved foot valve design (not needed if you have positive pressure on the pump input).
- Active sensor & software protection to detect and prevent:
  - overheating - run dry & ambient
  - freezing **(detect only cannot prevent)**
  - electronics overload
  - motor stalling
  - Comprehensive LED communication of fault errors

The product is designed to pump clean fresh water with the use of solar power (or other approved power sources) in the following conditions:

- To lift water on hill country farms for stock water needs. If you plan to use (or store) this pump in conditions below freezing, then extra protection in needed to protect the RP2 from damage due to freezing temperatures.
- Do not install unprotected in situations where the pipeline may freeze. Protection from freezing temperatures is outlined later in this document. Frost will damage the pressure sensor first, which is designed to fail safe and prevent operation of the pump.
- Water that will not corrode aluminium parts. Seawater is not permitted.
- Dirty pond water is acceptable **within reason, if sufficiently filtered, and the buyer understands that typical seal life will be reduced**. River water that includes pumice or other sharp abrasive material must be adequately filtered.
- Terrain that can be walked over safely for pipe laying etc. (i.e., no large vertical drops). The client confirms that the site is unlikely to: slip, have rock falls, flood, earthquake etc. Where such conditions exist, the client has taken appropriate measures (i.e., insurance cover). Product warranty does not cover such events.
- The client has read this install manual and other relevant information that we provide before starting on the installation of this pump.

- We advise engaging an experienced/qualified installer who has good mechanical, electrical, plumbing, reading and comprehension skills if you do not possess these skills yourself.
- The RP2 must be sited above any flooding level (but as low as possible) unless pontoon mounted. RP2 submersion will result in serious equipment damage which is typically 35-50% of the new cost to have repaired.
- Avoid long and high suction heads, otherwise you may experience ongoing problems that we do not support or cover under our warranty terms.
- The RP2, solar PV array and power cable must be adequately protected from large animal damage.
- Ensure the RP2 **is shaded** if exposed to high summer temperatures with a suitable roof. This roof must also be designed to protect the exposed cable connectors and LED's lights from wind driven rain and excessive UV exposure. Failure to provide a suitable cover will reduce the life of the RP2.

The client must determine:

- Vertical lift from the RP2 to the header/storage tank.
- Size of header tank to meet the required water needs.
- Length of pipe to the header tank.
- Inside diameter of pipe to the header tank to allow for the extra friction pumping head to be determined.
- Suction lift (vertical distance) from the lowest level of the water resource surface to the RP2 centre line (if a gravity feed intake or floating RP2 on a pontoon is not being employed).
- The suction pipe length. This must be less than **3m long** and the suction lift must be less than **1.5m**. Suction lift applications **must not be undertaken** if a gravity feed or pontoon application is viable at the site.
- Maximum daily water requirement in summer, or the driest season.
- Correct PV array size (for panels 400W nominal):
    - 800W for heads <50m (1 string of two panels).
    - 1600W for heads > 50m and <160m (2 strings of two panels).
    - 1600W for heads > 160m and <300m (2 strings of two panels and RP2 HP upgrade).

1.1.1. Items that are provided with all pump sales (via our NZ dealers - Independent Power NZ and Perkinz):

- RP2 with pressure limit control, float switch and protective fairing.
- Quick connect inlet and outlet fittings (**final pipe outlet fitting to your delivery pipe size is not provided – buy this locally).**
- Non-return valve for delivery pipe to storage tank. Pipe fittings for this valve are not supplied. Client must provide and install a bypass valve for air to clear on initial start-up.
- Foot valve, pipe clamp, stainless wire cage (to go inside filter bag) & 2 filter bags
- Staubli brand MC4 bulkhead fittings on the RP2 pump body:
    - **AS/NZS5033 standard requires that all mating MC4 connectors are the same make/brand. Independent Power NZ and Perkinz provide all the Staubli MC4 fitting that you will need with their PV panels.**

All other parts needed will be supplied by our NZ dealer who you are purchasing from.

1.1.2. Items that are provided with all pump sales for export (and in NZ if not purchased via Independent Power NZ or Perkinz):

- As above but with Slocable bulkhead fittings.
- 7-pairs on Slocable brand MC4 connectors (sufficient to convert each string of panels from the panel brand MC4 to the Slocable brand – to ensure all mating MC4's are the same make).
- 1 x pair of PV Branch Connectors 2 to 1 (for up to 4 panels – 2 strings).

- 1 x 32 amp DC switch with MC4 Slocable connectors.
- 2 x Slocable brand MC4 plastic spanner

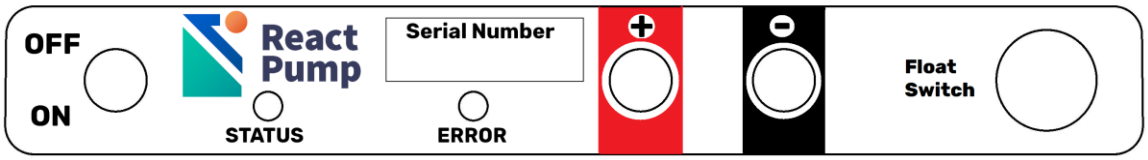
Optional extras include:

- High Head Upgrade - High Power PMA for heads >16 Bar (160m).
- We can also supply as needed:
    - Additional MC4 connectors
    - Spare foot valve
    - KWhr meter
    - Flow meter
    - Seal service kit and valve set
    - Plunger ceramic liner set
    - Wet side seal kit
    - Oil side seal kit
    - Complete RP2 seal/valve service kit
    - System design service
    - Pressure gauge

Note: Some items above may be provided by a local dealer/supplier/installer in your country, or you can source them yourself. Many will be available on our website at the time of purchase for an additional charge.

1.2. RP2 serial numbers

All RP2s have identification plates and serial numbers.



For example:
For example, serial number “RP2001” as per image below. This means you have RP2 number 1 manufactured. Write the serial number in your records, as from this number we can locate when it was made, when it was sold, to whom, software version etc.

If you ever need to query an installation or order spares for a product, take a picture of the serial number plate and forward it with your query.

1.3. RP2 LED flash key

This table shows all LED status and error codes. There is a simplified key located on the inside lid of your RP2.

STATUS LED

	Pump is running
	Pump is waiting for sufficient power to pump
	The button has been pressed
	Pressure sensor has detected the tank is full
	Float switch has detected that the intake is low
	Pressure sensor is active
	Critical Error - Check Error LED
	Temperature out of bounds - Check Error LED
	Oil change due

ERROR LED

	Pressure sensor has failed
	Internal temperature sensor has failed
	Pump head temperature sensor has failed
	Pump has stalled
	Pump has experienced a sub 2°C temperature
	Pump has experienced a sub 0°C temperature
	Pump has an intake air leak
	Pump head has overheated
	Pump controller has overheated

Setting System Pressure

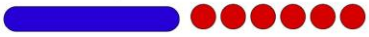
While the pump is running, and the delivery pipe to the tank is full, hold down the button until the Status LED changes from solid blue to flashing red and then finally to flashing blue (about 10 seconds). Then release the button.

Factory Reset System Pressure

Same procedure above but when the pump ignition switch is in the **off** position.

Clearing an Error

- Ensure you have noted the error in your logbook or phone so you have a record.
- Hold down the button until the Status LED changes from solid blue to flashing red (about 3 seconds). Then release the button.



LED Flash Key

1.4. Safety

The following safety warning signs are used throughout this manual.

Caution
Risk of electric shock. On this Solar ELV (extra low voltage) pump system electric shock is very unlikely if these instructions are followed. All voltages are ELV if the solar panels are correctly connected. Incorrect connection of >3 solar PV panels is LV (over 120VDC) and can result in electrocution (and/or damage to the RP2 speed controller).

Caution
Cautions identify conditions or practices that could result in damage to equipment, fire, or personal injury, other than by electric shock.

EcoInnovation will not be liable if you connect this equipment incorrectly and in doing so harm yourself, harm others, cause a grass/bush fire or damage other equipment in your system.

This section addresses safety concerns as required by international standards and accepted best practices.

If you are not technically competent, experienced and qualified you should not install this equipment until after you have read this manual and watched all relevant videos provided. Our support tab provides links to the most recent version of all these documents/videos.

Equipment can be installed or operated in such a manner that hazardous conditions can occur; compliance with this manual does not by itself assure a 100% safe installation. If the equipment is properly selected and correctly installed and operated according to this manual, then any such hazards will be minimized.

1.4.1. Rotational Machinery Safety

The RP2 is a rotating machine and is provided with a protective enclosure. There are rotational hazards present if the protective enclosure is removed. The RP2 must be turned off at the DC switch prior to removing the protective enclosure. It is also possible to turn off the RP2 (if the PV array is distant) using the RP2 on/off switch which is on the front of the base enclosure shown below.

Note: an RP2 can start rotating without warning if the solar DC switch is on and the RP2 on/off switch is on.

Once the RP2 has been commissioned, the protective enclosure needs to be secured in place with the screw provided.

The installer should ensure that the RP2 is mounted such that inquisitive children are not exposed to a rotational machine hazard.

Note: Direction of rotation is best anti-clockwise when looking at the electric motor end, this direction provides slightly better lubrication on the plunger guide surfaces when run anti-clockwise. For a fuller explanation view this video.

1.4.2. Pressurised Water Safety

In some countries, legislation covering pressurised pipes applies for pipe pressures over 10 bar (100m head). The PowerSpout RP2 often operates at more than 10 bar. It is capable of pumping to 30+ bar (300m head). Check with your local authority if you have any legal requirement that may concern this installation in your country.

In general, there is little risk at less than 10 bar pressure. The biggest risk is insecurely fastened pipe joiners that blow off, with the free end of the pipe hitting people. Securing the pipe at regular intervals, particularly near the joins, and checking all joiners are tight and that the pipe's pressure rating exceeds the pumping pressure will eliminate such risks.

1.4.3. Fire Safety

Solar pumping is often done in very dry parts of the world. In tinder-dry conditions the risk of fire can be extreme. These manual instructions comply with cited standards AUS/NZS 5033:2012 and AS/NZS 4509.1:2009, as such if installed as per this document the installation meets the requirements in NZ for ELV systems. Not all countries have the same rules and in many countries the rules are not clearly defined. Check with your local electrician and fire department if you are unsure of the rules in your country. Also call your insurance company to check that your cover meets your needs in this regard.

Warning: if you do not comply with standards/codes and laws in your own country then your fire insurance may not be valid. If your **inadequate** installation of this RP2 were to cause a fire you could be **personally liable** for any damaged caused.

- The electronics in the RP2 are contained in a metal enclosure to reduce the fire risk.
- The smart drive motor (stator and rotor) is made from fire resistant UL listed plastic and are the same parts used in Whirlpool washing machines.
- The pump outer body fairing is a metal skin. The plastic injection molded ends of the fairing are made from a fire-resistant glass filled plastic material. The RP2 does contain a very small amount of combustible plastic material.

Where the risk of a grass or forest fire is real in your area, the following measures shall be taken:

- Mount the RP2 centrally on a concrete base at least 1m square.
- Ensure the RP2 is shaded if exposed to high summer temperatures. The BLDC motor and pump do need cooling airflow. Provide shade but do not enclose it.
- In pontoon applications (see pontoon section) no additional fire protection is needed) thought shade from excessive summer heat may still be required.

Note: a shade cover is always needed to protect the RP2 from excessive solar heat gain, driven rain and excessive UV exposure.

Assessing the fire risk is the owner/installers responsibility:
The precautions required are the same as for petrol/diesel water pumps, which have a high fire potential due to their liquid fuel and high exhaust temperatures. The risk is small, but the consequences can be very high, so please take the time to ensure that your installation is fire safe.

1.4.4. Electrical Safety: ELV Wiring rules specific to NZ and Australia

Two definitions exist in NZ for ELV ("extra low voltage"):

1. Any voltage **normally not** exceeding 50 volts AC or 120 volts ripple-free DC.
2. Any voltage **not** exceeding 50 volts AC or 120 volts ripple-free DC.

AS/NZS5033 also defines “ripple free DC” as:

> 1.4.62 **Ripple-free DC**
> For sinusoidal ripple voltage, a ripple content not exceeding 10% r.m.s.
> NOTE: The maximum peak value does not exceed 140 V for a nominal 120 V ripple-free DC system.

All extra low voltage wiring should be performed by a 'competent' person, defined by NZS4509.1 as:

> "a person who has acquired through training, qualifications, experience or a combination of these, knowledge and skill enabling that person to correctly perform the task required".

Note – even with a reduced shock hazard there is danger of fire from incorrectly installed ELV wiring systems. Note the word “should” is advised (best practice) and not a legal requirement in NZ. ELV work in NZ is classified as “non prescribed electrical work”. You cannot break the law as the law does not apply to this work, nevertheless you can be liable for the consequences of improper installation practice. Do a quality job and seek paid assistance if/as required.

This document and supporting videos **(note we are still in the process of updating older RP1 videos)** are sufficient training and knowledge to enable a capable owner/installer to perform the tasks required. If you feel you are not capable and do not have the time to fully read and view our installation material (to become capable and competent) then engage the services of an experienced Electrician or Renewable Energy Installer/Technician.

Wiring is simple once you are familiar with solar MC4 type connectors. A dodgy MC4 connector that has not been correctly crimped or is not fully pushed into the correct position within the connector is a common installation error.

You will need to attach the MC4 connectors (from the Solar PV DC switch box to the RP2) as the wire length/size will vary from site to site. All that is required is for the installer to plug together the MC4 waterproof connectors (in the correct way) and secure the wiring as per our supporting information.

1.4.5. Installation Checklist

The installation shall be carried out by installers, owners or contracted persons with relevant experience and good practical skills relating to general water reticulation systems and ELV electrical systems.

The most important aspect of any RP2 installation is the avoidance of **any unnecessary suction head**. Loss of suction head overnight (due to a suction side pipe/fitting leak or worn/dirty foot valve) will prevent the RP2 from priming at sunrise the next day. With no cooling water flowing the brass head will quickly warm up, this will be sensed, and the pump will stop and flash an error light well before seal damage can occur. After a time, the RP2 will attempt to restart, but if the condition persists the pump will permanently stop and flash a warning error LED that attention is needed. The user will then have to fix the issue and go through the error clearing procedure for the RP2 to restart.

The best way to avoid a loss of suction problem, is to install the RP2 with positive head on the inlet side of the pump – then this potential problem cannot occur, and you will have a long and reliable experience with the RP2.

Install options:

1. Positive suction head - If your water source is a small falling stream, then a positive suction head is possible **- you must install the RP2 in this manner if it is viable to do so.**

2. Very low suction head - If your water source is a small pond/dam (that has no falling ground after the dam – otherwise see 1 above), then a very low suction head is possible using a pontoon **- you must install the RP2 in this manner if it is viable to do so and option 1 is not viable.**

3. Low suction head <1.5m - If your water is not either of the above, then a low suction head is possible provided the suction hose is not more than 3m long and that suction lift is not more than 1.5m and that our install instructions are diligently followed for this install situation.

4. Suction heads >1.5m - If your water source is not any of the above and requires a suction head >1.5m then **we do not advise that you purchase a RP2**. It may still be possible for you to operate a RP2 on < 3m of suction head but you will need to be very diligent for this to be reliable in the long term. Any small leak on the suction side (often hard to detect) will result in loss of prime and resulting error LED and RP2 shut down events. **If you install an RP2 on >1.5m head, you do so at your own risk, without our approval or product warranty or support.**

To meet good working practices and safety requirements for this installation, the installer must:

GENERAL

- Check for any transit damage to the product prior to installing it. If damaged it must not be installed.
- Connect equipment to a high standard to relevant good practices and standards.
- Read and comply with this installation manual and watch the supporting videos.

PIPES

- Ensure the tank delivery pipes are of the correct size. Undersized pipes will reduce RP2 performance and can result in pressure blowouts and failure of the RP2 to operate. There is a section later in this document to assist with pipe sizing.

- Do not confuse pipe ID with pipe OD when purchasing pipe.
- Use standard LDPE, MDPE or HDPE pipes. The pipes must withstand the maximum total pressure to which they are subjected. A safety margin is already included in the pipe rating, this safety margin allows the pressure stop switch to operate without rupturing the pipe. If you skimp on the pipe cost by installing 12 bar pipes when you have 160m of head, the lower section of the pipe will likely rupture on a hot day once the tanks is full.
- **In hot dry climates where the pipe lays on the ground the pressure rating must be reduced to allow for the maximum temperature. Burying the pipe protects the pipe from physical damage, heat (pressure derating) and cold (damage due to freezing).** If necessary, bury the pipe to protect it against heat, stock damage, rock falls, tree falls, slips, avalanches, freezing etc.

PLUMBING WORK

- Tighten all water connections with appropriate sealing tapes or compounds to ensure connections do not leak. **If you have a site with suction head, you must turn off the RP2 at the end of the day it is first commissioned and then return the next morning to check that the suction line is still full of water - before leaving the RP2 to run automatically.**
- Provide a suitable disconnection point fitted with a non-return valve, close to the RP2 so that it can be easily removed for servicing.
- Provide a suitable bypass valve (vent to atmosphere) after the RP2 and before the non-return valve above - so that air can be vented from the system to purge any trapped air.
- The RP2 includes a digital pressure sensor that monitors the pressure and will turn off the pump when a set pressure is reached. The pump will stop if is detects a pressure above 300m, this can be easily adjusted downwards or reset (a reset returns the default to 300m).

INSTALLING YOUR RP2

- Make sure that you install the RP2 such that it will not be exposed to freezing temperatures which may damage it. Ensure **the RP2 is removed to a dry/warm store for the winter.** Carefully read the relevant sections of this manual before you decide how best to install your RP2.

COMMISSIONING

- Check that wiring has been done correctly. Poor MC4 connections, wrong polarity, voltage too high (all 4 panel in series), voltage too low (all 4 panel in parallel) are common errors.
- Securely fix the pump base prior to operation and keep it a low as possible, it will work better if you do this.
- Ensure:
  - Rodents cannot get access inside the pump.
  - Grass and other vegetation are prevented from growing into the pump via the cooling vents. Cover the ground with corrugated steel or concrete to prevent plant growth if required. **Plant growth can be a significant fire hazard.**
- **Do not run the pump without first adding oil.** Each pump has been tested at our factory, this testing oil is drained out prior to freighting.
  Fill the pump body with clean SAE15W/40 **to the top of the oil level indicator glass**. **Oil level should never be less than the middle of the level glass**. **A little higher than the top of the level glass is also OK.**
- Do not intentionally run the pump without the water supply connected for more than 30s. Water is needed to cool and lubricate the ceramic plungers.
- When running from new it is advised that you first pour water into the head to wet the seals and valves. You can do this by attaching the suction hose supplied, lifting it up, filling it with water and then rotating the motor over by hand.

- Do not run the pump at a supply head above 160 or 300m (depending on the option purchased).
- To turn on the pump:
  - Ensure the solar panel DC switch is on.
  - Turn on the On/Off switch.
  - If pump fails to rotate check:
    - There is sunlight is on the solar PV.
    - If a float switch is connected that it has not dropped to a level which is preventing the pump from starting.
    - MC4 connector barrels have been pushed fully inside the MC4 connector until they click.

- In a pump runaway situation (where the high-pressure output pipe bursts) turn off the DC switch to stop the RP2.
- If you start the pump against a closed valve this may stall the pump. (You may also burst your pipe or fitting.) It may also go into sleep mode as the RP2 thinks your water tank is full. Turn off the pump at the On/Off switch
- . Open the valve, turn the switch back on and it will run fine.
- Check for excessive noise. There should be little/modest noise from the pump. Get familiar with what your RP2 normally sounds like. At lower speeds away from full sun you may hear a different sound, this is the Nano computer constantly adjusting the pump speed so that the solar power equals the pumping power. When you have plenty of sun the pump will run at maximum speed and any sound variation will cease.
- Check water is being pumped at the expected rate for full sun condition at midday.
- Ensure that all protective fairing/enclosures are locked in position after commissioning.
- Complete sensible signage requirements to help with pump maintenance and as required for AS/NZ 5033 compliance as per section 7.5.3.
- Complete all documentation and take pictures of your installation and the serial number identification plate. Pictures of the installation will be asked for if you ever need to make a warranty claim.
- Make relevant notes in the manuals that will be of assistance to yourself and any future service personnel.
- If installing the RP2 for a client, then all of the above must be completed before client handover.
- Train the client/user of the pump in routine care and maintenance of the RP2 and of the solar PV system.

SERVICING

- Keep all the RP2 packaging and the red oil transport cap. If you ever need to return the pump under warranty or for factory service you will need to: drain out oil, fit the red oil transport cap and repackage for freight in a similar manner to which it was received.
- Hold in stock a complete spare parts kit, spare pressure sensor, spare suction hose, spare foot valve, spare foot valve filter sock, spare SAE 15W40 oil.
- Check oil level and ensure level is always close to the top of the sight glass. If oil level is allowed to fall below the bottom of the sight glass serious damage may result.

1.5. CE and FCC Declaration

The RP2 contains electrical or electronic components.
The RP2 will be tested for radiated emissions as soon as practically possible.
The fact that the BLDC driver and Smart Drive BLDC motor are mass-produced & globally available means that it is likely that they already comply. We will provide an EMC lab test report in due course. Once tested the certificate can be located in our INDEX.

1.6. Standards and certification

The RP2 have been evaluated against the relevant sections of major international standards in regard to rotational machine safety and the restriction on the use of hazardous materials in the manufacture of the RP2.
The RP2 has a metal casing and meets product safety, impact durability and freight drop test requirements.

1.7. Consents and environmental impact

1.7.1. Solar PV Frame building consent

In New Zealand no building permit for the PV array structure is required as it is not a dwelling. PV arrays have recently being given specific exemption (in NZ) read more here. Please check the relevant laws in your country.

1.7.2. Electrical wiring COC (code of compliance)

A RP2 is inherently electrically safe in New Zealand (when correctly installed) as it runs at ELV (typically 50-90 VDC range) and hence does not need a COC and is very unlikely to be an electric shock hazard. Please check the relevant laws in your country.

1.7.3. Water abstraction resource consent

In New Zealand taking water for stock and domestic home needs no consent in almost all cases. Please check the relevant laws in your country.

1.7.4. Water usage with minimum impact on the environment

The RP2 may potentially affect:

- Plants and fish in the water.
- Plants and animals beside the water.
- Stream banks and surrounding land.

Local authorities in NZ do not need to provide consent to pump water for stock and domestic home needs, it is a permitted activity unless your resource is the habitat for an endangered species.

If, however, you intend to build a buffer storage pond in the water way consent may be needed. Always check first to see if you need to obtain consent to build any structures or intakes in the waterway.

If you do not have a ball cock fitted in your header tank and you wish to us the RP2 without the pressure stop feature enabled, then you should take care to ensure that the overflow water from your header tank can return without causing erosion. We advise a ballcock is fitted to reduce RP2 run time hours and related wear and tear.

1.7.5. RP2's Noise Levels

You are unlikely to be able to hear the RP2 at 50m away. Noise is not a normally an issue in a remote rural setting. For what little noise there is, vegetation and/or a pump shed around the RP2 will dramatically reduce the distance that any noise carries. Note a small pump shed is recommended to protect the RP2 from driving rain, damp, excessive heat and moisture ingress. A suitable pump shed can also prevent; stock nuisance, freezing temperatures, high temperatures and provide fire protection. **If building a shed or protective cover do so for: noise, stock, rain, freezing, UV, heating and fire protection.**

By way of comparison, most fuel engine pumps, and water rams are very noisy.

2. Product Overview

Congratulations on your choice of a React Pump – mark 2 (RP2). This ingenious little pump can give you years of trouble-free water pumping, avoiding the need for more expensive solutions. Not only does the RP2 give you renewable energy, but it is also made from 25% recycled materials, making it the most eco-friendly solar pump available on the global market.

Efficiency is the measure of the pump's ability to convert solar energy into moving water against gravity. The RP2 commonly averages 40-50% efficiency with 64% peak (when input power exceeds 700W and lifts approach 300m), which is superior to other products on the market, meaning that it will move more water using a given solar array size. For a document that compares the RP2 to other solar pumps and other methods of water pumping click here.

All RP2s are shipped fully assembled. You can locate a trouble shooting guide here and service videos here. Note the RP2 has a packed head, so servicing the plunger oil seals requires the head extension stand-offs to be removed. Otherwise the process is very similar.

Videos and other documents to introduce PowerSpout RP2 are available at the support tab here:

- RP2 installation videos
- RP2 comparison document
- Service video valve replacement
- Service video seal replacement

Please note that video clips are indicative only and do become out-dated quickly and may not be up to date. Where instructions differ, the latest written manual (available online) will always be the correct method to follow. If you are reading this document then please check you have the latest version.

2.1. Product design life

A Triplex ceramic pump is like a small car engine regarding life expectancy. It is a rotating crank shaft in oil with pistons. A small car engine has filtered oil and is good for about 300,000 km. If the car averages 30 km/hr – that is 10,000 running hours in the life of the car. If the pump does 1000-3000 hours a year – that is a design life of 3.3-10 years on the pump body. The water seals in the pump will need to be replaced every year (more often if dirty water is being pumped – these are quick and easy to replace – spares are provided). The four oils seals should be replaced if there is any sign of an oil leak. Oil seal life is typically 1-2 years. Oil level must be checked on a regular basis, as low oil can result is serious pump bearing damage. We advise that to attain the maximum pump life that oil should be replaced after 50 hours from new and then every 500 hours of run time. If you fail to do regular oil changes, then pump life will be reduced. Some clients may decide to only change the oil every year at the annual seal service - if you do this pump body life may be reduced.

The RP2 can be fully repaired and made as good as new, all major parts are available from our online store. In time it may be more economic (after 3-5 years of operation) to buy a new RP2 than to repair an old one.

2.2. Product up close

The following pages contain images and information about the product. Please note that the solar panels can be mounted in different ways, **array images are illustrative only**. If outside NZ please feel free to copy what we have done for our NZ clients.

2.2.1. Image cutaway of RP2

Note on the RP2 design the brass head is packed off the pump body

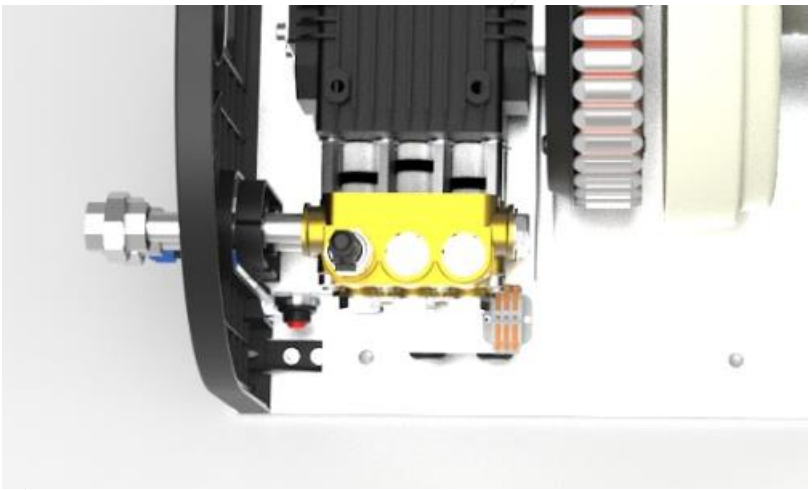
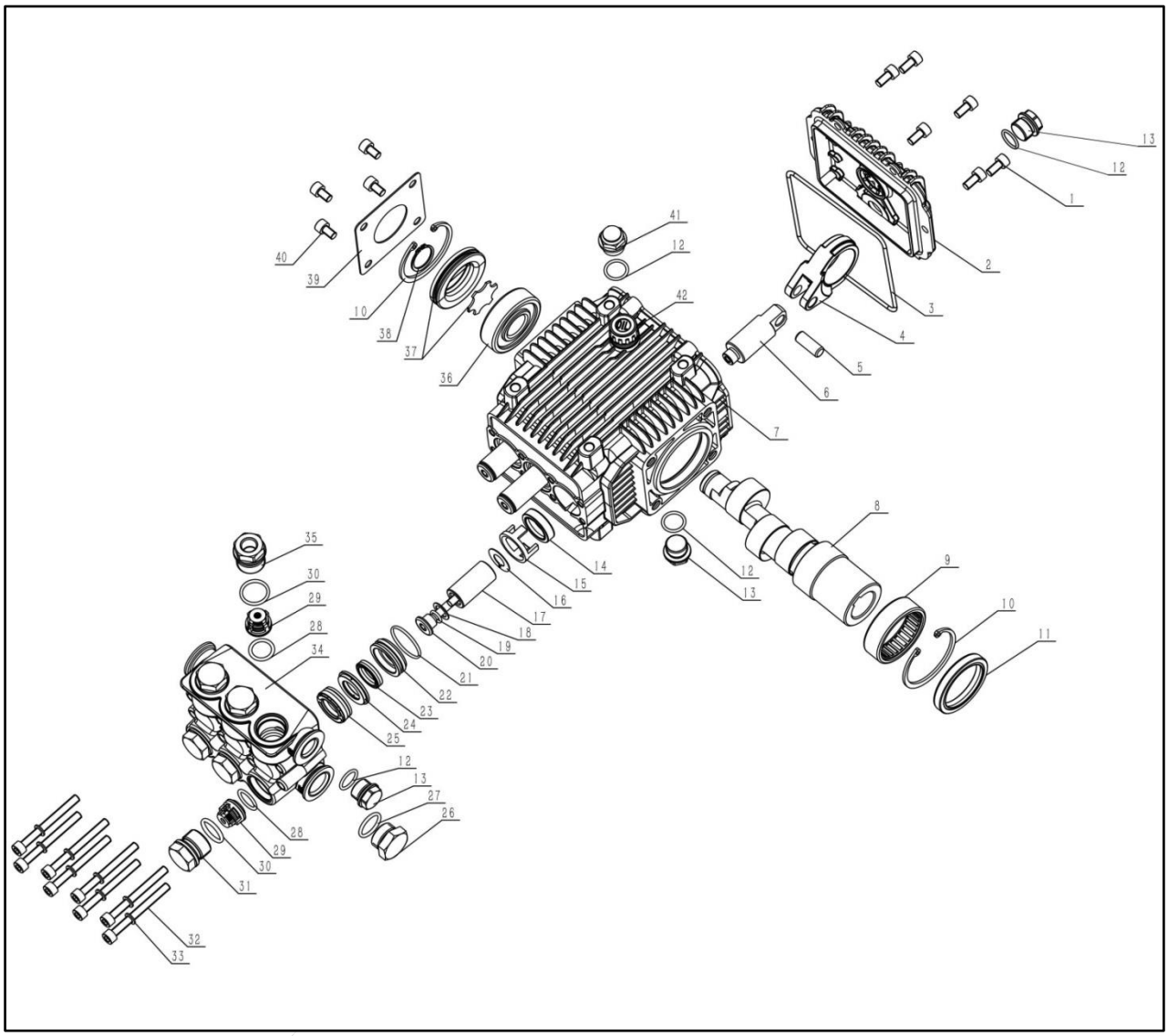


Image of packed head

2.2.2. RP2 exploded view and parts list (14mm stroke with 20mm diameter ceramic plungers)



2.2.3. Pump parts list – items is red are not shown in the manufactures pump drawing above and have been added by EcoInnovation to pack out the pump head

Part Number	Quantity		Description	Consumable part
1	4		M6 hex bolt for rear cover (5mm A/F hex)	
2	1		Rear cover with oil level glass	
3	1		Rear cover seal	
4	3		Big end bearing	
5	3		Gudgeon pin	
6	3		Plunger base	
7	1		Pump body	
8	1		Crank shaft	
9	1		Crank shaft front bearing	
10	2		Crank shaft front & rear retaining circlip	
11	1		Crank shaft front seal	Yes
12	1		Oil drain/filler O-ring seal **(only 1 fitted on RHS above)**	
13	1		3/8 BSP oil plug **(only 1 fitted on RHS above)**	

14	3		Oil seal for plunger base (6)	Yes
14B (not shown)	1		Copper spacer on top of seal	
15	3		Plastic spacer	
16	3		Ceramic piston seating washer	
17	6		Ceramic plunger liner (note on the RP2 packed head design 6 are provided, 3 are needed as extensions. The 3 packer plungers can be swapped over when the operating plungers become worn – so the plunger extensions are the spare set.	Yes
18	3		Ceramic plunger seating washer	Yes
19	3		Ceramic plunger sealing O-ring	Yes
20	3		Ceramic plunger liner bolt	
21	3		Brass ring O-ring	
22	3		Brass ring	
23	3		1st plunger seal	Yes
24	3		Plastic seat	Yes
25	3		2nd plunger seal	Yes
26	3		½ BSP suction plug	
27	3		½ BSP suction plug O-ring seal	
28	6		One-way valve seat	Yes
29	6		One-way valve	Yes
30	6		One-way valve plug O-ring seal	Yes
31	5		One-way valve plug	
32	8		M6 hex bolt for plunger head (5mm A/F hex)	
33	0		Washer – not required on this pump options	
34	1		Brass plunger head	
35	1		One-way valve plug (see 31) for ¼ BSP for pressure switch	
36	1		Crank shaft rear bearing	
37	1		Oil level glass	
38	1		Crank rear retaining circlip	
38	1		Read bearing cover plate	
40	4		M6 hex bolt for rear cover (5mm A/F hex)	
41	1		Transit plug	Yes
42	1		Oil vent cap	
43 (not shown)	1		Pressure transducer (not shown). **1 year life covered by warranty if not exposed to freezing**	Yes i
44 (shown below)	11		M6 grub screw to locate hex extenders for the packed head upgrade. 8 used to extend head, 3 used to extend pistons	
45A (shown below)	8		Hex extenders for the upgraded packed head design of the RP2	
45B (not shown below)	3		Similar to item 45A but machined to fit inside the ceramic pistons to allow them to be extended. Do not confuse these parts with 45A above	
46 (shown below)	8		M6 stainless wide washer to retain item 15	
47 (shown below)	3		Slingers on the ceramic piston extension to stop any small water leak ingress to the oil side seals	
48 (shown below)	3		Copper packing ring, place under item 15 to prevent seal (item 14) working loose	

Note: consumable parts **<u>are not</u>** covered by warranty, as the life of these parts depends on:

- Cleanliness of water pumped.
- Oil changes performed, oil level maintained, and quality/grade of oil used.
- Run time hours.
- Installation measures employed to mitigate freezing temperatures, water ingress etc.

Normally all consumable parts should last more than one year provided:

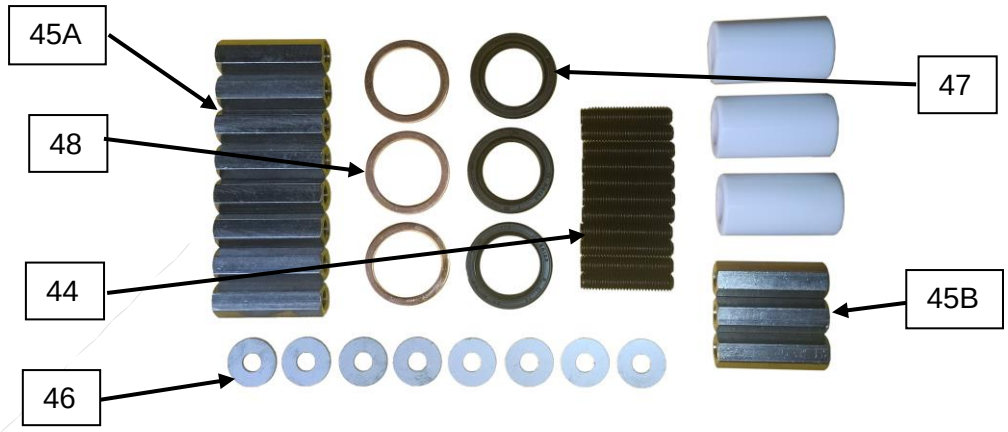
- The RP2 is installed correctly as per this guide.
- The water resource is clean.
- The pressure stop sensor has been employed to avoid excessive run time hours.
- Protection from freezing temperatures has been implemented.

Where consumable parts fail sooner than 1-year on clean water sites (while the RP2 is still under warranty), then replacement parts can be purchased from our web site on a pro-rata basis. For example, if the consumable parts lasted 9 months - then we would offer you a 25% discount. We may request that the failed consumable part be returned (or a high-quality image of it is emailed to us) once it has been removed & replaced.

This pump was originally designed to pump clean water up to 100 bar (1000m of water head) using a 4000W AC motor for commercial car forecourt cleaning machines. We use it for lifts up to 300m, running at slower speed with input powers up to 1200W. It is very conservatively rated. **Installation measures must be employed to mitigate freezing temperatures.**

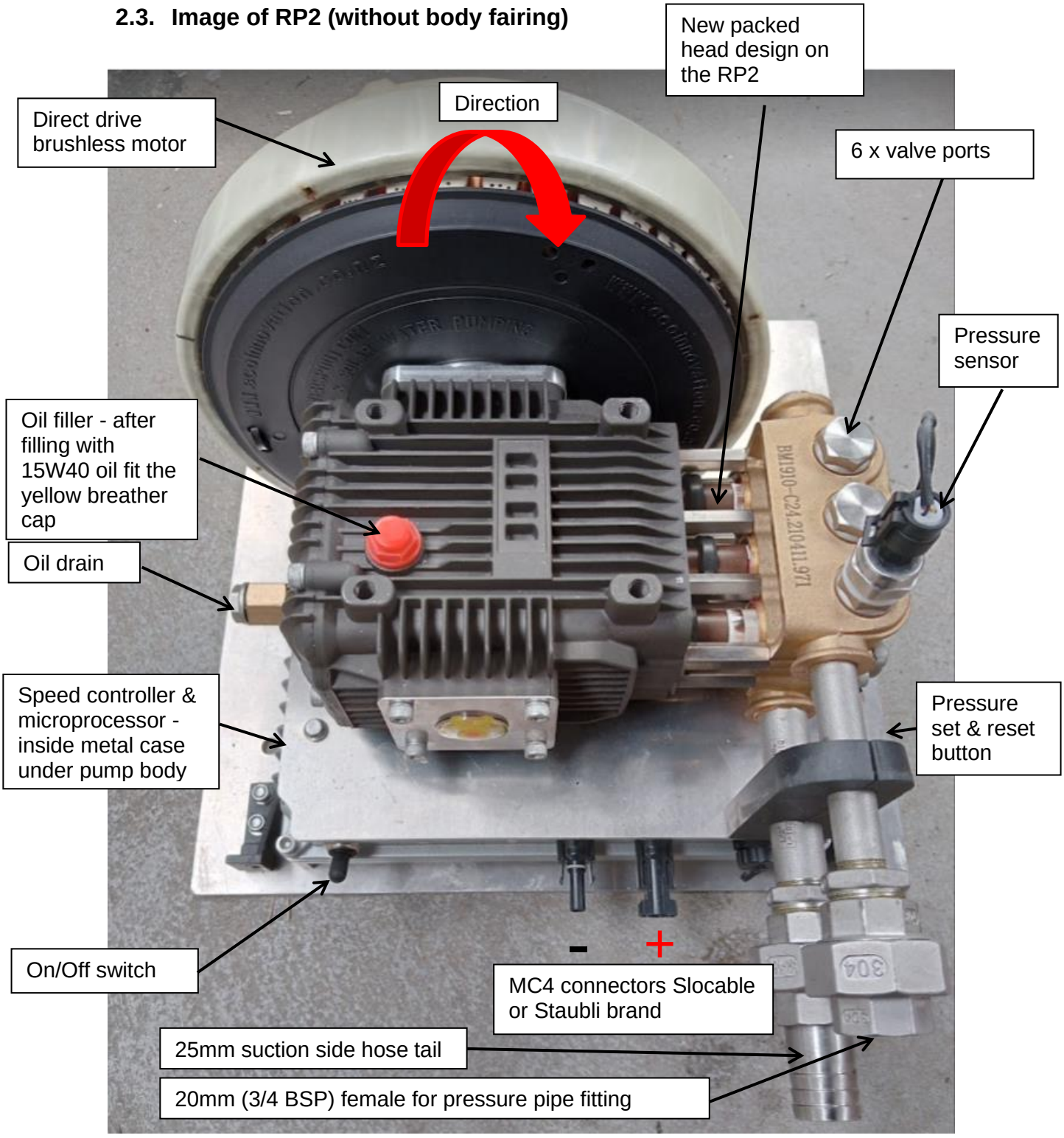
2.2.4. RP1 conversions to a packed head design

If you have an earlier RP1 (or SHP-TX) and you wish to upgrade to the packed head design, then you can with this kit - that you will find in our web store **in due course**. If you do upgrade to a packed head, note that the RP1 body fairing will no longer fit.



We hope to make a video of how to pack the head soon, this will help those clients upgrade who have an earlier RP1 product variant.

2.3. Image of RP2 (without body fairing)



Key parts of the RP2

LED indicators – Status and errors

STATUS LED

Pump is running	
Pump is waiting for sufficient power to pump	
The button has been pressed	
Pressure sensor has detected the tank is full	
Float switch has detected that the intake is low	
Pressure sensor is active	
Critical Error - Check Error LED	
Temperature out of bounds - Check Error LED	
Oil change due	

ERROR LED

Pressure sensor has failed	
Internal temperature sensor has failed	
Pump head temperature sensor has failed	
Pump has stalled	
Pump has experienced a sub 2°C temperature	
Pump has experienced a sub 0°C temperature	
Pump has an intake air leak	
Pump head has overheated	
Pump controller has overheated	

Setting System Pressure

While the pump is running, and the delivery pipe to the tank is full, hold down the button until the Status LED changes from solid blue to flashing red and then finally to flashing blue (about 10 seconds). Then release the button.

Factory Reset System Pressure

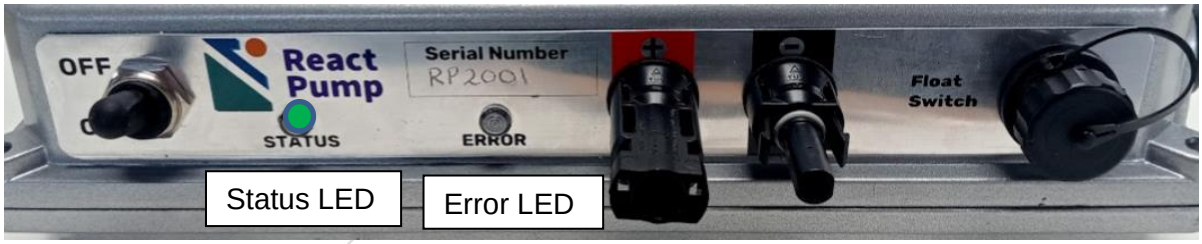
Same procedure above but when the pump ignition switch is in the **off** position.

Clearing an Error

- Ensure you have noted the error in your logbook or phone so you have a record.
- Hold down the button until the Status LED changes from solid blue to flashing red (about 3 seconds). Then release the button.

LED Flash Key

Solid | Slow Flashing 1/second | Fast Flashing 5/second | Periodic Once/5 seconds



The button is Red and located on the right-hand side of the pump as shown in the image below. **It can only be accessed with the fairing removed.**

RP2 performance
See the back of this manual for a summary of specifications.

These tables are given as a guide only for typical NZ conditions. The test site where this data was measured was in Taranaki NZ using smaller solar panels (270W) than are common/available today, **as such the tables below are conservative,** and you will in practice pump more water per month than is indicated below.

2.3.1. Summer flow volumes (litres per day)

Table of flow in L/day

When	PV array size	Pumping head 50m	100m	150m	200m	250m	300m
Best summers day	1080 W due North	9584	8685	7810	7028	6299	5575
Cloudy summers day	1080 W due North	4792	3884	3076	2530	2079	1728
Best summers day	1080 W split East/West	11980	10856	9763	8784	7874	6968
Cloudy summers day	1080 W split East/West	4792	3884	3076	2530	2079	1728
Best summers day	540 W due North	6825	5645	4508	N/A	N/A	N/A
Cloudy summers day	540 W due North	3889	2935	2081	N/A	N/A	N/A

Data collected in early Jan 2019

2.3.2. Estimated flow per day over the calendar year

1080W solar PV installed (540W East and 540W West)

Month	Head (m) <50m	100	150	200	250	300
December	8439	7378	6390	5610	4918	4287
January	8985	7855	6804	5973	5236	4564
February	8879	7763	6724	5903	5174	4510
March	8054	7041	6099	5354	4694	4091
April	6093	5327	4614	4051	3551	3095
May	4816	4211	3647	3202	2807	2446
June	3955	3458	2995	2629	2305	2009
July	4835	4227	3662	3215	2818	2456
August	5838	5104	4421	3881	3402	2966
September	6745	5897	5108	4484	3931	3427
October	7602	6646	5756	5054	4430	3862
November	8287	7246	6276	5510	4830	4210

For example: here on our test site, on a typical summer's day, we can expect about 6800 l/day to a 150m dynamic head. (120m vertical lift + 30m pipe friction head).

Note that for larger PV panels up to 400W each, the above flows will be exceeded.

This table may under predict for your NZ location; it is indicative only. As more data comes in from our test sites these numbers may be further refined. If you live in a blue-sky desert (like many parts of Australia) then performance will be higher. If your chosen pipe diameter results in a very high friction head, then you will get a little less.

The pump will work fine on heads as low as 30m (below 30m seek our advice), where it will run most of the time at full speed and peak flow rate. **For heads below 50m where less flow is needed, consider fitting only 2 solar panels PV facing midday sun**. With this array size you will still pump about 2/3 of the flow indicated above. On your best summers day, it is possible to pump up to 12,000 litres on a 1080W PV array on heads below 50m. Below 50m less power is required so the pump spends more time running at full speed, limited by the electronic BLDC speed controller to about 1200 rpm.

It is our view that most of our NZ customers will wish to pump in the 50-160m static head range and so our advice is to install a 1600W PV array (4 x 400W panels) with half facing East and half facing West.

2.3.3. Maximum flow rate possible at each head

Head	Peak L/min
50	15.79
100	15.24
150	14.56
200	13.81
250	13.10
300	12.40

This maximum (peak) flow of the pump (see right) can be a little misleading and should not be used to calculate daily water quantities. What is more useful is the average flow per day over the calendar year as listed in the previous table.

The peak flow figure is needed (as you will see later) when determining the size of pipe from the RP2 to your header tank.

2.3.4. Peak pump efficiency

RP2 efficiency increases steadily with head. Efficiency is best when:

- RPM is lower.
- Pump is highly loaded.
- Incoming solar radiation is not at its peak. (Peak PV power is more than can be used whereas morning, afternoon and cloudy periods provide usable power.)

Head	Peak L/min	Peak Efficiency %	Efficiency % at peak flow
50	15.79	32	26
100	15.24	47	40
150	14.56	56	50
200	13.81	61	57
250	13.10	65	61
300	12.40	67	64

2.3.5. Maximum input power of RP2 at various heads

Head (m)	Max Power (Watts) RP1 can use
50	510
100	620
150	720
200	805
250	880
300	945

As shown opposite, installing more PV will not result in significantly higher peak pumping rates on very sunny days, but **more solar PV is needed on higher head sites to ensure reliable starting and to limit stalling events of the RP2.**

A larger East/West PV array will increase the hours of operation in less ideal weather, extend the operating day length and the amount of pumped water.

2.3.6. Pumping Height of the RP2

The RP2 has a maximum ***dynamic*** pumping head of 300m (1000 feet) for the High Power model. 160m (16bar) is the upper limit of common HDPE farm pipes so our standard model is rated to a maximum ***dynamic*** pumping head of 160m.

2.3.7. Seasonal Variation

The RP2 delivered flow will change throughout the year with sunlight intensity but this tends to be a good match to demand. In general, farm animals drink much more water from troughs on sunny days than wet overcast days. A solar PV powered pump is a very good choice to meet stock water needs.

The RP2 is intended for cattle and sheep farms, water demand peaks with sunlight intensity. Farmers who intend to use the RP2 for the water supply for dairy cows milking in winter need to check winter radiation levels carefully in selecting the optimum number of RP2's required and implement protection from freezing temperatures.

Such farms should install up to 1600W of solar PV per RP2 to lift winter pumping yield. You may need to consider using a backup pump or a backup power source for your RP2 at marginal solar times.

2.3.8. Recommended PV array size

Dynamic Head	Nominal PV array size	RP2
<50m	2 panels up to 800W	Standard version
>50m < 160m	4 panels up to 1600W	Standard version
>160m < 300m	4 panels up to 1600W	RP2 HP Higher torque/power version (surcharge applies)

1.1. Step by step design overview

This section briefly outlines the main choices you will need to make in the design of your system.

You will need to do the following:

- Consider whether a single RP2 is likely to meet your L/day needs before you commit to purchase. (If you are unsure of your needs, you can always install one and see how you go before deciding to buy a second unit.)
- Install a suitably sized header tank - if you do not have one already.
- Install a correctly sized pipe from your RP2 to your header tank (typically 20 or 25mm NB (nominal bore) PE pipe.
- Install the PV array in a sunny location, typically within 100m of the RP2.
- Install the correct sized wiring between the RP2 and the PV array.
- Commission the system.

All the above should take 2-3 days work for a competent person.

2.3.9. RP2 site data requirements

We only make one size of pump. It will pump in the range of 10-300m head and the only **site information we need from you prior to purchase is if your dynamic head is above or below 160m**. For a successful system design, you do need to survey the site to establish the pipe size, pressure rating and pipe length and to get an initial estimate of the pumped volume per day that you can expect to reach the storage tank.

2.3.10. Measuring head

You will need to measure the vertical rise in feet or metres (referred to as head or lift). You can use an Altimeter, GPS, Smart Phone app or Google Earth - not very accurate but it will give you a rough indication of the head and pipe length. You then allow for the extra head due to pipe friction to get the total dynamic head, refer to section 7.5.3.

2.3.11. Measuring flow in your water resource

Try and find a place in the stream where it drops quickly over a rock, place your bucket below and measure the time to fill it.

If the flow rate is not enough to keep up with your RP2 pump (see table opposite) then you may want to consider a storage pond that fills with water overnight. In order to be useful this must hold at least 5 cubic metres of water (5000 litres) per RP2. If half a metre deep on average, this would be a pond with an area of 10-square metres.

Head	Peak L/min
50	15.79
100	15.24
150	14.56
200	13.81
250	13.10
300	12.40

2.3.12. Choosing the correct number of RP2's for your site

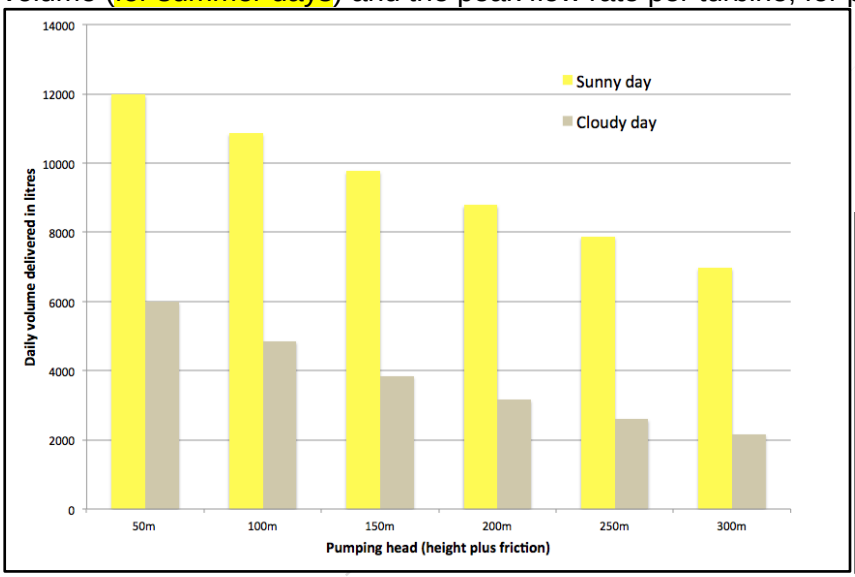
Different sites will need a different number of RP2's depending on the head and daily volume you need to pump. It is not an economic option to manufacture many different RP2 size options. If you need more flow or more head all you need to do is install another RP2.

More than one RP2 greatly improves system reliability on parallel installations, as if you need to remove one pump for servicing or you suffer a RP2 failure then the remaining RP2 will function until the other is repaired.

Servicing or repairs when needed is simple and fast. If you are in New Zealand, you can either send it back to us by courier or you can do it yourself by buying the parts you need online.

With many water source combinations, 2 x PV array sizes, multiple RP2s, parallel and series installations the RP2 can solve almost any stock water pumping problem.

Once you have determined the head, use this chart and table to estimate your daily pumped volume (for summer days) and the peak flow rate per turbine, for pipe sizing.



Head	Peak L/min
50	15.79
100	15.24
150	14.56
200	13.81
250	13.10
300	12.40

These estimates are based on performance measured at our test site in Taranaki NZ. We regard this data as indicative of minimum performance – you may pump more than this.

- If for example you need 7,500 l/day in summer to a 100m tank you will need to install one RP2 with pipes rated for 12 bar.
- If for example you need 15,000 l/day in summer to a 100m tank you will need to install two RP2s in parallel with a larger pipe rated for 12 bar.
- If for example you need 5,000 l/day in summer to a 200m tank you will need to install one RP2 High Power with pipes rated for 20 bar.
- If for example you need 6,000 l/day in summer to a 320m tank you will need to install two RP2s in series with pipes rated for 16 bar.
- If for example you need 5,000 l/day in summer to a 750m tank you will need to install three RP2 High Power pumps in series with pipes rated for 25 bar

2.3.13. Matching the RP2 supply to demand changes

Matching the supply of the pump to your demands is achieved by adequately sizing your storage tank. Bigger is always better. The amount of water pumped will change with the available sunlight but this will normally also mirror your demands.

2.3.14. Incrementally increasing the system size to meet your needs

Let's assume you are a farmer with a moderate sized herd and need a water supply on the back hilly part of the farm. There is no utility/mains power available. Water had previously been provided by access to a stream and small man-made pond. The pond has falling terrain below it. This practice is no longer acceptable due to the new fencing requirement to help reduce water pollution from large farm animals. You also want to fence into paddocks the large hill block, so gains can be made from improved stock & pasture management.

You are very busy, have only $5-6000NZ to spend on the pump and PV array. You do not want to waste any more time trying to accurately determine how much water you will need each season as you need the problem mostly solved immediately. Fencing work is about to start and that means water for paddock troughs is needed urgently. Your gut feeling based on decades of farming experience is that 5,000-10,000 L/day in summer should do it. Google Earth indicates the hill is about 70m high (above pond level).

In this case the farmer can:

- Start off by installing a minimum package of one RP2 and up to 1600W of PV (4 panels - the head is > than 50m) on a gravity feed PE pipe though the dam wall – thus ensuring the pump always has positive head. Positive head is always the best solution where this can be achieved.
- If still more flow is needed another RP2 can be installed with another 1600W of PV.

The above example illustrates that you can take a "watch and see approach" if you are unsure of your pumping needs, or if your demand grows in the future. The farmer will need to consider whether the original delivery pipe is large enough and it may need to be upgraded or additional pipe(s) installed as the system is upgraded.

2.4. Gravity feed pipe size selection

A gravity feed to the RP2 is best solution and must be undertaken where possible, even if this results in a long feed pipe. Gravity feed pipes can normally be installed on farm dams and on small falling streams (no dam needed). Feed pipes up to several 100m long are fine. The table below indicates the pipe size needed depending on the pipe ID per 100m length of pipe. **No foot valve should be installed on gravity feed intakes, but you will need a small intake screen to ensure that stones do not enter your pipe.** In general, you will gravity feed from your stream to a small tank, this tank allows stones and silt to drop out and fall to the bottom of the tank. About ¼ up the side of this tank you will connect the 3m long x 25mm pipe supplied to feed water to your RP2. Ensure you have an opening in the bottom of your tank so that you can flush out dirt, silt and small stones each year.

Pipe bore mm	1 x RP2 Fall per 100m	2 x RP2 Fall per 100m	3 x RP2 Fall per 100m
25	6	25	N/A
30	2	8	18
40	1	2	3
50	0.25	0.5	0.75

For example:

- 1 x RP1 pump on 100m of 25mm feed pipe requires need 6m of fall
- 1 x RP1 pump on 100m of 30mm feed pipe requires need 2m of fall
- 1 x RP1 pump on 50m of 25mm feed pipe requires need 3m of fall
- 2 x RP1 pumps on 50m of 25mm feed pipe requires need 12.5m of fall
- 3 x RP1 pumps on 33m of 40mm feed pipe requires need 1m of fall

2.4.1. Preventing gravity feed pipe airlocks

Feed pipes can airlock, this is where an air bubble grows in the pipe and stops or restricts the flow of water to the RP2. To stop this from occurring do the following:

- Lay the feed pipe on an always descending grade with no high points where air will become trapped.
- If the above is not possible due to the terrain, then limit the number of high points to as few as possible.
- At each high point drill a small 2mm weeper hole so that air and water can escape.
- If your river flow is very low and you do not have sufficient surplus water for the loss to these weeper holes, then fit a loose stainless screw in the hole so the water just drips out slowly – this will still prevent air locks from forming.

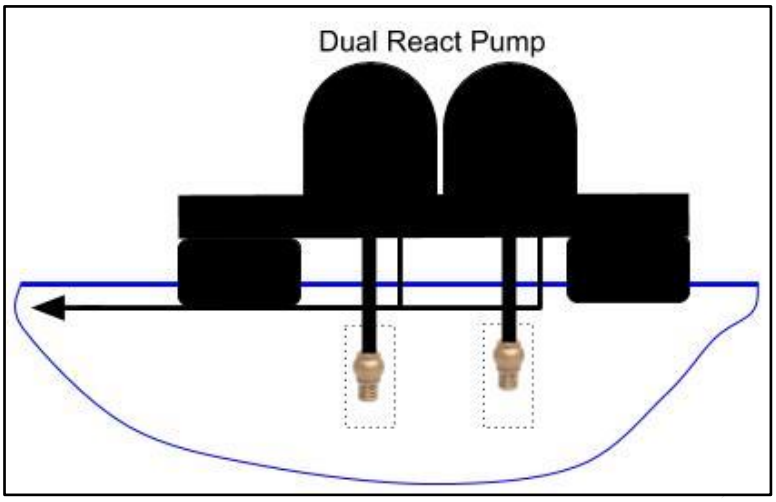
2.4.2. No room for a small settling tank

If the fall on your stream is small, you may not have sufficient fall to mount the settling tank and keep your RP2 above the river flood level.

In such a situation you may decide not to install a settling tank but instead to install a fine intake screen and accept that fine silts will enter the feedpipe which will increase wear on the piston seals which will then not last as long. But as these seals are low cost and easy to replace, this may still be an acceptable solution. Fine intake screens will also need cleaning more often.

2.5. Multiple RP2 install examples

2.5.1. Higher flow parallel installation

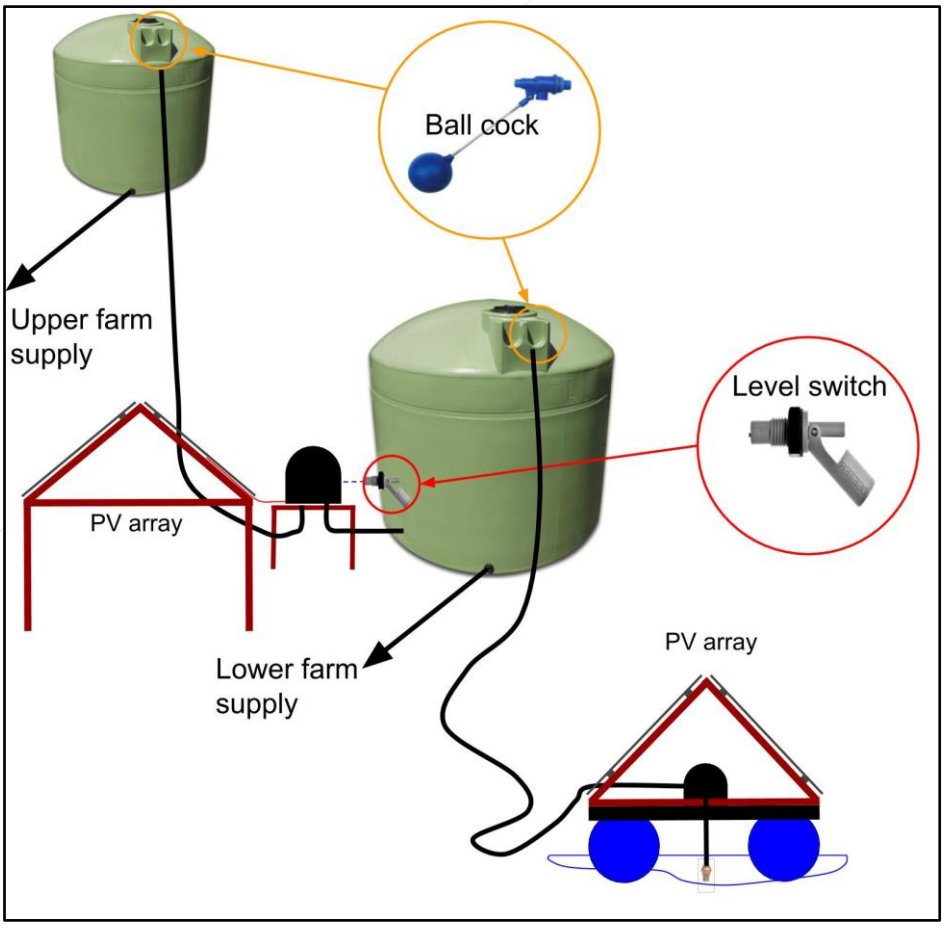


Multiple pumps can be connected to the same delivery pipe to increase your flow.

2.5.2. High head series installations

A series installation is where one pump feeds another one halfway up the slope.

Series installations are more reliable than one RP2 as if the lower RP2 fails the upper RP2 can be moved to the lower position so that at least the lower part of the farm has water.

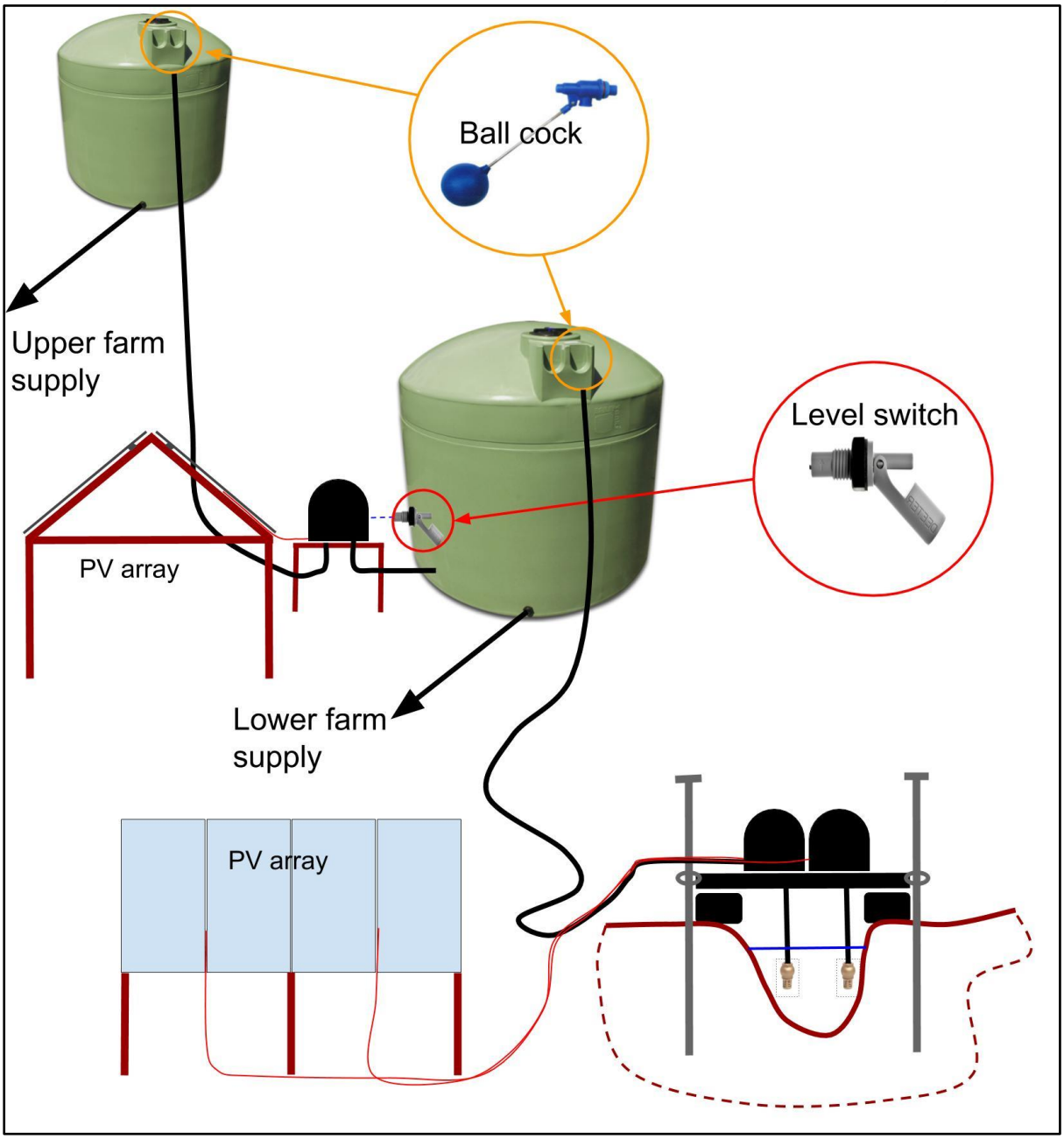


2.5.3. High flow twin RP2 to lower farm, high head series RP2 to upper farm

If you decide to pump all the water to a tank on the highest hill (so as to supply all troughs below) then you need to think carefully on these points:

- You may require more costly pipes or a pressure reducer to prevent pipes from bursting at lower locations due to the high pressure.
- If most water on the farm is consumed at the lower troughs, then pumping all the water to the highest point is a less efficient use of your pumping infrastructure.

The illustration that follows for farms with high heads (typically 160-500m) can work well. Up to twice as much water is available on the lower part of the farm than the higher smaller part of the farm.



2.6. Effects of having not enough water for the RP2

The flow of water through the RP2 depends on having water available in your resource. If your resource flow cannot keep up with the RP2 flow, then the level will fall until air enters the pump supply pipe. A small buffer pond in the water resource can store the water that flows during the night when the RP2 cannot run.

Once air enters the RP2 it will continue to rotate, but no water can be pumped, as suction prime will have been lost. This causes the brass head of the RP2 to rapidly heat up and this will be sensed, and the pump will stop, the error LED will flash an error alarm.
After the head cools the down the RP2 will attempt to restart a few times, but if the same error repeats, then the RP2 will permanently shut down and require the issue to be attended to and the error cleared.

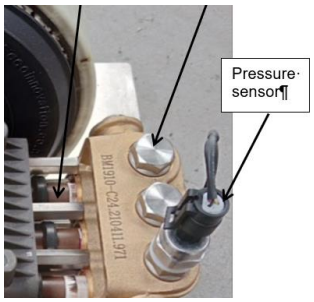
The RP2 has a packed-off brass head to prevent water leak ingress into the oil once the water seals are worn and start to leak. If you notice water dripping off the brass head, then this is your warning that the wet side seals need replacing soon.

Once air enters your suction line you will need to manually reprime it. If the delivery pipe to the header tank is full of water, then you will need to manually open the bypass valve while running the RP2 so that the air can clear.

To avoid the above issues, fit the supplied float switch to stop the RP2, then if the level ever gets too low it will stop and wait for the water level to increase again.

2.7. Pumping too much water and conserving your water resource

Your RP2 may pump more water than you need at times, your RP2 is fitted with a pressure sensor which will turn the RP2 off at a pressure you can set via a button.



When you start your RP2 for the first time, the long delivery pipe to your tank will start to fill. Depending on factors such as head, solar radiation, pipe length and pipe size, it may take a while before your storage tanks will start to fill. While the pipe is filling you can walk the line slowly and check for any leaks.

2.7.1. Setting the off-pressure

Once you can hear that water is entering the tank, return to the RP2.
Hold down the button until the status LED changes from solid blue to flashing red and then finally to flashing blue (about 6 seconds). Then release the button.

The above action sets the off-pressure to be greater than the measured pressure. The allowance added to the measured pressure is approximately 20%. You cannot set the off-pressure to >300m. You cannot set the off-pressure to < 30m. 3-bar pipe grade are higher rated must always be installed.

Then when the tank is full and the ball cock starts to close, the pressure will rise and the pump will turn off for 30 minutes before attempting to restart.

2.7.2. Resetting the off-pressure

If you accidentally set the off-pressure at the wrong time or wish to reset the off-pressure (after changes to your system or sending it to us for a service) you can follow the same procedure as 2.7.1 but with the On/Off switch in the **off** position. This restores the factory setting of 300m. Then repeat 2.7.1 to set your off-pressure.

2.7.3. If you fail to set the off-pressure

If you fail to set the off-pressure and have a ball cock fitted in your tank the pump will keep going until your pipe bursts or 300m head is reached. Therefore we advise the installation of a weak link as detailed next. This also protects your pipe in the event of a pressure sensor failure.

Warning

If you disable the pressure sensor (or fail to commission your RP2 and check correct operation) and a ball cock is fitted in your tank, the RP2 will probably rupture the pipe. This will not normally (see below) harm the pump; it will increase in speed and keep pumping water through the hole in the burst pipe.

It is inevitable that some installers and owners will do just this, we suggest you weaken your pipe (or use a short length of lower pressure rated pipe) just after the RP2 in a section of the pipe that is easy to access with a pipe joiner on either side of the weakened section. (Ensure this section is on land if your RP2 is pontoon mounted.) You do not want the pipe to rupture at the RP2 outlet fitting (where the pressure is greatest) as this could spray water all over the internal workings of the RP2 and could cause serious damage.

You can weaken the pipe by filing a flat on the top of the pipe plastic with a file, it will then fail at this point should the pipe be exposed to excessive pressures.

File a few samples if one bursts while pumping normally take less off next time.

2.8. Supply water to top or bottom of storage tank

You have the option to connect the delivery pipe from the RP2 to either the top or the bottom of the storage tank. These are some considerations.

Top connection:

- Easy to fit a ball valve.
- Silt can settle out in the large storage tank where it can be easily syphoned out every few years.
- If the delivery pipe is damaged and leaks the water in the tank is not lost to the leak.
- If the delivery pipe is used to feed troughs on the way to the tank (this can be a saving in pipe quantity needed), then these troughs will have a limited supply from the RP2 (no night-time supply) combined with limited pipe storage.

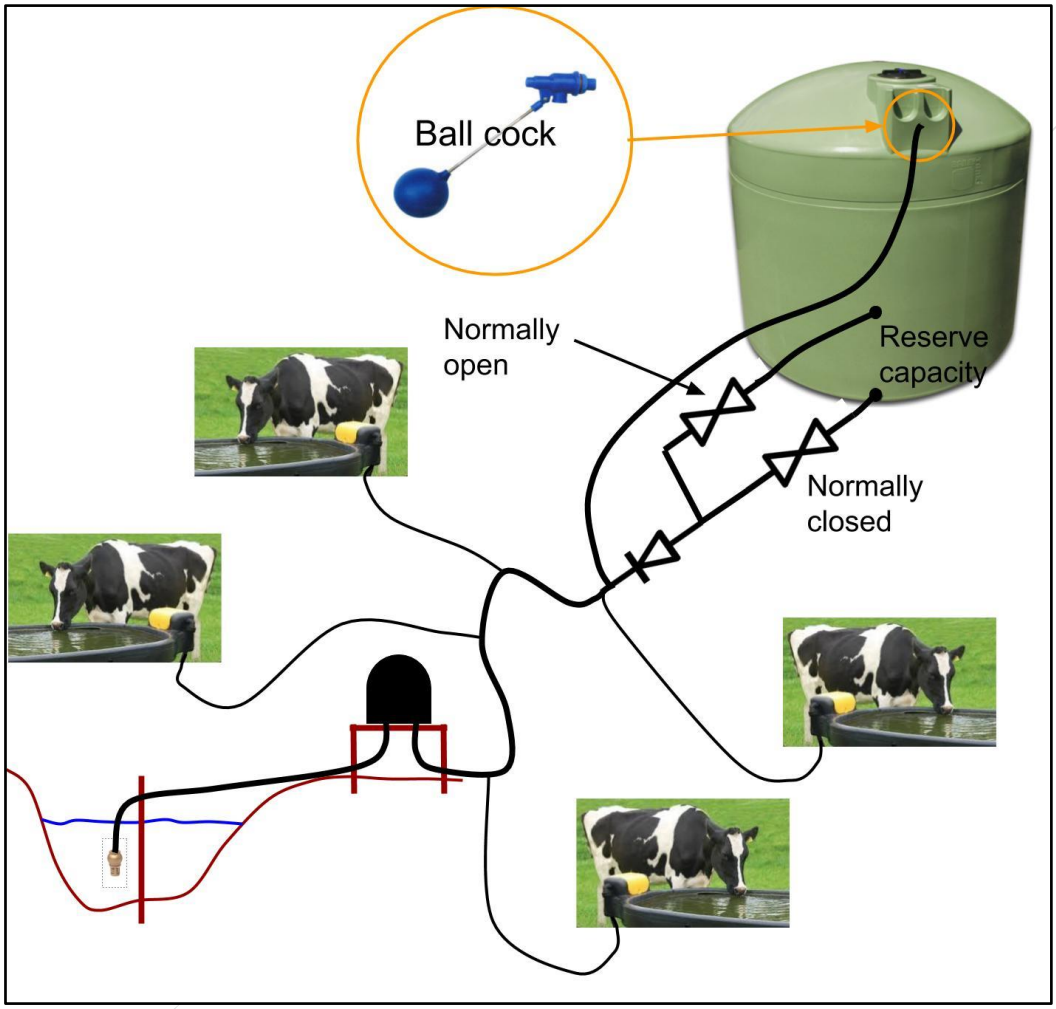
Bottom connection:

- Float for the ball valve must be on a rope, such a ball valve is difficult to access as you have to get inside the tank to install and maintain it. Working in a confined space can be dangerous, legislation applies.
- If the delivery pipe is damaged, water in the tank is lost to the leak.
- The delivery pipe can be used to feed troughs on the way to the tank.

In general, it is more common to top feed the storage tank. The pipe outlet about 1/3 of the way up the tank can give reserve capacity in the event that any pipe in the system is damaged and leaks. A compromise, such as a middle connection may be a good option for some farmers to consider if reserve capacity is critical to the farming operation.

Advised connection (a compromise of top and bottom options):

- Easy to fit a ball valve.
- Silt can settle out in the large storage tank where it can be easily syphoned out every few years.
- If the delivery pipe is damaged and leaks, all the water in the tank **is not** lost to the leak as you have a reserve capacity.
- The delivery pipe can be used to feed troughs on the way to the tank.

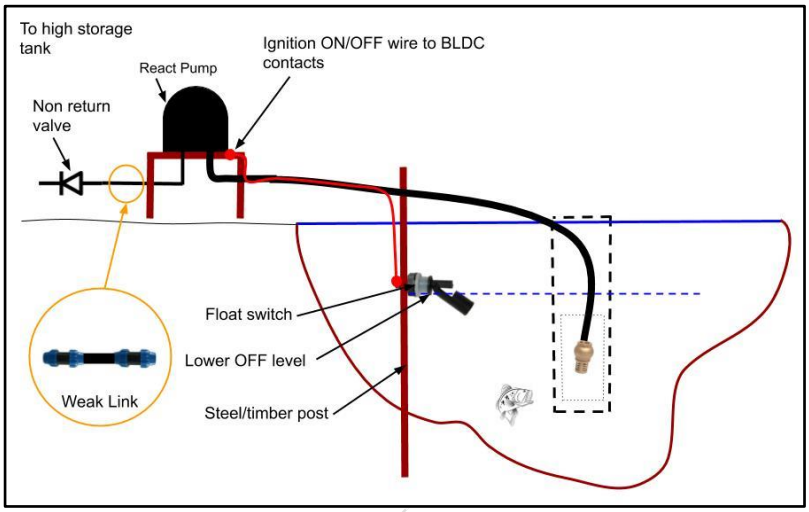


2.8.1. Overflow pipe

If you do not intend to use the pressure sensor to turn the pump off (we advise that you do use it to reduce unnecessary wear and tear) then we suggest that you install a return pipe on the tank overflow fitting. This is the simplest option for dealing with surplus water. If you have previously used grid electricity or a fuel pump you would normally stop the pump when the water tank is full to save running costs. You do not need to do this with a solar pump as sunlight is free. There is more wear and tear on the pump if you let it run when it is not needed, this is an extra cost in maintenance. Farmers who require all the water that can be pumped or those with lower pressure rated pipes may opt for this option.

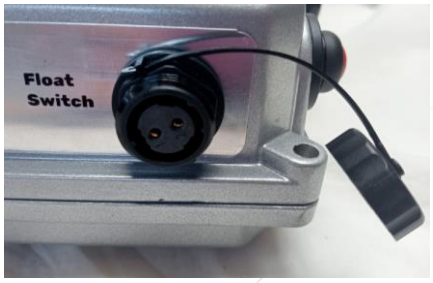
2.8.2. Conserving your resource

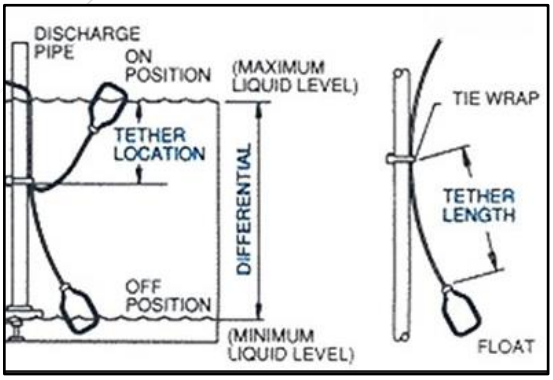
There will be occasions when your resource may run dry, or the pumping rate exceeds the natural flow rate of the resource. In such cases you either need to stop pumping or provide a pumping buffer (tank or pond) for the resource to accumulate when the RP2 cannot pump.



If for example you have a small spring with a dry summer flow of 0.1 l/s (10s to fill a 1 litre container) then in a day this is 9000 litres and a very helpful amount on a dry sheep/cattle farm. If we assume you need all this water to be pumped to your tank on a 60m hill each day, then some buffer storage of the water resource is required. Normally this storage would naturally replenish at night when your RP2 cannot operate.

To stop the RP2 a float switch port and float is provided.

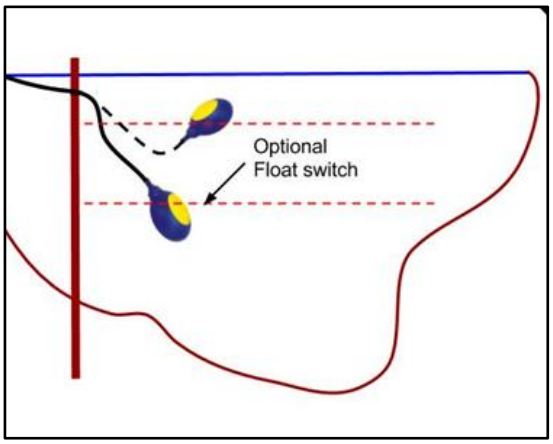




This solution will stop the pump at the lowest acceptable level of your water intake resource.

Floating switches that are tethered by their own wire can provide a wide, adjustable hysteresis between turning on and off. Much of the time they float level on the water surface. The switch will not operate until it tilts.

If the small spring can be diverted into a pipe and fed by gravity into a 10-15,000 litre tank, then the outlet of tank can be connected to the input of your RP2 - then this is the best solution.



If you do not have sufficient fall for a tank, you can excavate a small pond to store about 20,000 litres. **Ponds can be a death trap for children and animals, so fence it appropriately.**

Then you can install a RP2 on a small pontoon in the middle of your pond with the suction hose set about 200mm below the surface where UV from the sun helps to sterilise the water being pumped. Design the pontoon structure to sit on the bottom of the pond before the foot valve intake hits the mud/silt level and where the RP2 turns off.

2.9. Dealing with dirty pond or river water

No farmer wants to pump dirty water, as this dirt will foul pipes, tanks and troughs resulting in more work at some future date to clean it all out.

2.9.1. Our advice for moderately clean water resources (gravity feed where the intake is above the pump level):

- Refer to sections 4.2.1 and 4.2.2

2.9.2. Our advice for moderately clean water resources (below pump level):

- Each RP2 comes with an intake foot valve strainer and replaceable intake filter socks. It is fouls too quickly install a much larger stainless wire basket and filter sock.
- Ensure you have good access so that you can easily lift out the foot valve and replace the sock as needed and to check that the foot valve is always in perfect working order.

2.9.3. Our advice for rather dirty water resources (below pump level):

- Provide a small pond (or settling tank) where possible so that your water resource has more time to settle. Ensure you have a large flush pipe and valve in the bottom of your pond/tank so you can flush silt away, otherwise your pond/tank will soon silt up and be difficult to clean out.
- Ensure you have good access so that you can easily lift out the foot valve and replace the sock as needed and to check that the foot valve is always in perfect working order. See the operation section at the end of the manual.

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3. Solar array design and installation

3.1. Understanding PV size and orientation

The size of the solar PV array you need to install depends on the head, the amount of water you wish to pump, your budget, sizes available in your market and our advice. There are many possible solutions. You can use any make of monocrystalline or polycrystalline panel so long as the open circuit voltage per panel is <45 VDC (at the minimum temperature expected) and the voltage for peak power is >30 VDC. They must be wired in pairs. You can fit 2 or 4 panels, depending on your head and pumping volume required.

Our installations examples (that follow) use 270W panels as these were the most cost effective at the time of writing, but 300-400W panels are more common these days.

The solar panels power the BLDC driver that in turn powers the pump motor. The BLDC driver takes power from the solar array with a voltage in the operating range 60-90V approx. The pump will stop and start in marginal conditions. It needs a minimum of 100-200W of actual solar power to start, and it uses a maximum of 900W (at higher heads). How much power is available depends on the brightness of the sunshine and the number of solar panels. We recommend using two solar arrays per RP2, each panel approximately 300-400W. Each array normally comprises two standard solar panels connected in series.

The pump will slow (or stop) every so often so that the microprocessor can measure the Voc to obtain the maximum power point voltage Vmp. Vmp = 0.8 x Voc. The rpm of the pump is then continuously adjusted to ensure it runs at the Vmp until the next check (typically every 60 minutes).

The comments that follow focus mainly on pumping water in the head range 50-160m with a 1200-1600W PV array, with a focus on summertime flow, as most farmers will need this type of system.

3.1.1. Single array facing midday sun

In NZ (southern hemisphere) the midday sun is due north between 1 and 1:30 PM rising at about 6 AM and setting at about 9 PM. An array facing north will not be able to power the RP2 until about 8 AM, and it will stop at about 7 PM. This is because close to sunrise and sunset the sun is behind or edge-on to the solar array and low in the sky so less solar radiation is available to be harnessed at these times.

We also have to consider that the RP2 at heads below 160m cannot use more than 750W of power despite up to 1200-1600W being nominally available from a north facing array at times close to midday sun. This PV array is chosen because it will only generate this peak power for a short time in full sun around midday which is not a long time. There will be clouds much of the time. Higher midday temperatures mean that a PV array may never generate full power (as solar panels are less efficient at high temperatures).

There is no value in producing a very high peak output at midday if that peak is greater than the pump can utilise, so do not orient a 4-panel system to all face due north (or south in the northern hemisphere). The important consideration is to extend the operating hours by starting the pump earlier in the day and keeping it running later in the day. For a 2-panel system see section 3.1.4.

3.1.2. Array split into two halves facing East and West

If the installation site is not shaded by hills, trees, or buildings from morning to evening sun and we want to pump longer and have more power available sooner it makes sense to have an array split into East and West facing halves. The RP2 would then start pumping at about 6:30 AM and stop at 8:30 PM.

Pumping power at midday will not be affected, as with the sun directly overhead the 1200-1600W East/West array will still be able to deliver the power needed for the pump to be at full power capacity.

On an overcast summer's day, the light is diffused by the clouds. So, on a cloudy day both arrays will generate to a similar extent regardless of where the sun is. We may never generate more than 400W from a 1200W array on a heavy grey summers' day in NZ, but all this 400W can be used - so the pumping yield does not suffer as much as you might expect.

Winter sun is never directly overhead unless you are close to the equator. The angle of an East/West array should be biased to morning, evening, and winter sun. 45 degrees is a good angle for an East/West array. Visualize a roof with a 45-degree pitch facing East and West and you have it. The 4 x 300-400W panels are then very easy to mount onto a simple truss (pictured above and described in more detail later). Such a truss can be mounted on 4 posts in the ground or on a pontoon floating on your water resource.

In summary an East/West array pitched at 45 degrees will yield:

- more pumped water on a sunny day
- more pumped water on an overcast day
- better all day and all year production if pitched at about 45 degrees

3.1.3. Sites with shading in the morning and/or evening

Where the site does not benefit from early sun in the morning, and/or late sun in the evening due to shading, the optimum arrangement will be a NE-NW orientation pointing the PV panel arrays at the mid-morning and mid-afternoon sun as shown here.

3.1.4. Smaller PV array orientation

If your pumping needs are modest **(<50m head)** and mainly summer biased, then a smaller 2-panel PV array of 600-800W may be sufficient. This array size must be pointed at midday sun at a pitch of 20-30 degrees. Or point it in the middle of the shade free time-zone if your site is clipped by shading from surrounding features. (Do not face the two panels in different directions as they must work together in series as a pair.)

600-800W PV - facing midday sun (10-50m head)

3.2. Wiring the PV to the RP2

The RP2 comes with two MC4 bulkhead connectors on the body of the pump. Mating MC4 connectors of the same brand are supplied by us or by your dealer. If supplied by us we assume that 4 panels will be fitted – so you may end up with some extra fittings that you can practice your crimping skills on.

- **AS/NZS5033 standard requires that all mating MC4 connectors are to be the same brand. For this reason, we provided extra MC4 connectors with the pump. We supply the Slocable brand. You can make MC4 PV panel adaptor leads with these extra fittings so that all mating MC4 connectors are the same brand. Please check the laws/codes in your country.**

In NZ, our dealers can supply solar PV wire from the Solar PV array switch box to the RP2 (normally 4mm^2 tinned double insulated). It all arrives ready to plug together if you purchase via one of our NZ dealers, but you must advise the wire length required. If the distance is long, then you may need larger wire. Beyond 100m you may need to install aluminium wire to keep costs low. The % loss table below is based on 650W at 65VDC.

Cable Length (m)	% loss in cable at 650W and 65 VDC				
	4mm^2 copper	6mm^2 copper	10mm^2 copper	16mm^2 copper	25mm^2 aluminium
10	1	1	1	0	0
20	3	2	1	1	1
30	4	3	2	1	1
40	5	3	2	1	1
50	N/A	4	3	2	2
60	N/A	5	3	2	2
70	N/A	N/A	4	2	2
80	N/A	N/A	4	3	3
90	N/A	N/A	5	3	3
100	N/A	N/A	5	3	3
125	N/A	N/A	N/A	3	3
150	N/A	N/A	N/A	4	4
175	N/A	N/A	N/A	5	5
200	N/A	N/A	N/A	N/A	N/A

The table above indicates the percentage power loss at 650W pump power. Cable runs less than 40m are typical and are a very cost-effective solution. Longer cable runs should be avoided where possible. Try to keep cable losses under 5% loss (some countries mandate only up to 3% loss).

The SEIDP guideline states that: "Under maximum load conditions the voltage drop from the most remote module in the array to the input of the controller should not exceed 3% of the maximum power point voltage (V_{mp} at Standard Test Conditions) of the array.". To comply with this guideline larger cables than stated above may need to be installed.

3.2.1. ELV Wire protection

In NZ and Australia ELV wire protection is covered in:

- AS NZS 5033
- AS NZS 3000
- AS NZS 4509

At the time of writing (for NZ) these are the rules for ELV wiring:

> 5033: 7.5.11.3 Underground conductors. **There are no depth-of-burial requirements for the safety of extra-low voltage cables**. NOTE: Consideration should be given to the risk of mechanical damage.

The above means that in NZ ELV cables that lay in contact with the ground do not need to be buried and can be laid ***on the ground***, only “Consideration” needs to be given to protection of the cable, for example from:

- UV radiation (sleeve in LDPE pipe).
- Cattle hoofs (sleeve in LDPE pipe).
- Cattle teeth (sleeve in LDPE pipe).
- Tractors and farm bikes (Sleeve in LDPE pipe and bury 100-200mm down at gate/track crossings).

3.2.2. Over current wire protection

In all cases no over-current protection is required, as (unlike the case with a battery or grid connected system) the short circuit current is limited to the "Isc" the PV panels can produce. Here are typical values:

- 18amps (1060 W PV).
- 27amp (1600 W PV).

These currents cannot therefore overload the MC4 connectors and 4mm^2 wiring that is rated for 30 amps.

A 32A DC switch is supplied with every RP2 to allow the system to be turned on/off at the PV array. This switch is a convenient DC on/off switch, which can be opened without damage under full load current. This switch is required to be labelled to identify its use and purpose. This DC switch should be mounted under the PV array so that it is:

- Accessible and easy to see.
- Shaded from the sun.
- Protected from driving rain.
- Clearly and permanently labelled “Solar PV disconnect switch”.

3.2.3. PV array maximum voltage calculation (must be < 45V per panel)

4.2 PV ARRAY MAXIMUM VOLTAGE

The PV array maximum voltage is considered to be equal to $V_{OC\ ARRAY}$ corrected for the lowest expected operating temperature, as follows:

$$\text{PV array maximum voltage} = V_{OC\ ARRAY} + \gamma_v (T_{min} - T_{STC}) M$$

where

$V_{OC\ ARRAY}$ = open circuit voltage of the array at STC, in volts

γ_v = voltage temperature co-efficient, V/°C/module supplied by the manufacturer (negative value for crystalline silicon)

T_{min} = expected minimum daily cell temperature, in degrees Celsius

T_{STC} = cell temperature at standard test conditions, in degrees Celsius

M = the number of series-connected PV modules in a string

Correction of the voltage for the lowest expected operating temperature shall be carried out as follows:

(a) Using the formula above.

(b) Calculated according to manufacturer's instructions.

(c) Where manufacturer's instructions are not available for crystalline and multi-crystalline silicon PV modules, $V_{OC\ ARRAY}$ shall be multiplied by a correction factor according to Table 4.1, using the lowest expected operating temperature as a reference.

Where the lowest expected operating temperature is below –40°C, or where technologies other than crystalline or multi-crystalline silicon are in use, voltage correction shall only be made in accordance with manufacturer's instructions.

PV strings constructed using d.c. conditioning units shall have a PV array maximum voltage in accordance with Clause 2.1.5.

TABLE 4.1

VOLTAGE CORRECTION FACTORS FOR CRYSTALLINE AND MULTI-CRYSTALLINE SILICON PV MODULES

Lowest expected operating temperature °C	Correction factor
24 to 20	1.02
19 to 15	1.04
14 to 10	1.06
9 to 5	1.08
4 to 0	1.10
–1 to –5	1.12
–6 to –10	1.14
–11 to –15	1.16
–16 to –20	1.18
–21 to –25	1.20
–26 to –30	1.21
–31 to –35	1.23
–36 to –40	1.25

3.2.4. Lightning protection

In NZ no lightning protection is required as the risk is normally low. This may not be the case in Australia and other countries which may require lightning protection to be fitted and/or the PV frame to be earthed. **In NZ lightening damage is normally covered by your insurance provider, it would be wise to check your policy.**

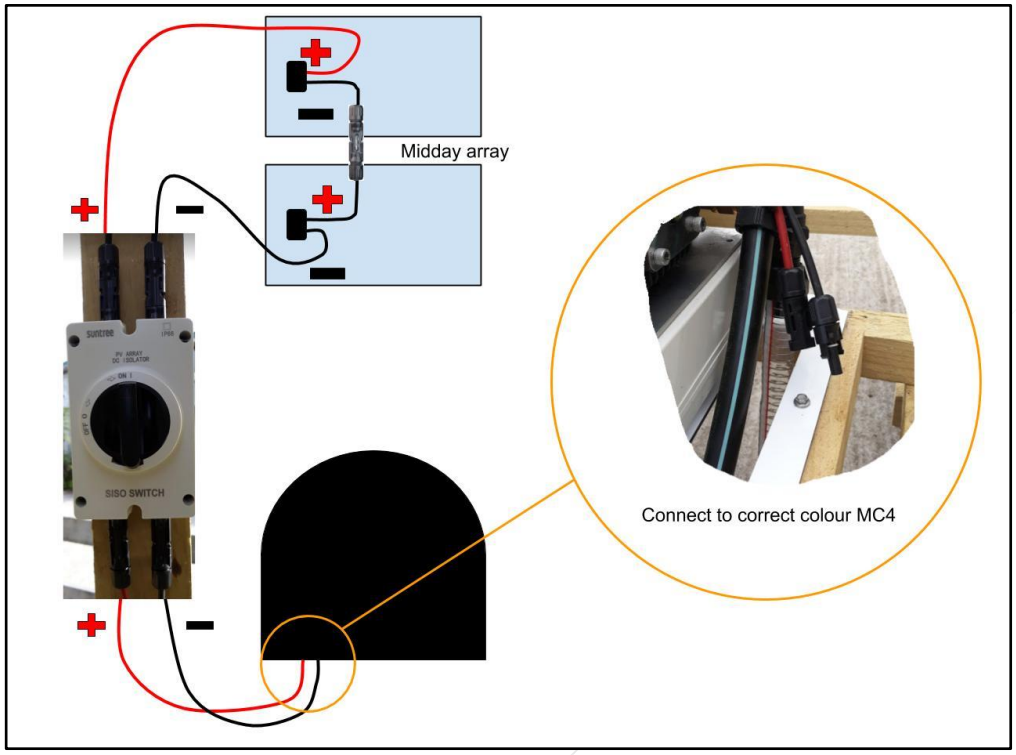
3.2.5. Earth Connection

In NZ the solar PV array does not need to be earthed as the system is ELV and there is no lightning protection required. You can however earth conductive parts if you wish.

This may not be the case for Australia and other countries (where for example lightning is much more common).

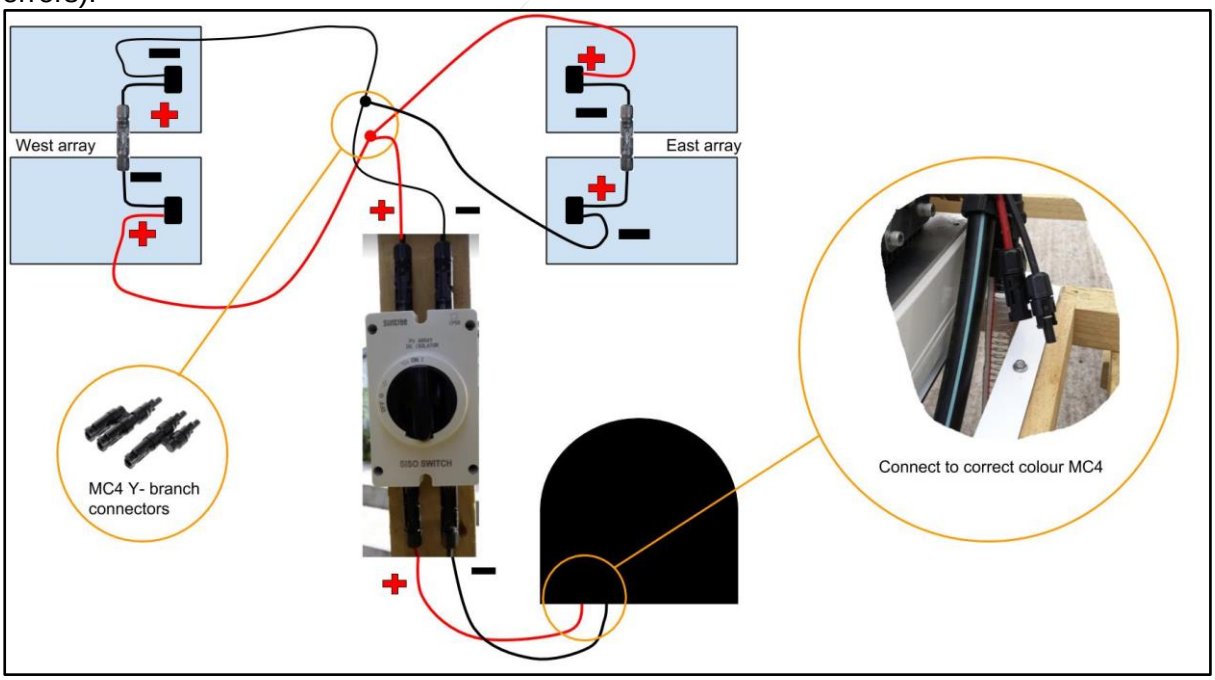
3.2.6. Wiring schematic for 2-panel PV array

(**Note:** if all your wires are black mark the + wire with red PVC tape every 0.5m to avoid errors).

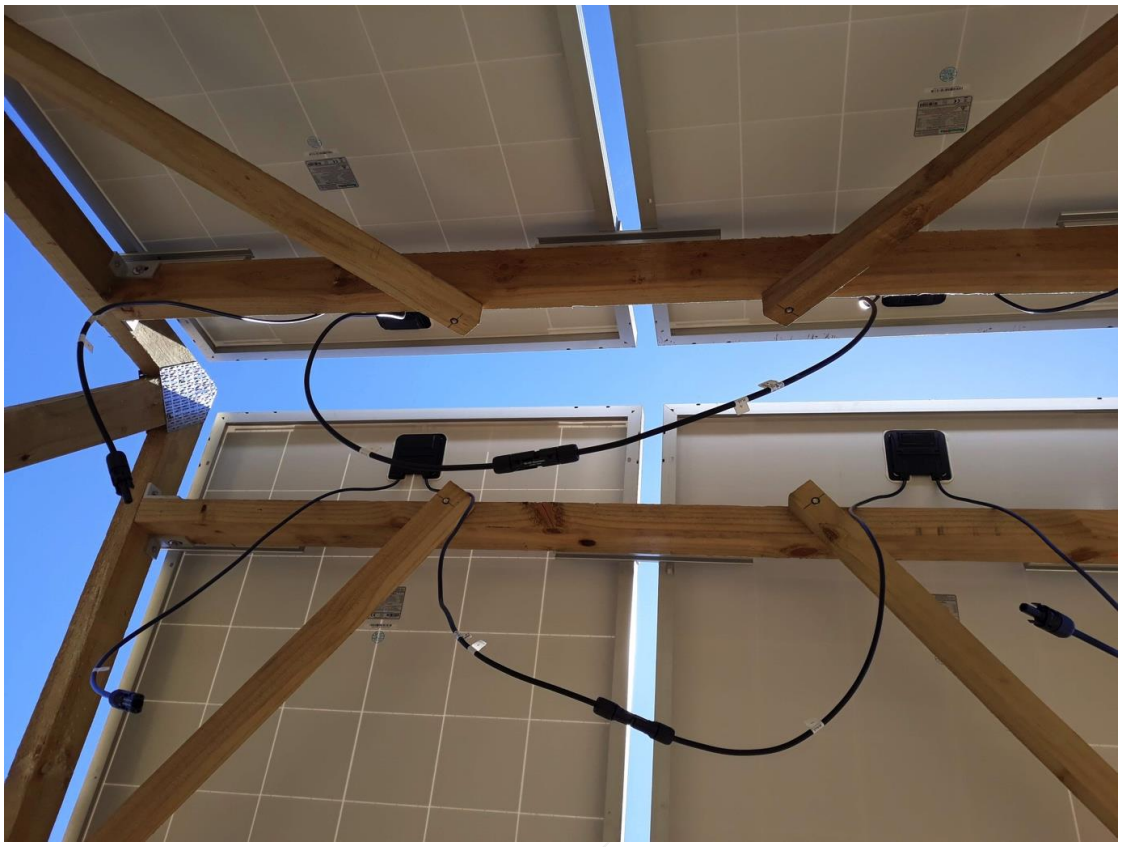


3.2.7. Wiring schematic for a 4 panel PV array

(**Note:** if all your wires are black mark the + wire with red PVC tape every 0.5m to avoid errors).



3.2.8. Solar array general wiring practice

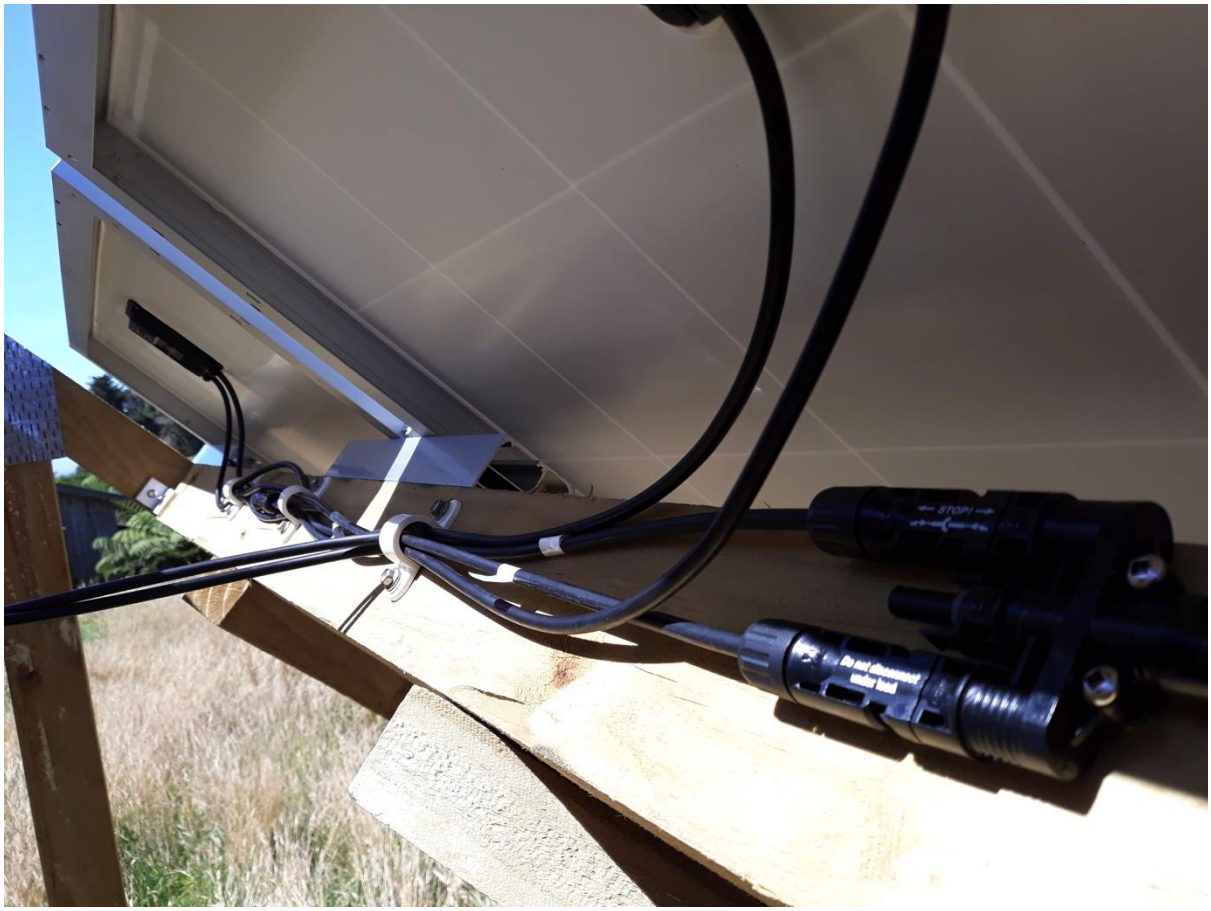


Wiring is very simple.
Start by plugging together each panel pair in series as shown above. You are connecting a "+" to a "-" of two panels that are mounted in the same orientation.

Note if you <u>have not</u> purchased a complete pump/PV package via one of our NZ dealers, then you will need to make up short MC4 brand conversion leads to convert the fitting brand on your PV panels to the Slocable brand.
Do not cut any plug fittings off your PV panels as it may affect panel warranty.

Connect the positive wires into the 2 to 1 Branch connector. Note the connectors shown allows for 3 connections **(6 panel systems are no longer approved as the higher wattage panels available these days allow for ample power with only 4 panels and no fusing requirements that a 6 panel system requires).**

Connect the negative wires into the 2 to 1 branch connector.
Secure and tidy up the wiring in line with the advice in the section below.



Tidy and secure wiring on both sides as shown above.

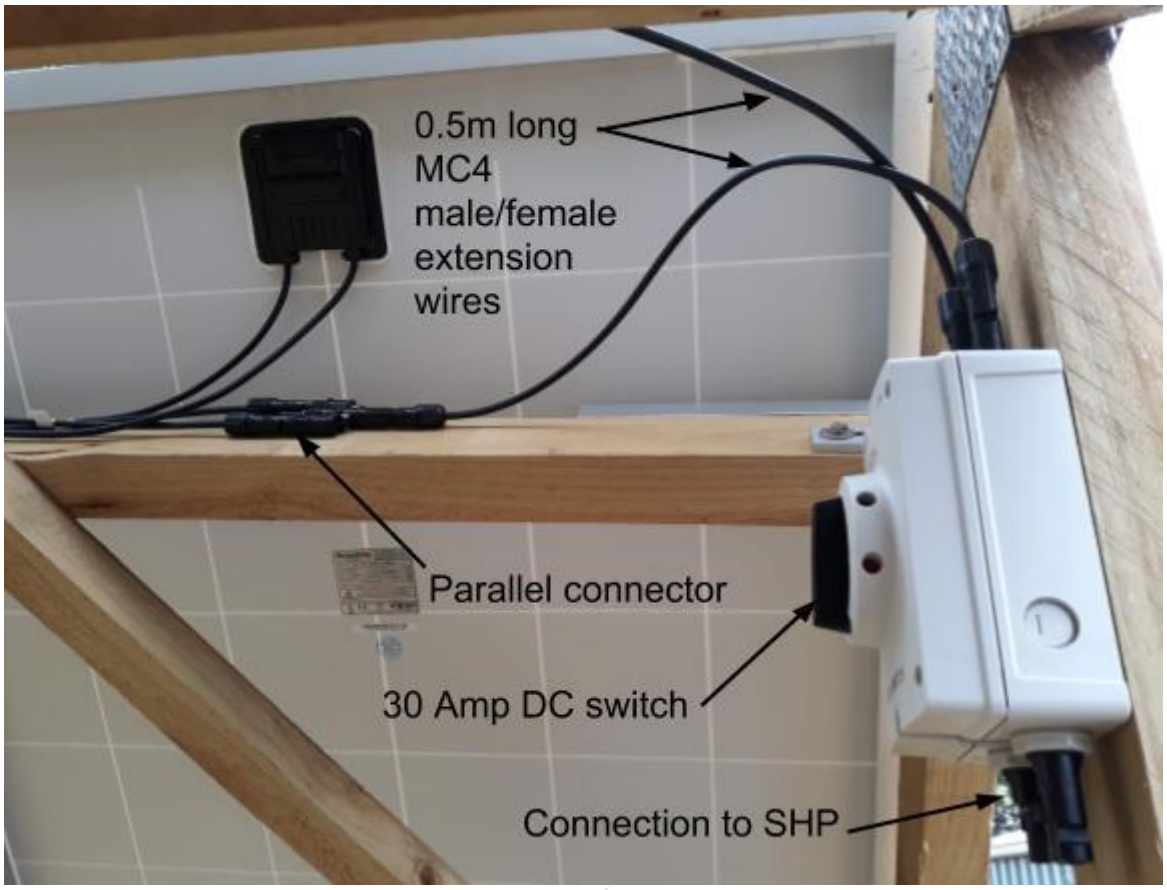
If you are mounting for the following:

- 4 x PV panels not on an East/West truss frame (as per this example)

Then the leads from each PV panel pair may not all be long enough to reach the 2 to 1 branch connectors. In such cases you will need to add an extension wire. When making **this extension wire ensure that all mating MC4 connectors are the same brand.**

MC4 extension and brand conversion leads are easy to make onsite to the length required or they can be purchased pre-made. Remember if you are making extension leads have a male plug on one end and a female on the other end. Get this wrong and you will change the polarity of the wiring which may damage the RP2.

3.2.9. RP2 wiring to main DC disconnect switch



Each RP2 is supplied with a waterproof MC4 DC switch for easy and fast connection as shown above. **Install the DC switch out of direct rain and sunlight.**

3.2.10. Wiring of DC switch to RP2

The wiring from the DC switch to the pump may need to be in conduit to protect it from animal damage. In general, large animals should be kept out but smaller animals may get in and chew on wiring.

Rats and other small gnawing rodents can be very difficult to keep out. Putting a metal skin around the 4 posts of a trussed mounted array can prevent rodents from getting up onto the unprotected PV wiring. To keep out possums the entire 1.2m long post will need to be skinned, for smaller rodents 600mm is fine. Normally stainless-steel sheet material is used.

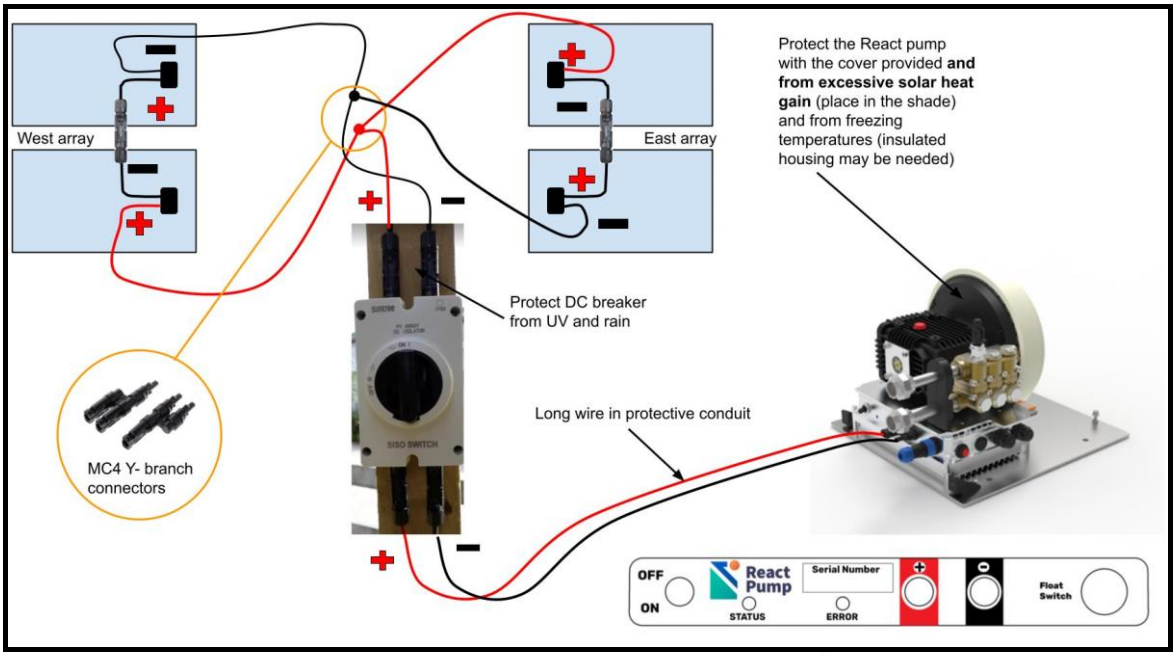
3.2.11. Check polarity

With the switch on in good sun, red lead in + MC4 connector as shown check:

- Voltage is typically in range 60-90V, 68 in this example.
- Confirm polarity, -68 would be the wrong polarity.

Wrong polarity is due to a wiring error from the panels to the switch or the leads in your multi meter being in the wrong position **(Black = COM).**

3.2.12. Final wiring to RP2 (1200-1600W example)



3.2.13. Regulations about cable ties, and UV protection of PV wiring

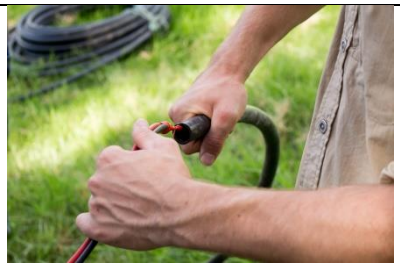
In NZ & AUS the cited AUS/NZ 5033 standard specifically discourages the use of plastic cable ties to secure PV wiring. The reason for this is that thin plastic ties outside do not last long in our harsh UV sunlight (this is even the case in the shade), the cable ties break, and the wires are then buffeted by the wind and get damaged. This can be a serious issue on higher voltage LV systems. There is no ELV exception to this requirement. Use plastic ties first as they are easy to use, then when all tidy place a stainless one alongside each plastic one. You will have noticed that our East/West truss mounting does not require any cable ties as we have used PVC saddles. Some installation variations may require cable ties.

PV wires are double insulated with UV rated PVC plastic and when located in the shade under the panels require no extra UV protection to achieve an acceptable life. Where the cables are exposed to direct sunlight and for animal nuisance protection, then sleeving in LDPE pipe or PVC conduit is required.

Rodents - A key ingredient to PVC is salt (which rodents like to eat), which makes PVC low cost and fire resistant. Rodents also need to chew and will often chew on PVC wires and PVC protective conduit for these reasons. Keep an eye out for this damage over time, as it can cause shorts, water ingress and ultimately the loss of power to the RP2.

3.2.14. How to feed your electrical wire inside a long LDPE pipe.

You will need to protect the wires from the bottom of the DC switch to the RP2. Here is a simple technique for feeding wires through a LDPE pipe that works well in remote locations. You will only need a farm bike and a length of string at least as long as the pipe.

1. Drill a small hole for a string line near the end of the pipe. Make a pipe pig of a rag and fasten this to the string inside your pipe.	 2. Tape the LPDE pipe so it fits into the exhaust pipe of your quad/farm bike.	3. Rev the engine and help by feeding the string into the hole Pipe runs up to 50m long are easy to do this way If longer, then do 50m at a time, and use a joiner
 4. Once through, connect wire to the string securely and tape	 5. Pull wire through pipe	 6. Connect to switch box under the PV array

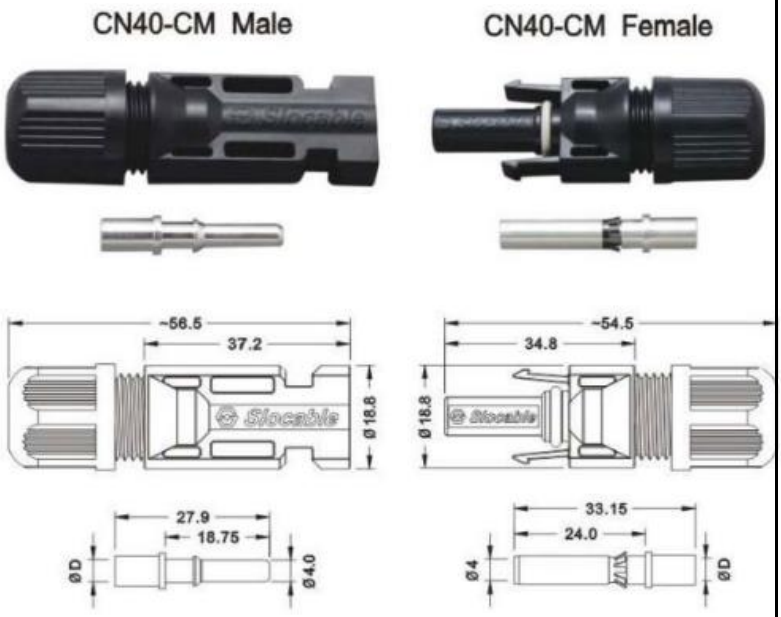
The bike exhaust method works for PE pipes up to about 75m long, you will need an assistant. For longer PE protective pipe runs consider these options:

- Small generator set and air compressor.
- Small generator set and vacuum cleaner.
- Use the water pressure from the RP2.

We have used all these methods in the past and all have worked well.

3.2.15. How to wire and fit the Slocable MC4 connectors

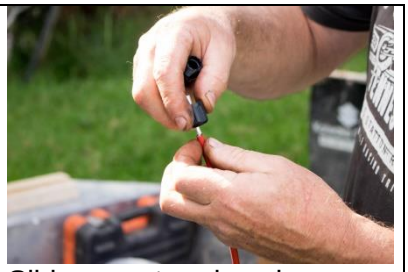
The MC4s connectors are either male or female. Each plug type carries a + or – sign. The convention is to have the + on + ive generation wires and – on –ive generation wires. If you check the voltage polarity of the pre-wired MC4 connectors on the solar panels you can confirm this. (All wires on PV panels are black, but they carry a + or – marker tag on the wires).



The confusing part (and a common error to make) is when fitting MC4s to load wires (i.e. the wires <u>on the RP2</u> which is the electrical load). In this case a –ive wire will have + MC4 fitted and a +ive wire will have a –ive MC4 fitted.

You can only get the polarity wrong if you have made up extension cables that are male/male or female/female instead of male/female. If you do this you may damage the RP2, so you must take care, and read what follows **very carefully.**

3.2.16. To fit Slocable MC4 connectors with correct tools (barrel crimping tool):

 Strip off 8mm of PVC sheath	 Crimp on fitting of correct type. Give the wire a tug to ensure your crimping has been successful.	 Slide on nut and seal
Do not mix up MC4 parts! Keep them in separate bags to avoid errors. The body of the MC4 fitting pushes over the crimped metal inner until you hear it click.	 Tighten the nut	If you make an error the MC4 will have to be cut off and thrown away. if you are still unsure seek help from an electrician.

The make of MC4 we use (Slocable brand) requires no special tools other than a 4mm barrel crimping tool. If you do not have access to a crimping tool then fencing pliers and a drill bit suffice.

3.2.17. To fit MC4s with available farm tools:

 Use a knife to strip PVC sheath back as shown (longer than normal)	 Slide on metal fitting and crimp hard as shown	 Crimp again with the blunt end of a 3mm or 3.5mm drill bit inserted as shown. Give the wire a tug to ensure your crimping has been successful.
 Push the metal fitting into the plastic connector **until it clicks**. You may need to use a small flat screwdriver to help	 Push in surplus wire as shown so that the seal and nut can fasten on the PVC	 Tighten the nut and pull hard to check it is firm

3.2.18. How to wire and fit Staubli brand MC4 connectors

If you are in NZ and have purchased from Independent Power or Perkinz, you will have been supplied with Staubli Brand MC4 connectors and the option to purchase the correct crimping tool below.

The crimping tool looks like this:

Click on image above to watch a video on how to use this tool.

The MC4 spanners look like this and can be used to tighten the glands at the ends of the connectors and to disconnect the connectors if required.

3.3. Operating your RP2 from auxiliary (not solar) power sources

3.3.1. Systems with a 230/115 VAC supply

It is possible to run the RP2 off a 230 or 115VAC supply with a suitable power supply.

To run the pump on a fixed power supply:

- If currently connected to a solar PV array first disconnect the pump at the MC4 connectors on the body of the pump.
- Open the electronics enclosure by removing the 4 corner screws using the provided 5mm hex driver.
- Ground yourself by touching the usb port of the microprocessor.
- Locate the jumper as shown in the image above (top right-hand corner of the microprocessor PCB)
- Connect the jumper on the processor board marked "Power Supply/MPPT Mode" which stops the unit from tracking the maximum power point and instead sets it to a fixed throttle.

RP2 up to 160m head requires:

- 60V 15 Amp supply and operates at 760 RPM at 160M head.

High Head RP2 unit requires:

- 60V 25 Amp supply and operates at 580 RPM at 300M head.

For example, a small 2kVA portable gen-set could be used to run the RP2 at night so the tank can be refilled at times of very high water demand. You may need a COC for the VAC part of your system installation (as 230/115 VAC is "LV"). Seek advice from your electrician.

You will need an 60V power supply to do this. These you can buy online (for example) here. Sorry we do not sell these power supplies.

4. Intake

In NZ most water resources are from springs or small streams on falling land. Often it is just a collection of springs in a small gully at the base of higher hills that can provide 0.1-0.5 l/s flow rates. Some earthwork may be needed to provide:

- Consolidation of a few small springs.
- A storage buffer (night-time water accumulator).
- Sufficient water depth for a foot valve intake and floating pontoon.

4.1. Suction or gravity feed (pump priming issues)?

Gravity feed the RP2 if you can. This will avoid issues with having to manually prime the pump as a result of air getting into the suction pipe. **Gravity feed is exceptionally reliable and worth the extra effort to do it where possible.**

The RP2 can develop good suction head against an **empty delivery pipe**. It will usually prime itself without problems on first use for suction heads up to 1.5 metres with wet valves, but it will not pump the next morning if air enters the suction pipe. If the delivery pipe is full and there is air in the suction pipe, then the RP2 will need to be purged of air by opening the bypass valve. A foot valve (if required) must be kept in **perfect working order**, hence good access to this valve is important. It is essential to buy a spare foot valve so you have one when required.

Prime can be lost (air enters the pipe) if:

- Suction fittings are not airtight or have worked loose.
- Suction hose has rubbed on a rock and developed a pin hole leak.
- Foot valve is not supported - fixed and secured in the vertical position.
- Foot valve is partially open due to grit stuck under the seat.
- Foot valve is badly worn and no longer watertight, so leaks down at night.
- Snails have grown in the suction pipe over time and got jammed under the one-way valve seats in the pumps brass head.

To avoid loss-of-suction issues:

- Keep your suction pipe as short as possible.
- Keep your suction **lift as low as possible – avoid suction lift if possible**.
- Ensure the foot valve seat is clean and in good condition protected by a suitable filter sock.
- Ensure the foot valve is off the bottom of the stream/pond where grit can damage it.
- Replace the foot valve and suction hose each year.

Unlike long stroke piston pumps used on many farms (pictured opposite), the RP2 cannot always expel air against a pressurised delivery line. So, if prime is lost with a full delivery pipe, then it will need assistance to prime by opening the bypass valve.

Long stroke piston pumps (typically 75mm stroke are common on many farms as shown opposite), these pumps have a higher compression ratio so they are able to compress air in the body of the pump to a pressure greater than the static water pressure in the delivery line (up to about 50m heads only). Hence they are able to prime themselves while working against a head of water pressure, without the need for a foot valve in some limited lower head applications.

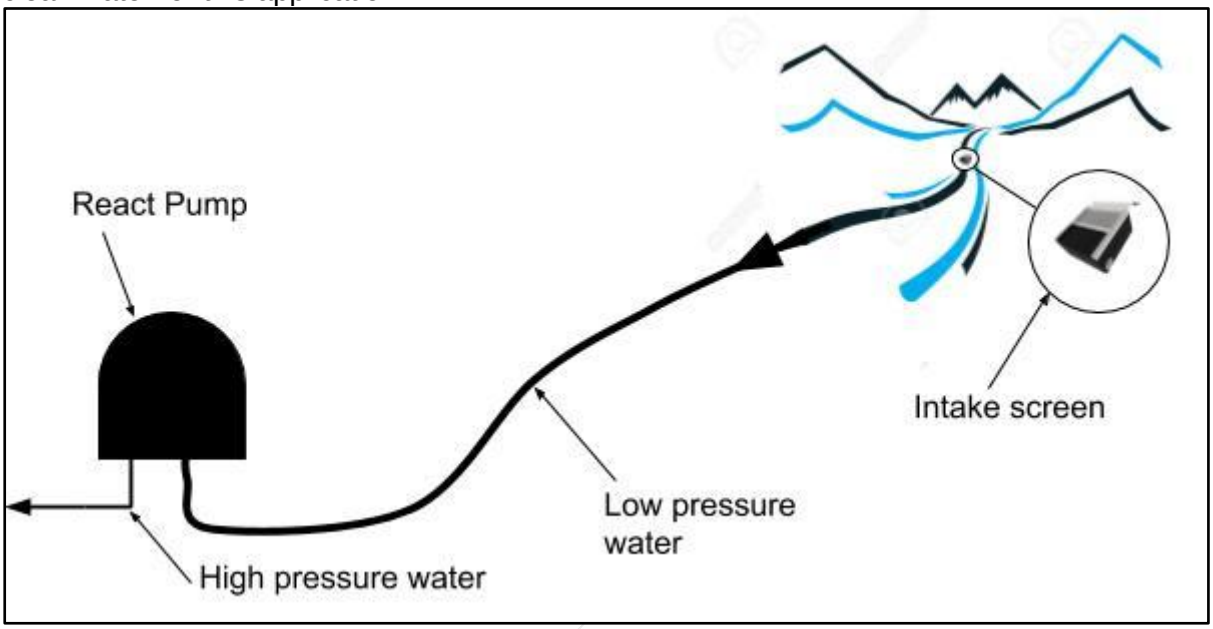
The RP2 has 3 small stroke plungers (14mm not 75mm stroke) and these plungers do not run in a close-fitting bore. This means that the compression ratio when compressing air is lower than that of a piston pump, the peak air pressure in front of the plunger may be less than the water pressure already in the delivery line.

4.2. Site installation options

The following installation examples are illustrated **in preference order**.

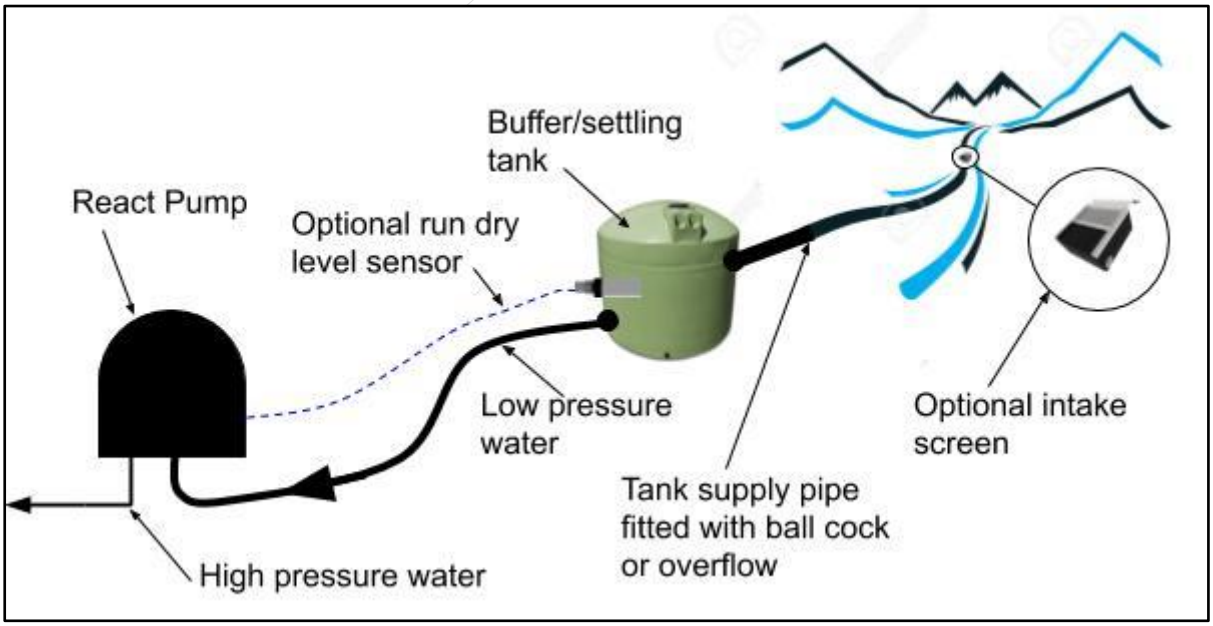
4.2.1. Gravity feed (very little fall – small creek or stream)

This is the good option (the next gravity feed variation is even better), do this if you can. Choose a site for the pump that is slightly below the point where water is extracted from a small creek or stream. The pump will prime itself. Our Coanda intake is ideal for collecting clean water for this application.



A 1mm intake screen to filter flow is required – no foot valve is needed

4.2.2. Gravity feed with silt settling tank (where more fall allows for the tank height)



A 1mm intake screen to filter flow is advised – no foot valve is needed

The above examples will self-prime and are very unlikely to air lock. Gravity feed is the best solution if you have such a suitable stream resource.

Where flows are always greater than 0.3l/s (per RP2 installed) the intakes commonly used for small hydro turbines can be employed. Your 25mm ID pipe (larger pipe may be needed for long runs or multiple RP2s) is fed water via an angled intake screen. Surplus water keeps the screen clean.

To review our advice for small hydro turbines click here. We suggest using the same technique, but smaller than most hydro examples.

Remember, intakes have to be strong to survive floods and your RP2 must be mounted above the maximum flood height unless a pontoon is used.

The intake of a gravity feed RP2 should be positioned at the base of a small set of rapids (to allow room for a sloping intake screen as shown opposite). Channel the water flow over the top of the screen, so it falls through the holes into the chamber below that feeds the intake line of the RP2. Leaves and twigs are washed away with surplus water preventing the intake from blocking.

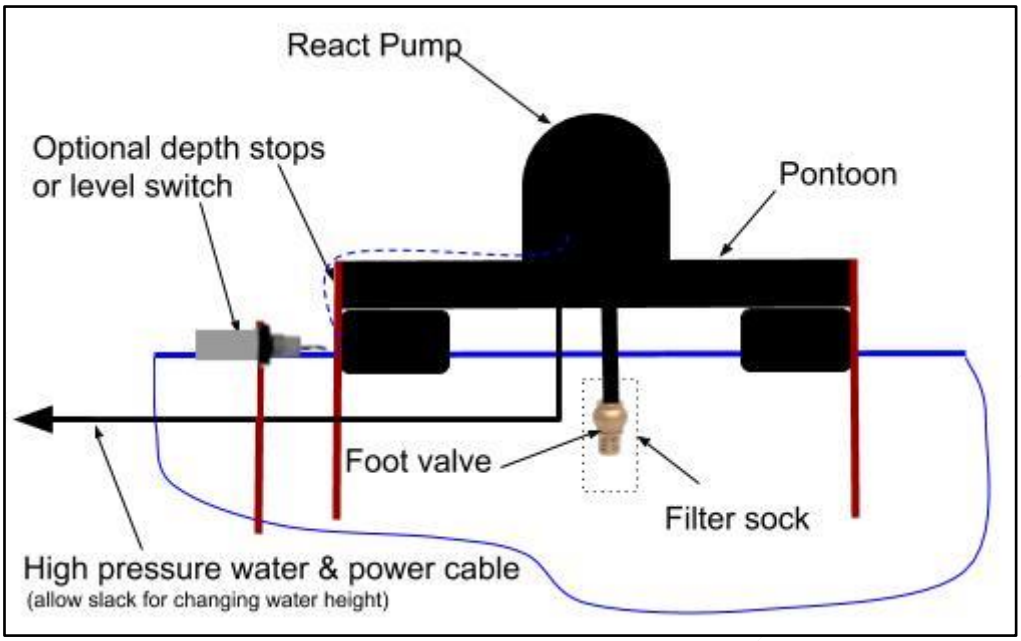
Intakes often need to be made to suit the site. An angled guide with screen is the recommended way to make a good strong maintenance-free intake screen. You must ensure you securely attach the intake and screen to the riverbed by driving galvanized stakes into the ground, or by attaching to large boulders with brackets, bolts and concrete.

Intake screens can be purchased. Opposite is a leaf slide made for domestic downpipes. These are a perfect size for RP2 intakes and are available with fine screens. They are mass produced and low cost. Perfect for small gravity intakes, where you have a suitable fall from your water resource to the RP2.

However, they are also easy enough to make to suit your site. You can use a stainless steel mesh and a plywood box or plastic tank. Make sure you support the screen from behind with stainless steel rods/frame otherwise during floods the mesh will be pushed in. A fine, smooth stainless steel gauze or perforated plate with a hole size typically 0.5-1mm should then be placed over the stronger frame. This smooth screen will allow debris to slide off easily and prevent small aquatic life forms and insects from entering the suction line. Coanda type screens are even better, and we can supply these.

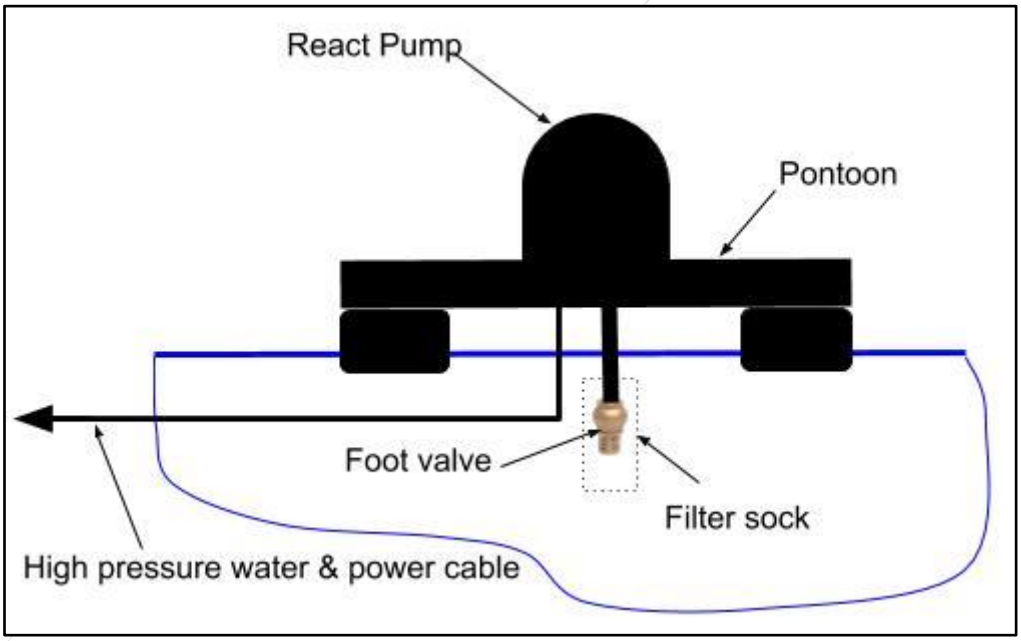
If the flow rate in your resource is below the RP2 peak pumping rate then air may be drawn into the suction pipe. The pump will stop and alarm when this occurs. On sites where the flow varies or the intake filter gets clogged, you may benefit from using a buffer tank and a float switch as described above, to switch the pump off when the water level falls. Do not install a switch on the PV supply wires.

4.2.3. Small pontoon (pond, dam, stream or small lake with changing surface level)



Note the pump should not be allowed to operate unless the foot valve is fully submerged.

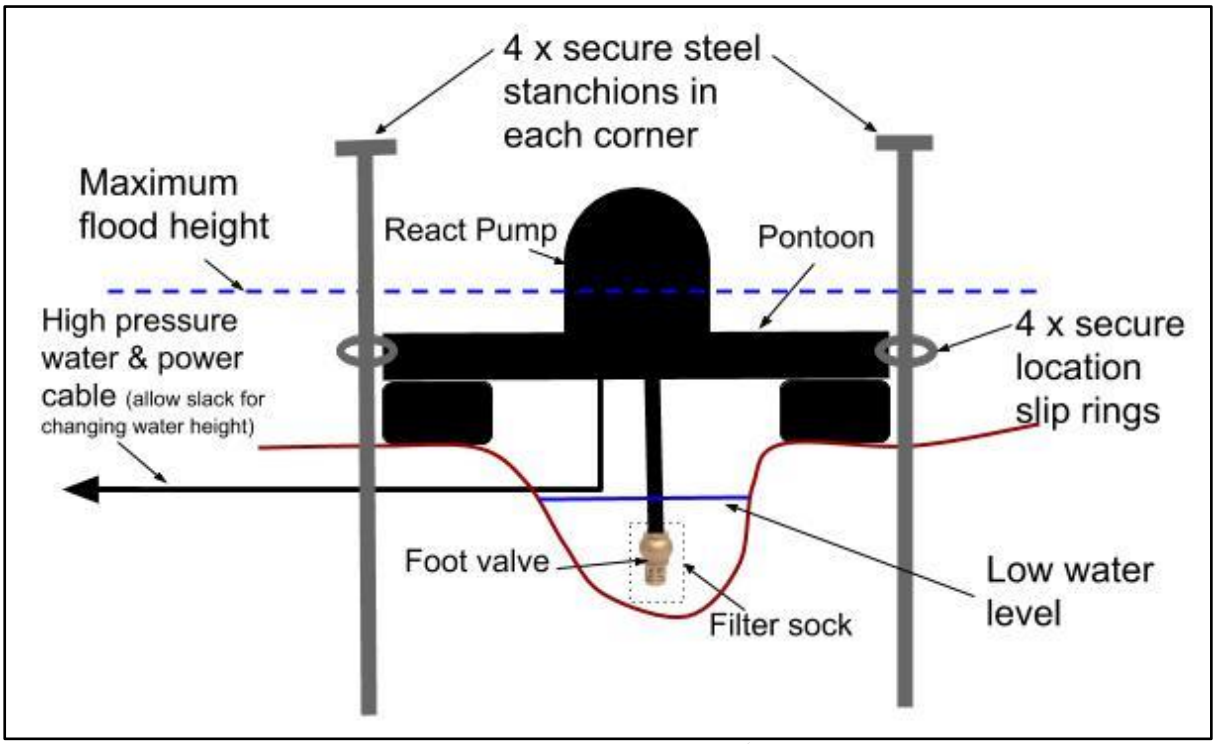
4.2.4. Small pontoon (large water surface with little change in surface level)



Please note that all pontoons used on streams or rivers need to be adequately secured against flood flows, wind and flood debris. For lakes and dams (that are not exposed to such risks) ropes from the pontoon and anchored to the bank are sufficient for the pontoon to maintain its set location against strong winds and water currents.

Pontoons mounted on fast flowing water surfaces need careful consideration as the risk of complete equipment loss in floods events is high. Refer to the next section for guidance on such applications; also talk to your insurance company if you intend to implement such an installation. EcoInnovation is not liable if your pump is destroyed by flood waters.

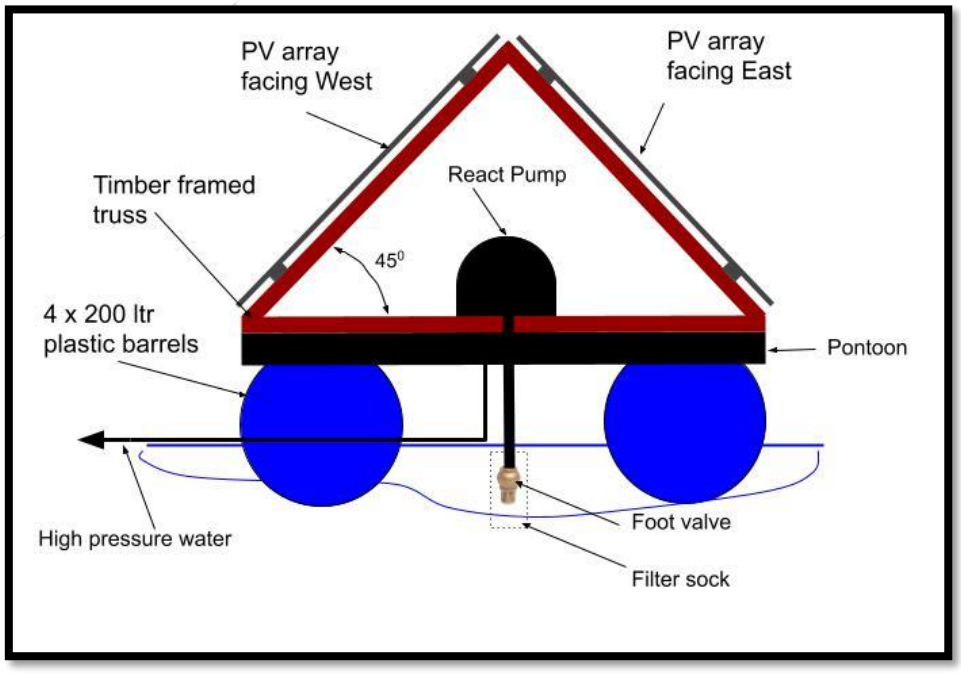
4.2.5. Small pontoon on rivers subject to moderate flooding



Such installations are ideal for small streams and rivers where occasional flood flows breach the wide river banks. Do not install this solution on the following streams and rivers:

- in deep ravines (use the bore pump option that follows)
- subject to large boulders and trees descending in the flood flow
- subject to high flood velocities

4.2.6. Larger pontoon with solar PV and RP2 (large water surface with changing surface level).

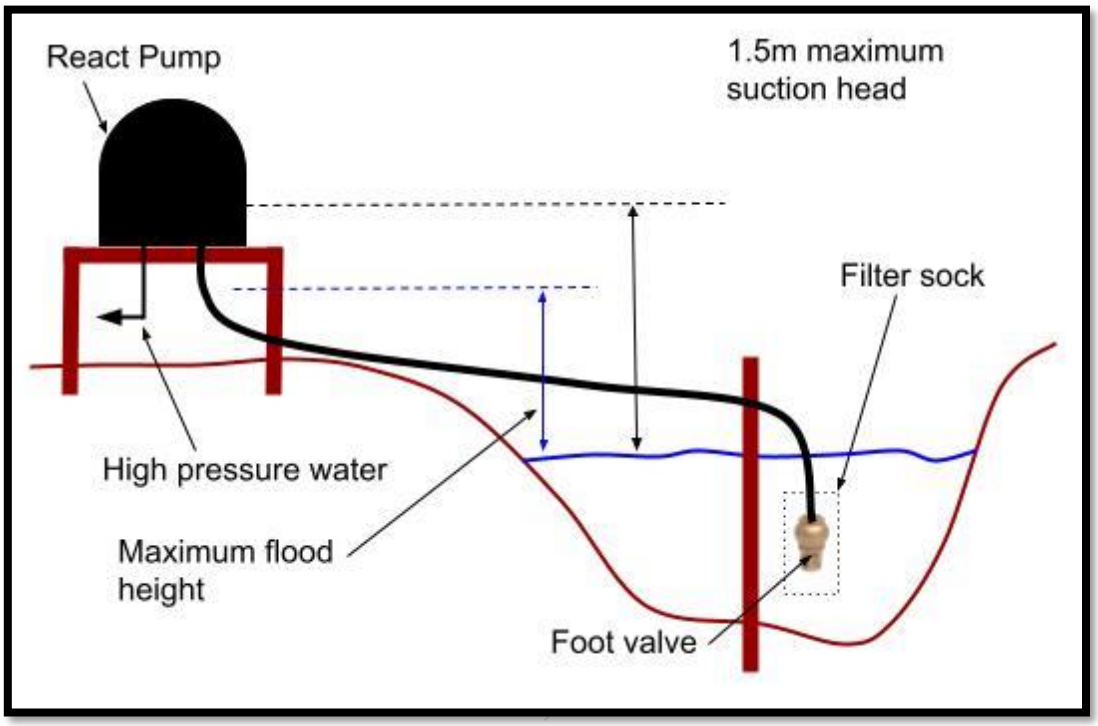


Larger lakes and dams can accommodate the solar PV array on the same pontoon as the RP2. The advantages are:

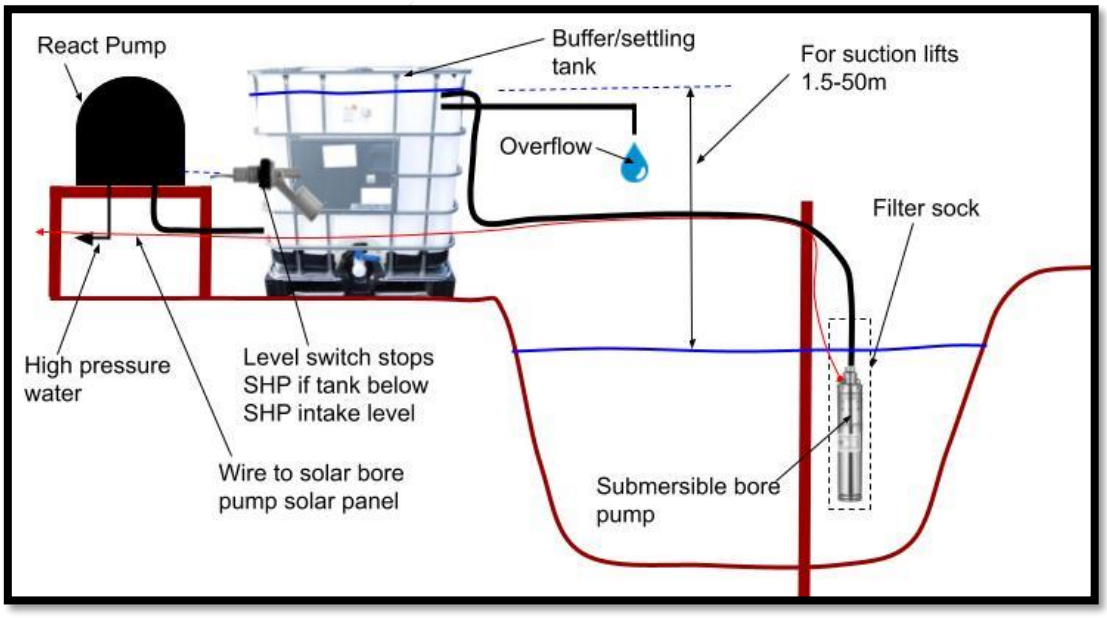
- Large lakes and dams may be relatively shade-free and exposed to all day sun.
- Different orientations of the PV array are very easy to make.
- Pontoons are low cost to make from surplus 200 litre plastic drums and treated timber (both common on farms).
- The PV array does not need any extra fencing to prevent animal damage.
- The PV array can be lower, as long grass shading the panels in not an issue.
- Shade from the pontoon may help to prevent water weeds from growing into the intake foot valve.
- Reflection of sunlight off the water surface can assist solar PV power generation.
- Security of the equipment from theft is improved (although theft is less common these days as PV prices have fallen).
- The power cable is short, reducing cost and improving efficiency.
- PV panel shade on the RP2 casing helps to keep it all cooler.
- The risk of pump damage due to freezing from frosts is lower, as the large water body helps to keep the night time air temperature higher than on land.
- The pontoon can be made off-site in your workshop and taken to site on a trailer when completed.
- Water is always close by to wash the PV panels as needed. PV panel washing can be automated as you have high pressure water available. It is important to keep your PV panels clean at times of peak water demand.

4.2.7. Suction lift (head) up to 1.5m will self-prime

The pump can be ground-mounted at a height **less than 1.5m** above the water surface and it will prime itself (provided the pipeline is empty or the bypass valve is open). This is not advisable where flood levels can reach the pumps and submerge it in water. For best result keep your suction lift (heads) as low as possible.



4.2.8. Submersible pump & settling tank for dirty water supplies from 1.5-50m below the RP2



Note the buffer/settling tank and float switch will accommodate flow variations between the RP2 and the small low cost bore pump while always ensuring a positive head to the RP2.
Note: small bore pumps with external controllers can have an external float switch added to stop the bore pump when the buffer tank is full.

4.2.9. Key parts to a good suction intake design:

- 25mm ID **short** suction hose (a 3m length of suction hoses is supplied with your RP2), install with as little suction lift a possible. It **may be possible** to install on suction heads > 1.5m. If you do this, please read our different terms and conditions of sale - as above 1.5m suction lift we do not advise or support such sites. **So proceed at your own risk.**
- 1 x foot valve with 25mm hose tail, pipe clamp, two filter bags and stainless wire bag frame are supplied with the RP2.
- Steel/timber pegs as required to secure foot valve intake in the vertical position – this peg is not supplied.

The stainless hoop wire frame ensures that the filter bag does not collapse around the foot valve which would reduce the effective filtering area. The large surface area of the filter bag means that it will not need cleaning/replacing that often. If it does need cleaning/replacing often it is likely too small. In this case you will need to make a larger one to better suit your site.

Cut the black cable tie as shown in the picture opposite.

Secure the filter bag with a cable tie as shown below and opposite.

The filter bag should be replaced as required. An intake that needs cleaning every 2-3 months or longer is a realistic goal to work towards in the design of your intake, some fine tuning for your site conditions will often be required.

If after a short duration the filter sock is completely blocked with debris, then fit a larger wire basket and filter sock until an acceptable cleaning duration is achieved.

For reasonably clean water resources the filter screen supplied will work fine and prevent small (< 1mm) aquatic life forms and particles from entering the suction line. With the filter bag removed or damaged the foot valve strainer would quickly block with leaves and grasses.

Dirty water resources are likely to need a larger intake to reduce cleaning intervals.

4.2.10. Filter sock advice

It is surprising how quickly a filter sock can become completely blocked. Once this occurs the suction increases which can lead to cavitation damage, loss of water prime, overheating and pump damage.

We advise a filter sock with a <1mm opening. Two are supplied with each RP2 and 5 filter bag packs are available from our web site.

4.2.11. RP2 pipe fittings supplied

The RP2 is supplied with 30 bar (300m) stainless quick connect type fittings that require no tape to sealing - they are sealed via a silicon face washer and by tightening with spanners. **The threads of these fittings must be coated with anti-seize grease prior to use to avoid damage by galling.**

When the fittings opposite are attached to the pump, both are ¾" BSP female (often called 20mm).
A 25mm to ¾" BSP male hose-tail fitting is supplied for those using the 25mm ID suction pipe supplied.
For the pressure side delivery pipe, you will need to provide a pipe fitting for your pipe size that is ¾" BSP male.

Please note that countries who use NPT threads (mainly North America) that ¾" BSP and ¾" NPT are compatible threads with a suitable thread sealant.

If pumping to >16 bar you must purchase the RP2 HP – it has a high-power upgrade. The RP2 HP has a motor that can delivery 25% more torque and will be limited to a maximum speed of < 1000 rpm. Also ensure that all pipe and fittings that you buy locally are rated for the pressure required on the hottest day expected. High temperature reduces the pressure rating of plastic pipe/fittings. Seek local supplier advice for higher pressure applications > 16 bar.

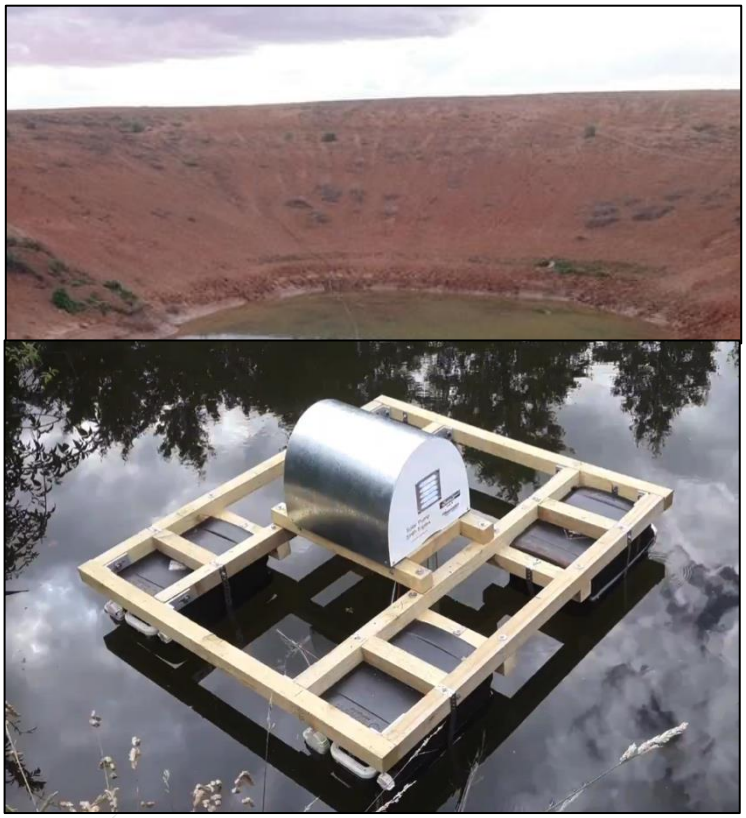
Pipe pressure ratings (working pressure) do include a good factor of safety and bursts are unlikely provided the water temperature is not too high. The picture opposite shows a burst 12 Bar pipe that failed at 16 bar on a very hot day.

Note - all threads must be PTFE tapped or sealed with Loctite thread glue unless the fitting has a silicon face seal.

5. Practical examples of installations

5.1. Pontoon pump system

In flat very dry countries that do not receive regular rain it is common to have very large dams for stock water which fill up every few years as rain allows. Australia is well known for years of drought followed by floods.



An RP2 on a floating pontoon is an easy solution that makes sense because the RP2 is light. Mounting the solar PV array on a larger pontoon also makes great sense.

A pontoon ensures a small and constant suction lift without danger of the pump being submersed by flood water.

The picture opposite shows a typical dam in Australia and a PowerSpout RP2 on a small pontoon made from timber fence battens and 4 x 20 litre UV resistant plastic containers. A black plastic freight pallet also makes a great base for your RP2 pontoon and these are common and often free.

Petrol/diesel pumps are often drowned in flood events as it is not practical to put them on a floating pontoon (as they need refuelling) and are heavy. If you fail to move petrol/diesel pumps quickly during heavy rain they can get drowned in the rising water.

Large petrol/diesel pumps are not well suited for smaller sized long PE pipes due to very high pipe friction losses. Some delivery pipes in Australia are over 20km long and nearly all the pumping head is due to pipe friction.

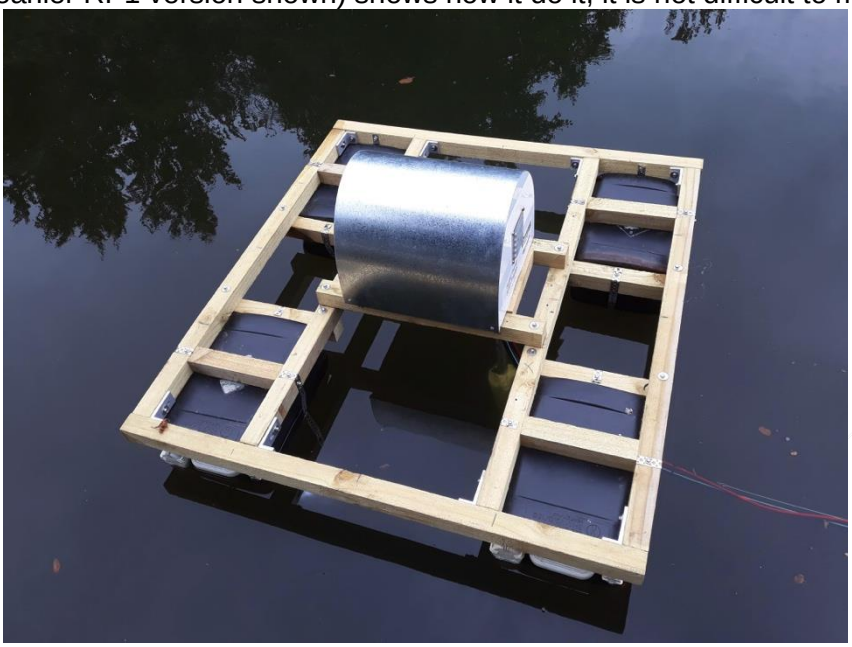
A smaller, solar-powered pump is the perfect answer, because it runs for long hours at lower flow rates so can use smaller lower cost pipe.

RP2s are very light at <20kg (with the fairing removed) and are easily separated from the pontoon. Each part is easy for 1 person to carry.

The PV array is either fixed on level ground above the highest level of the dam or floats on a larger pontoon with the RP2. The waterproof double insulated ELV power cable can be sleeved in LDPE pipe if extra protection from damage is required.

5.1.1. How to make a simple pontoon (1 x RP2)

This picture (earlier RP1 version shown) shows how it do it, it is not difficult to make.



The black floats are from 4 x 20 litre black (HDPE) containers that are good for >15 years in NZ's harsh UV sun. They are common on farms and easy to find on the surplus market for minimal cost.

The timber frame is made from ten 50 x 50 x 1200mm treated fence battens. Every NZ farm has these on hand. It is all held together with angled brackets and stainless Tek screws. It took less than 1 hour to make at a cost of <$50NZ.

The four containers are held in place with perforated stainless straps as shown opposite. 8 small ratchet tie-downs could have also been used.

As a general rule the buoyancy of a 4 float pontoon (mass of water to fill floats) needs to be >2 times higher than the total mass. This it to ensure that should one float leak the pontoon will still float upright with the RP2 above the water line. This will then be observed and the leaking float repaired or replaced.

Mass of pontoon & RP2	Mass of water to fill floats	Ratio
43 kg	88 kg	2.05

5.1.2. How to make a simple plastic pallet pontoon (1-2 RP2s)

Using a surplus plastic black HDPE pallet is even faster to make a pontoon solution. This can be combined with the floats used in the previous example or (in the case of 2 x RP2's) with larger floats, both options are shown below.

These larger floats can hold 33kg of water (EcoInnovation can supply these floats to NZ clients only).

This took less than 20 minutes to make at a cost of <$200NZ (almost all the cost was the new floats) the plastic pallet was obtained for free.

Testing buoyancy of the pontoon prior to connecting: suction pipe, foot valve, filter sock, delivery pipe and power cable

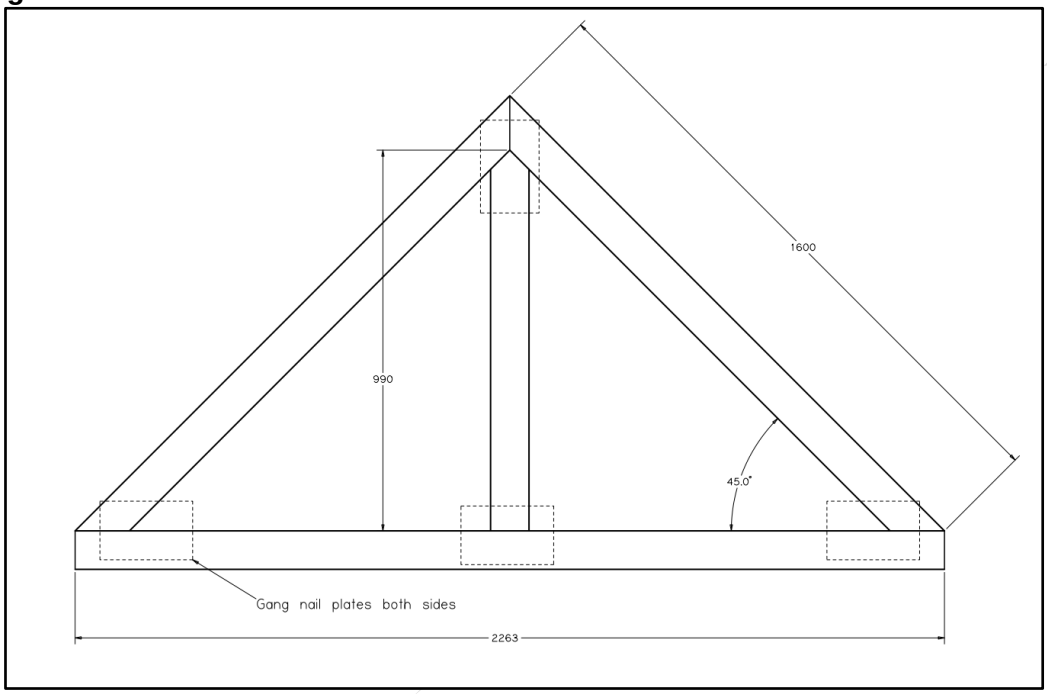
Mass of pontoon & 1 RP2	Mass of pontoon & 2 RP2's	Mass of water to fill floats	Ratio
45 kg	63 kg	132 kg	2.1

5.1.3. How to make a large pontoon for 1 x RP2 and 2-4 PV panels

A large pontoon will take about 8-12 hours to make once all the parts have been secured. A truss is a very strong structure and easily made from treated timber. This truss solution can also be used for a land frame mounted on four (4) treated corner posts.

As there is much more wind loading once the PV is installed, such a pontoon will need to be secured with three (3) triangulated ropes and screw anchors good for 200kg each

Making the trusses



Note the above was designed for 270-280W panels. Larger 300-400W panels will need a larger truss with the side length increased from 1600 to 1800mm.

Make 2 trusses as shown from 100 x 50mm treated timber. You will also need 4 x 2m long 100 x 50mm treated timber purlins to connect the 2 trusses together as shown later.

Note the four 50 x 50 x 1200mm fence battens are used for lateral bracing.
It is all held together with common Tek screws, gang nail plates and angle brackets.

5.1.4. Making the pontoon

In this installation example we already had a pre-existing pontoon (made from 4 x 200 litre plastic drums) that has been used for the last 12 years as diving platform.

As you can see this works fine, the plastic drums are less than 40% submerged.
The trussed frame was then slid onto the pontoon and attached with angle brackets.
In this case the panels were attached to the timber frame with stainless steel builders strap.
Professional installers are more likely to use aluminium PV mounting rails to replace the timber rails. PV panel mounting is then faster but at higher material cost than illustrated above.

The pontoon was made as follows:

- 4 x 200 litre plastic drums.
- Treated timber frame that located each drum (made from 100x50 timbers).
- Two stainless steel wires at each drum end to secure them in place (made tight with turnbuckles). Ratchet tie-downs are also a good option.

Note our drums had a lip at each end that prevents the stainless wires from sliding off.
Locate this drum type if you can.

5.2. How to make a ground mounted 1200-1600W array

A ground mounted East/West installation using the same trussed frame was then permanently installed close to our factory to illustrate the process.

All that is required are 4 large farm strainer posts securely mounted.
Strainer posts are H4 treated pine normally 150-200mm diameter in lengths 2.1, 2.4, 2.7 and 3.0m.

If you own a tractor mounter post hole rammer and the ground is suitable for rammed posts then this is a fast solution.

4 posts rammed 1.2m into firm ground will normally provide sufficient uplift restraint and lateral bracing for this structure not to work loose due to repeated wind loads.

Otherwise, you can concrete in shorter posts at 1m deep with sufficient concrete mass to resist uplift forces.

If these foundation posts have any tendency to rock (or work loose over time) then diagonally brace them to each other. Structures higher off the ground (so that large animal cannot cause panel damage) will need bracing.

In our example we only have sheep in the field, so used 4 x 2.1m posts concreted 900mm into the ground. There is good clearance under the trussed frame for the sheep to graze and seek shade on a hot summer day.

5.2.1. Dig holes and position the 4 corner posts as shown

Posts are 2.1m long, 0.9m in the ground and dry mix concrete rammed to secure in place.

5.2.2. Position trussed frame

Bolt or use several long Tek screws to secure truss at each post location.
The late afternoon shadow confirms the trussed frame is mounted East/West.

5.2.3. Aluminium rail mounting

To make the mounting of the PV panels quick and easy to do, we used short offcuts of aluminium mounting rails as shown. These offcuts can normally be purchased from PV install companies for $2/kg.
The PV panel fixing clamps fit into this rail.

If you prefer, you can use 4 aluminium rails to replace the timbers rails completely but this will cost a little more to do.

Or you can secure the PV panels like we did in the pontoon example with stainless straps.

5.2.4. Completed East/West array

5.2.5. How to land mount the RP2

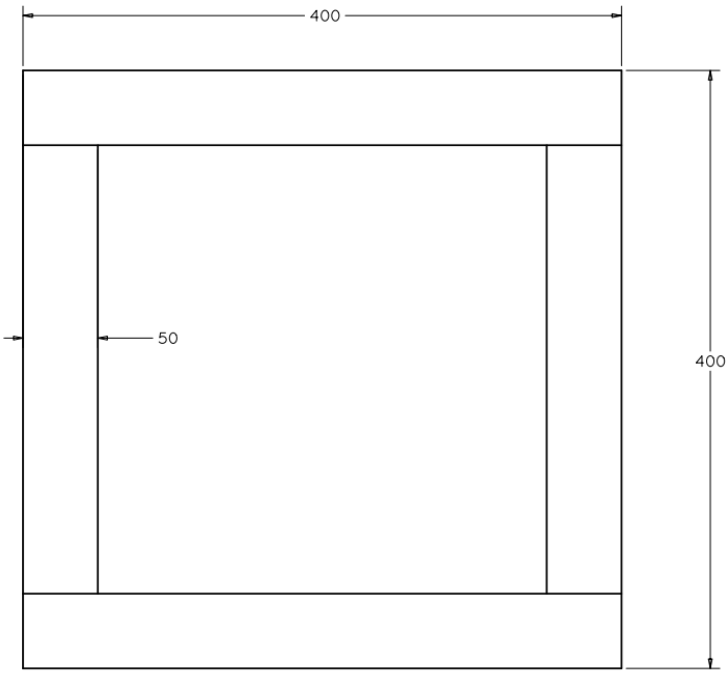
If your water resource:

- Does not allow for a gravity feed solution
- Does not easily allow for a pontoon solution
- Has a suction lift <1.5m **(the lower the better)** and is not prone to high flooding
- Is in a deep ravine and you intend to use a submersible lift pump

Then the instructions that follow illustrate how to install the RP2 on land.

5.2.6. RP2 base

You will need to make a treated timber base for your RP2. The base is square and 400x400mm.



This RP2 base is easy and quick to make from:

- 1 x 100x50x1400mm timber
- 4 x 100mm long stainless Tek screws

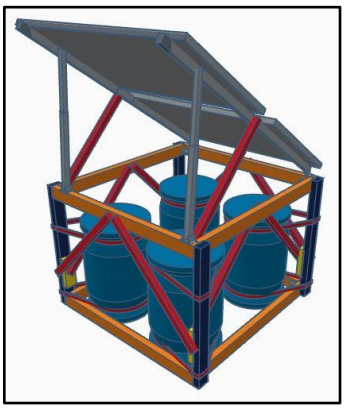
The base is them mounted at the desired location. This must be:

- within 1.5m vertical of the water resource
- in a shady location
- if not in a shady location then in a suitable pump shed

5.2.7. Where ground foundations are not possible

If, at your site, the ground is too rocky for ground post foundations then you can consider 4 x 200 litre plastic drums filled with water (common surplus items on farms) secured to each corner of your frame with two ratchet tie-downs (as shown) to prevent the wind from blowing over the frames. For high wind sites fit and secure a fifth drum in the centre position.

You can also use old plastic (or steel) drums. Fill them will local rocks and concrete. These very heavy drums then become the corner foundation masses for your structure.
You may want to position a timber or steel post in the middle of the drum (while it is packed with rocks and concrete) to provide a location point for the frame or truss that will carry your PV array(s). You can use the truss method for an East/West array as detailed earlier.



6. Pipe size selection

PE pipes are the obvious choice for the PowerSpout RP2 because of the range of available sizes, pressure ratings and lengths and the fact that they are durable, low cost and commonly available.

6.1. Selecting suitable delivery pipes (from RP2 to tank)

Pipe friction (depending on both the flow rate, pipe size and length) will add to the static pressure resulting in a higher "dynamic head" at the RP2. Dynamic head is the sum of the vertical height (static head) and the friction head (due to pipe friction). Your RP2 will self-optimise to produce maximum flow as it comes with maximum power point tracking (MPPT) software. If more power is available the pump speed is increased, less power the speed is decreased.

If you incorrectly calculate your dynamic head and install a delivery pipe which is rated for a pressure sufficient for only your static head, then your pipe may burst in hot weather.
Such an error will not damage the RP2 as it can operate to 300m head.
Start by measuring:

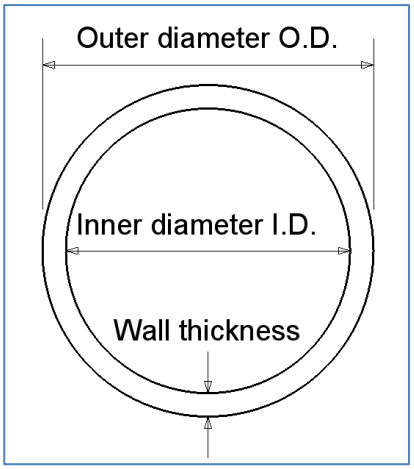
- the suction lift at your site from water surface up to RP2 centre (is it less than 1.5m?).
- the lengths of your suction and delivery pipes.
- the height of your header storage tank above the RP2 (static head).

Based on the tables provided in this document you will need to select, purchase, and install the correct suction and delivery pipe sizes. Your supplier will be happy to help you with this. If in doubt always go up a size to keep your options open for more future pumping capacity. Pipes will also foul over time with fine sediments and this can increase the pipe friction head on long pipe runs over time.

Every site is different, so the design process is worth doing, and the measurement of head is key. However, if you get your site data wrong, the RP2 will work just fine so long as your pipe does not burst.

6.1.1. The difference between internal (ID) and outer diameter (OD)

Inside diameter is critical for calculation of pipe friction loss since a variation of as little as 1mm can have a very significant effect on the friction head loss, which increases the dynamic head and hence reduces the output flow of the RP2. Your pipe can rupture if you make a gross error in pressure calculation.



A given pipe size based on "outer diameter" OD is often available in a number of pressure ratings and the actual "inner Diameters" IDs will not be the same. Pipes that have the same OD but different IDs due to differing wall thickness are referred to as being in the same NB (nominal bore) size classification. Bore means inner diameter but nominal bore is the not the same as actual ID.

But you need to find out the exact ID of your pipe because this will determine the head loss.

6.1.2. Quick guide to finding the best pipe with a single RP2

You need to know rough figures for your vertical rise (static head), and your pipe length.

1. Find the entry on the left that is closest to your static head.
   (For example if your head is between 63-104m then choose 83m).
2. Find a pipe size (Internal diameter!) that you can buy in the yellow box. (Say 25mm.)
   (If you are using two RP2s then choose one of the larger green pipe sizes instead.)
   Ask your pipe supplier for a list of specifications (see examples below), with diameter, wall thickness and pressure rating.
3. Based on your chosen row for the head, and the column for the pipe size, find the pipe length for 20% loss (83m and 25mm pipe gives 1042m)
4. If your pipe is shorter than this length, your loss will probably be under 20%, so this internal diameter choice will be fine. If your pipe is longer then consider using a larger pipe size.

Choosing a suitable Internal Diameter		Pipe lengths with 20% pressure loss (longer pipes will have more than 20%)											
		Pipe IDs for single SHP pump											
Vertical rise or Static head	Peak flow per pump approx.	19mm	20mm	21mm	22mm	23mm	24mm	25mm	26mm	27mm	28mm	29mm	30mm
		Pipe IDs for twin SHP pumps flow											
		25mm	26mm	27mm	29mm	30mm	31mm	33mm	34mm	35mm	36mm	38mm	39mm
42m	16 l/min	128m	163m	208m	260m	321m	397m	463m	556m	694m	833m	926m	1190m
83m	15 l/min	287m	370m	463m	575m	725m	877m	1042m	1282m	1515m	1852m	2083m	2381m
125m	15 l/min	431m	556m	694m	862m	1087m	1316m	1563m	1923m	2273m	2778m	3125m	3571m
167m	14 l/min	654m	833m	1042m	1282m	1587m	1961m	2381m	2778m	3333m	4167m	4762m	5556m
208m	13 l/min	926m	1190m	1488m	1894m	2315m	2778m	3472m	4167m	4630m	5952m	6944m	8333m
250m	12 l/min	1282m	1613m	2083m	2500m	3125m	3846m	4545m	5556m	7143m	8333m	10000m	12500m

If the pipe cost is low, then err on the side of using a larger pipe, to reduce losses.
If the pipe cost is a large part of the project budget, then you may wish to tolerate higher losses to reduce pipe cost.

6.1.3. Pipes commonly available from Rural Direct in NZ

Pipe OD Mm	Pipe ID mm	Material	Pressure rating PSI	Pressure rating M	Pressure rating kPa	Pressure rating Bar
17	15	LDPE	130	90	900	9
25	20	LDPE	116	80	800	8
25	22	MDPE	130	90	900	9
25	21	MDPE	180	125	1250	12.5
32	25	LDPE	94	65	650	6.5
32	28	MDPE	130	90	900	9
32	27	MDPE	180	125	1250	12.5
38	32	LDPE	72	50	500	5
40	35	MDPE	130	90	900	9
40	34	MDPE	180	125	1250	12.5

The above table will assist you with commonly available pipe ID sizes in NZ.
Pipe with pressure ratings up to 160m and higher are available, but not as common.

6.1.4. The IPLEX pipe range of LDPE/MDPE/HDPE pipes

This is the IPLEX pipe range. Pressure ratings are 60, 90, 125,160, 200 & 250m rated.

		Greenline (370 Series)		Redline™ (360 Series)		Rural Black (340 Series)		BlacklinePN16 (3500 BTS Series)		BlacklineHPPN20 (3500 B Series)		BlacklineHPPN25 (3500 B Series)	
		Bar	PSI	Bar	PSI	Bar	PSI	Bar	PSI	Bar	PSI	Bar	PSI
Pressure Rating *	20	9	131	12.5	182	✗	✗	✗	✗	✗	✗	✗	✗
	25	8	116	12.5	182	✗	✗	16	233	✗	✗	✗	✗
	32	8	116	9	131	12.5	182	16	233	✗	✗	✗	✗
	40	6.3	91	9	131	12.5	182	16	233	✗	✗	✗	✗
	50	6.3	91	9	131	12.5	182	16	233	✗	✗	✗	✗
	63	6.3	91	9	131	12.5	182	16	233	20	291	25	364
	75	✗	✗	✗	✗	12.5	182	✗	✗	✗	✗	✗	✗
	90	✗	✗	✗	✗	12.5	182	16	233	20	291	25	364
	110	✗	✗	✗	✗	12.5	182	16	233	20	291	25	364

Iplex approx. pipes **costs (in 2020):**

- Redline 125m rated 25mmOD (20NB) pipe $1.94 NZ/m
- Redline 90m rated 32mmOD (25NB) pipe $2.04 NZ/m
- Redline 90m rated 40mmOD (35NB) pipe $2.69 NZ/m

6.2. Example of the full calculation to predict pressure loss at a higher accuracy

The example that follows will help you to work out in detail a suitable pipe size for a system that uses just one RP2 per pipe. We have a pipe efficiency target of 20% friction loss at peak flow as a starting point.

Remember that you can vary the pipe pressure rating along the length of the run to minimise costs. For example, if you have a 160m delivery head you start with high grade (16 bar) pipe at the RP2, 12 bar, then 9 bar and finally 6 bar. Laying 16 bar pipe all the way can almost double the cost of the delivery pipeline to your tank. You can use the table below to calculate the friction head ("head loss") in your pipe for a given pipe ID.

Site data (Northland NZ):

- Lift to tank 80m (plus 2m height of tank =82m) + 20% for pipe friction = 98.4m.
- Distance 1000m.
- Summer flow requirement less than 5,000 litres/day.
- Grade is relatively constant.
- Initially assume pipe friction head = 20%.

From the peak flow table (right) at 100m head the RP2 can do 15 L/min (round to nearest L/min)

The table on the next page tells us how much pressure will be lost per 100m of pipe run.

Head	Peak L/min
50	15.79
100	15.24
150	14.56
200	13.81
250	13.10
300	12.40

6.2.1. Head loss in m per 100m length of new smooth bore plastic pipe

Flow l/min	Smooth new plastic pipe ID in mm																					
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
10	2.9	2.2	1.8	1.4	1.2	0.9	0.8	0.6	0.5	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
11	3.4	2.6	2.1	1.7	1.4	1.1	0.9	0.8	0.6	0.5	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
12	3.9	3.1	2.4	2.0	1.6	1.3	1.1	0.9	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1
13	4.5	3.5	2.8	2.2	1.8	1.5	1.2	1.0	0.9	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1
14	5.1	4.0	3.2	2.6	2.1	1.7	1.4	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1
15	5.8	4.5	3.6	2.9	2.3	1.9	1.6	1.3	1.1	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2
16	6.5	5.1	4.0	3.2	2.6	2.1	1.8	1.5	1.2	1.0	0.9	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2
17	7.2	5.7	4.5	3.6	2.9	2.4	2.0	1.6	1.4	1.1	1.0	0.8	0.7	0.6	0.5	0.5	0.4	0.3	0.3	0.3	0.2	0.2
18	8.0	6.3	5.0	4.0	3.2	2.6	2.2	1.8	1.5	1.3	1.1	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.3	0.2
19	8.8	6.9	5.5	4.4	3.5	2.9	2.4	2.0	1.7	1.4	1.2	1.0	0.9	0.7	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.3
20	9.6	7.5	6.0	4.8	3.9	3.2	2.6	2.2	1.8	1.5	1.3	1.1	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.3
21	10.4	8.2	6.5	5.2	4.2	3.4	2.8	2.4	2.0	1.7	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3
22	11.3	8.9	7.0	5.6	4.6	3.7	3.1	2.6	2.1	1.8	1.5	1.3	1.1	1.0	0.8	0.7	0.6	0.5	0.5	0.4	0.4	0.3
23	12.2	9.6	7.6	6.1	4.9	4.0	3.3	2.8	2.3	1.9	1.6	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4
24	13.2	10.3	8.2	6.6	5.3	4.4	3.6	3.0	2.5	2.1	1.8	1.5	1.3	1.1	1.0	0.8	0.7	0.6	0.6	0.5	0.4	0.4
25	14.2	11.1	8.8	7.1	5.7	4.7	3.8	3.2	2.7	2.2	1.9	1.6	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.4
26	15.2	11.9	9.4	7.6	6.1	5.0	4.1	3.4	2.9	2.4	2.0	1.7	1.5	1.3	1.1	1.0	0.8	0.7	0.6	0.6	0.5	0.4
27	16.2	12.7	10.1	8.1	6.5	5.3	4.4	3.7	3.1	2.6	2.2	1.9	1.6	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.5
28	17.3	13.5	10.7	8.6	7.0	5.7	4.7	3.9	3.3	2.7	2.3	2.0	1.7	1.5	1.3	1.1	0.9	0.8	0.7	0.6	0.6	0.5
29	18.4	14.4	11.4	9.2	7.4	6.1	5.0	4.1	3.5	2.9	2.5	2.1	1.8	1.5	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.5
30	19.5	15.3	12.1	9.7	7.9	6.4	5.3	4.4	3.7	3.1	2.6	2.2	1.9	1.6	1.4	1.2	1.1	0.9	0.8	0.7	0.6	0.6

(The table above is sufficient for sizing pipe systems with 1-2 RP2s installed. For larger RP2 installs seek manufacturer advice.)

We only have 2 options we can buy: pipe with ID just over 20mm (20NB) and those just over 25mm (25NB).

Let's consider them both. Looking at the above table, for every 100m of 20mm ID pipe at 15l/min we have 4.5m of extra friction head. Can you locate the 4.5m on the table above? When you can find this figure at the intersection of the 15 L/min row and the 20mm ID column, then proceed to read what follows.

- Dynamic head on 20mm pipe = 82 + 10x4.5 = 127m
- Dynamic head on 25mm pipe = 82 + 10x1.6 = 98m

We first decide to use 25NB (from Rural Direct) pipe that has a common 32mm OD. This comes in 3 pressure grades suitable for our site: 65m (25mm ID), 90m (28mm ID) and 125m (27mm ID) rated. The lower pressure ratings are fine for the upper stretches of pipe.

25NB pipe example

Pipe needed	Pipe ID mm	Friction head per 100m roll	Total
2 x 200m rolls of 125m rated pipe	27mm MDPE	1.1m	4.4m
2 x 200m rolls of 90m rated pipe	28mm MDPE	0.9m	3.6m
1 x 200m roll of 65m rated pipe	25mm LDPE	1.6m	3.2m
		pipe friction head	11.2m

So the calculated head is 82m static lift + 11.2m pipe friction head = **93.2m**. Head loss is about 14%, this is less than the 20% we initially allowed for so all is well. If it was over 20% we would need to go up another pipe size.

Let us now look at a 20NB pipe example for comparison

Pipe needed	Pipe ID mm	Friction head per 100m roll	Total
2 x 200m roll of 125m rated pipe	21mm MDPE	3.6m	4.4m
2 x 200m rolls of 90m rated pipe	22mm MDPE	2.9m	3.6m
1 x 200m rolls of 80m rated pipe	20mm LDPE	4.5m	3.2m
		Pipe friction head	35m

So the calculated head is 82m static lift + 35m pipe friction head = **117m**. Headloss for 20mm pipe is about 42%

The reality is that pumping to 93.2m or 117m would not make a large difference in the L/day yield for the following reasons:

- Pipe flow will rarely be at 15L/min (so friction head is less in reality), this reduces the dynamic head on the smaller pipe to a greater extent than the larger pipe.
- The RP2 pump is more efficient on higher lifts.

It all depends on the relative pipe cost while taking account of the fact that smaller pipe will have higher losses may require a higher pressure rating. If the quote for the 1000m of 20NB pipe is much less than the 25NB pipe then maybe go for the cheapest option. If there is say less than 20% in it go for the larger pipe. The larger pipe does keep your future options open.

If in doubt (and funds are available) we would always recommend using a larger pipe size, given that pipes will become fouled over time and so the friction (head-loss) will increase. A decision must be made based on:

- the required flow rate
- the relative costs of pipe at the calculated dynamic pressure
- your future options

6.2.2. Onsite flow test (25 NB)

On a typical day at midday in January we measured 20 litres in 80s = 15 l/min
Here is the pressure gauge (25NB pipe example):

- Dynamic pressure = 980kP = 100m (calculated 82+11.2 = 98.2m)
- Static pressure = 820kPa= 82m

The initial static head estimate by the client was very close, dynamic pressure ended up as 100m @ 15 L/min in agreement with the calculations.

6.3. The suction (water supply to pump) pipe

Suction head must **not exceed** 1.5 metres if you want the RP2 to self-prime (with an empty delivery pipe **or with the bypass valve open**). **We advise you to gravity feed if you can, if you cannot then you must keep your suction lift under 1.5m.**

Gravity feed is best if possible (no suction at all). See the next section for intake design and RP2 priming issues in detail.

Multiple RP2s can share the same intake line but only if the water can gravity feed to the RP2. Otherwise every RP2 at the same site should be fitted with its own separate suction hose and foot valve to ensure a high reliability factor.

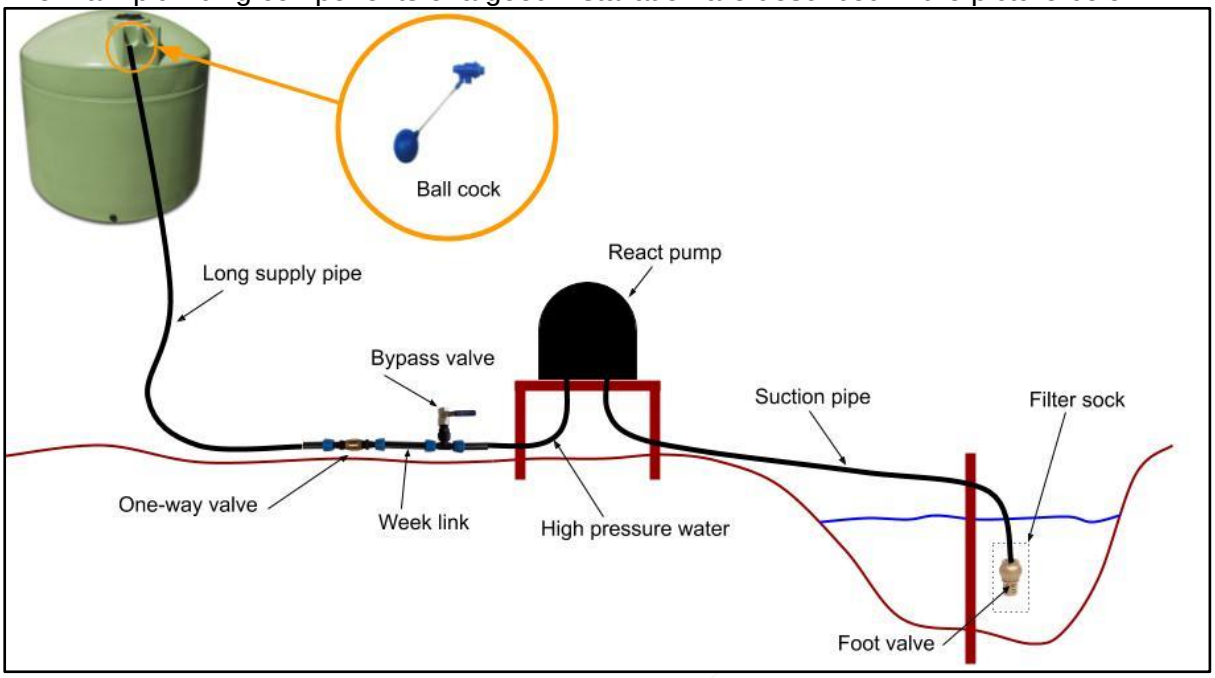
We supply each RP2 with a 3m length of 25mm ID clear suction hose, foot valve and pipe fittings. On suction lift sites use a clear suction pipe, so you can observe:

- Water in the pipe.
- Air bubbles that may indicate a leaking joint, pinhole in the pipe or cavitation.
- Growths in the pipe such a snails and algae (clean or replace the suction hose as needed - we advise every year).

7. Commissioning the system

7.1. Installation plumbing of the RP2

The main plumbing components of a good installation are described in the picture below.



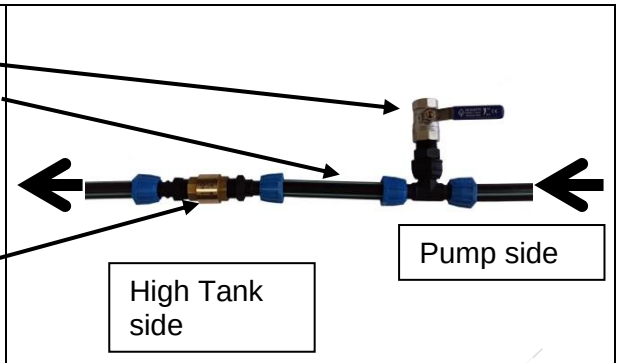
The key points to a good RP2 installation are as follows:

- Keep the RP2 as low as possible to allow for gravity feed or to keep the suction lift as low as possible.
- Ensure that vegetation is prevented from growing into the RP2 and clogging the vents. (Cover the area under the RP2 motor with concrete or corrugated steel.) Dry vegetation around the RP2 can be a fire hazard.
- Secure the RP2 to the ground with steel or timber pegs
- If exposed to freezing temperatures, ensure that the RP2 is mounted in a suitable enclosure to prevent freezing.
- You must protect the RP2 from excessive solar heat (pump shed or locate in permanent shade - this will help to keep the pump cool in the summer heat).
- Protect all ELV wires in suitable conduit if they are likely to be damaged.
- Protect the RP2 from potential animal damage with an electric fence and/or pump shed.
- In high fire risk areas, mount on a concrete base and cover with a vented metal fire enclosure.
- Seal all threads with sealing tapes, compounds or seating washers to ensure no leaks.
- Fill the pump body with clean SAE15W/40 **to the top of the indicator glass.**
- Secure pipes and cables with saddles and cable ties as needed.
- Protect the DC switch from UV and direct rain by mounting it under the PV array for extra protection.

7.2. Important pressure side connections to the RP2

Final plumbing connections after RP2:

- Bypass valve (**NOT supplied**)
- Week link or pressure relief valve at your pipe pressure rating (**NOT supplied**)
- One-way valve (supplied with RP2 with 3/4" (20mm) female thread – pipe fittings shown not supplied)



The detail above is very important and often missed by DIY installers

7.2.1. Stainless steel mac unions

When using the stainless steel mac unions supplied:

- Apply anti-seize grease on the treads.
- Do not over tighten - Hand tight or light use of a spanner/poly-grips.
- Be careful not to lose the silicone washer – this can easily drop out when disconnecting.
- Support pipes to reduce side load on connections.

7.3. RP2 Components

In order to reduce the length of this installation manual, instructions on how to service and re-assemble the RP2 are in a separate video.
Click here for the RP2 videos (note we are still in the process of updating our service videos the new RP2).

NEVER work on your RP2 while it is in operation.

7.3.1. RP2 Protection

RP2's arrive fully assembled, other than oil and final pipe fittings.
The RP2 is encased in a durable housing, ensuring all internal parts are protected from rain, rodents, children and UV. **This housing does not provide freezing protection, the installer must make provision to ensure that the RP2 is not exposed to freezing temperatures.**

7.4. Commissioning procedures

7.4.1. Checks with cover off - before start-up

These tests ensure you have completed the plumbing connections and have no leaks.
By this stage you should have:

- Installed the suction (foot valve and filter sock) or a gravity feed intake pipe.
- Securely attached the RP2 to a suitable base above flood level.
- Connected the RP2 suction and delivery pipes.
- Connected the delivery pipe to the tank with a ball cock fitted (inside the tank) if you want to RP2 to turn off when full.
- Filled the RP2 with SAE15W/40 oil **to the top edge of the level glass**.
- Manually primed the RP2 suction line - if required. If your pipeline to tank is already full of water you will need to open the bypass valve to purge out trapped air before closing again. The RP2 will normally self-prime with an open bypass valve. The RP2 may not self-prime is your pump has worn seals or worn head valves.
- Check the PV switch is in the off position and then connect the RP2 MC4s to the PV wires from the switch.
- Secured all protective fairings.

7.4.2. Commissioning the RP2

- Check that there is sunlight on the solar panels.
- Turn the RP2 on at the on/off switch.
- Provided you have good sunshine on the panels the RP2 will start to rotate.
- It will spin fast at first, and there should be little noise.
- As the delivery pipe fills with water and the backpressure builds up, the RP2 will steadily slow in speed.
- While the pipe is filling keep an eye on the RP2 pipe fittings for any leaks.
- Turn off and fix them if observed.

If the delivery pipe is already filled with water following a service or repair. You will need to open the bypass valve for air to purge from the RP2. After 15-30s of observed water flow this valve can be closed.

Once the sun gets too low in the sky there is not sufficient power for the pump to continue to work then it will stop. It may still attempt to start (clicking noises) but will in due course stop completely. Likewise, on sunrise the pump will attempt to start and in due course will run continuously increasing speed with sun intensity.

7.4.3. How to disable/enable the pumps pressure sensor

Only disable the pressure sensor if you do not need to use it or as a short-term work around if you want to continuously pump while you wait for a replacement sensor.

Make sure you remove the ballcock from the tank or any other valve that could block the outgoing water, otherwise the pump pressure may burst the pipe.

To disable the pressure sensor:

1. Unplug the pressure sensor.
2. Hold down the button until the Status LED changes from solid blue to flashing red and then finally to flashing blue (about 10 seconds). Then release the button.
3. The pump will now run without the pressure sensor.

To enable the pressure sensor (follow the same procedure as setting the system pressure):

1. Plug in the pressure sensor.
2. Turn the On/Off switch On.
3. While the pump is running, and the delivery pipe to the tank is full, hold down the button until the Status LED changes from solid blue to flashing red and then finally to flashing blue (about 10 seconds). Then release the button.
4. The status LED will flash once every 5 seconds to show that the pressure sensor is active.

7.4.4. Trouble shooting commissioning problems

Every RP2 is tested on our test rig at a 160m working head of pressure (HP models to 300m). If it has been correctly installed but fails to operate then these are the most likely causes:

- RP2 was damaged in freight.
- Wrong size and/or voltage PV panels have been used.
- All 4 PV panels have been connected in series - resulting in a higher voltage that has damaged the RP2 – contact your supplier for help/advice.
- All 4 PV panels have been connected in parallel - resulting in a low voltage – fix the wiring error, this mistake will not cause any damage to the RP2.
- Your solar radiation level is too low because of the weather, you live close to the poles or it is night time.
- You did not push the MC4 crimped metal components into their plastic housings until they clicked. They need to be pushed fully home or else the electrical connection can be compromised.
- The On/Off switch on the RP2 is turned off or the DC switch by the PV array is turned off.
- You fitted a float level switch incorrectly. Attach float switch wires after initial commissioning has been completed - then you have fewer sequential problems to deal with.

See next page for a table of problems and suggested solutions.

7.5. Commissioning checks

It is important to formally commission the RP2 and associated system to ensure it is working correctly prior to leaving the site for the day. It may take another day on site to test everything because by the time you have completed the RP2 installation the sun may be too low in the sky to test correct operation.

7.5.1. Operating checks

- Check that the intake is submerged or has surplus overflow water.
- Check for any leaks on the delivery pipe and fittings.
- Check for any leaks on the suction pipe and fitting (visible air bubbles).
- Check for any excessive vibrations.
- Check for any signs of an oil leak.
- Check flow to your tank is in the expected range for the sunlight conditions and time of year.
- Check and adjust the operation of any float switches or pressure settings.

Note that the pump will stop from time to time to do a new Voc test – this is normal it is not a fault.

7.6. Record the facts!

Please now fill out the form at the end of this document for future reference.

7.6.1. Troubleshooting

Problem	Check
RP2 does not start.	Is it daytime? It will not start with poor light. Is the solar panel DC switch turned on? Is RP2 On/Off switch turned on? Is the tank full and the pump waiting (Status LED will slow flash blue). Have the MC4 connectors been pushed fully home?
RP2 does not start and blue blinking light is on during the day, water tank is not full.	Pressure sensor has likely been damaged by freezing or failed – it is a consumable part. You can get the pump going again by disconnecting the pressure sensor, clearing the error LED and disabling any ballcock in your header tank. A spare pressure sensor is sent with every new RP2. Order a new sensor (so you always have a spare) and improve the frost protection of the pump installation to avoid a repeat of the issue.
RP2 stops and starts every 20s.	There is not enough light to run. Wait for more sun. It should then start and run fine.
RP2 stops for a few seconds every 60 minutes and the LED goes briefly to red before restarting as normal.	The RP2 will stop from time to time to do a new Voc test – this is normal, it is not a fault.
RP2 stops when sun goes behind a cloud but then restarts at a lower speed.	This is normal, all is well. Varying power levels can be too low at times for it to run.
RP2 is spinning quickly but no water is being pumped.	Open the bypass valve. Prime the RP2 manually if necessary. Check suction line hose clamps for leaks. Check for pin hole leaks in the suction hose. Check foot valve/intake is still under water. If you cannot resolve the issue turn off the RP2 and seek assistance. Pump may need new water side seals, or you may have debris stuck under the valves in the brass head.
Suction head is more than 1.5m and the RP2 will not hold prime, what do I do?	Modify your site to have less suction head by lowering the RP2 to be closer to the water resource. Fit the RP2 on a floating pontoon if possible or fit a submersible lift pump.
The RP2 is dead. It was running fine and none of the issues listed above are the problem.	In NZ return to EcoInnovation for repair/service. International clients contact your dealer who will contact us for advice.
RP2 went under water in a flood and no longer works.	In NZ return to EcoInnovation for repair/service. International clients contact your dealer who will contact us for advice.
I started to install the RP2 but have realised that I do not have the skills to complete the job	Seek out local experts in pumping and solar PV and provide them with this manual. For online support contact your dealer for advice or book an online consultation.
I have installed it exactly as per the manual, but it does not work, can you help?	Return the RP2 for to us to test operation again. If the unit has been damaged by overvoltage, then it will have to be returned for repair.

	Note this can only happen if all panels are connected together in series and not as advised in this document. If you did in your haste connect all panels in series, then the BLDC and microprocessor will have been damaged. International clients please contact your dealer for advice.
I got the wires from the switch box to the RP2 the wrong way around, and after correcting this mistake the RP2 will not work.	In NZ return to EcoInnovation for repair/service. International clients contact your dealer for advice. The BLDC and/or microprocessor may have been damaged.
My pump ran fine. I had it turned off and in dry/warm storage all winter. When I re-installed it in the spring it would rotate but will not prime or deliver any pressure.	We have noted in some cases, chemical dust in farm winter stores has contaminated the suction side valves gluing them shut. Check these 3 valves. When you next store the RP2, let it dry out then put it in a bag to prevent such contamination. 

7.6.2. Documentation as per AS/NZS 5033

The PV system installer shall prepare the following documents and a copy shall be provided to the PV system owner:

(a) A list of equipment supplied.

(b) A list of actions to be taken in the event of an earth fault alarm.

(c) The shutdown and isolation procedure for emergency and maintenance.

(d) A basic connection diagram that includes the electrical ratings of the PV array, and the ratings of all overcurrent devices and switches as installed.

(e) System performance estimate.

(f) Recommended maintenance for the system.

(g) Maintenance procedure and timetable.

(h) The commissioning sheet and installation checklist.

(i) Array frame engineering certificate for wind and mechanical loading.

(j) Installer/designer's declaration of compliance declaration to Clause 2.2.

(k) Warranty information.

(l) Equipment manufacturer's documentation and handbooks for all equipment supplied.

(b) is not relevant for ELV systems in NZ

Note the "PV system installer" is the farmer/owner if they install it themselves. The above is a mandatory requirement for LV systems. As your system is ELV the above can be regarded as good practice. To comply with good practices the installer shall prepare and retain these documents. This manual meets all the above requirements.

7.6.3. Labelling for disconnection devices as per AS/NZS 5033

5.5.2 PV array disconnecting device

The PV array d.c. switch-disconnector shall be provided with a sign affixed in a prominent location with the following text:

PV ARRAY D.C. ISOLATOR

Where multiple isolation/disconnection devices are used that are not ganged (refer to Clause 4.4.1.3) signage, stating:

WARNING: MULTIPLE D.C. SOURCES

TURN OFF ALL D.C. ISOLATORS TO ISOLATE EQUIPMENT

shall be placed adjacent to the PCE.

The sign shall be black lettering on a yellow background.

The sign below should be installed on the DC isolator (switch or DC breaker).

PV ARRAY
D.C. ISOLATOR

7.6.4. Advised periodic maintenance NZS 5033 (these are advised only)

C2 PERIODIC MAINTENANCE

The following maintenance activities should be considered for inclusion in the maintenance procedures, according to the location, size and design of the PV array:

(a) Safety warnings and manufacturer's recommendations.

(b) Cleaning of the PV array might be periodically required in locations where it is likely to collect dust or other shading materials.

(c) Periodic inspections should be carried out to check wiring integrity, electrical connections, corrosion and mechanical protection of wiring.

(d) Verify open circuit voltage and short circuit current values.

(e) Verify functioning of earth fault protection (if relevant).

(f) Verify operation of tracking systems (if relevant).

(g) Measure I-V characteristics (if possible).

(h) Perform seasonal PV array tilt adjustment (if relevant).

(i) Check PV array mounting structure(s).

(j) Test operation of switches regularly.

(k) Check for module defects (fracture, moisture penetration, browning, etc.).

(l) Verify status of surge arrestors (if relevant).

(m) Infrared scans can be of use in identifying problems.

A sample maintenance schedule is shown in Table C1.

e,f,g,h,l & m are **not relevant** to this RP2 ELV installation

7.7. Feedback

We welcome your constructive feedback on how we can improve our products, including this manual. Any emails or Facebook posts that contain rude, offensive or abusive language will not be replied to.

8. Operation and maintenance

8.1.1. Changing a foot valve

Always change a foot valve on a day when you have good sun. If your tank is full, and the status LED is slow flashing blue, you can run it by opening the bypass valve and restarting the pump via the RP2 On/Off switch.

Turn off the RP2 at the On/Off switch, replace the old foot valve and filter sock with a new one. Start the RP2 and open the bypass valve to allow air in the suction line to clear. Close the bypass valve. Check the suction hose and fittings for any leaks and repair as required. If the suction head is above the 1.5m limit that the RP2 is approved, then you may also need to prime the suction pipe manually by lifting it up and filling it with water.

8.2. Particular points to monitor

Ensure that rodents cannot get access inside the pump. Ensure that grass and other vegetation is prevented from growing into the pump via the cooling vents. Cover the ground with corrugated steel or concrete to prevent plant growth if required. Ensure that the installation of the pump provides sufficient freezing protection. Ensure that the pump is installed in a pump shed to protect from excessive heat. If the RP2 is mounted outside, then you must install it in a position of full shade.

8.2.1. Oil

Do not run the pump without first adding oil.
Fill the pump body with clean SAE15W/40 oil to the **top edge of the oil level indicator glass**. If you significantly over fill the oil level drain some out before starting. Oil level should never be less than the middle of the level glass.

From new the pump should be run for 50 hours and the oil replaced. We then advise that the oil should be replaced every 500 hours or every 12 months whichever comes first. A red periodic flash (once every 5 seconds) on the status LED will indicate when oil replacement is due based on actual runtime hours.

8.2.2. Operating conditions

Do not intentionally run the pump without a water supply. If you do this the pumps brass head will get hot and the microprocessor will stop the pump and flash a LED warning.

In a pump runaway situation (where output pipe bursts), turn off the solar PV DC switch to stop the RP2.

8.2.3. Rapid pump deceleration

In certain light conditions you may observe rapid pump deceleration and the motor coming to a complete stop and then restarting. This can happen when the sun rapidly disappears behind a cloud so that the available power reduces quickly. The pump must decelerate quickly, but its inertia delays this and the voltage of the PV array crashes below the BLDC re-set voltage. Hence the motor stops, then the voltage recovers, and the BLDC does a motor restart. This is normal behaviour in certain light conditions, it does not make any great difference to the amount of water pumped but may appear unusual if you have not been warned to expect this at times. In overcast diffused light (or blue sky) conditions you will not observe this behaviour as solar radiation levels are more constant and not subject to rapid changes. **Note the pump will slow (or stop at times) every 60 minutes as part of its internal Maximum Power Point Tracking (MPPT) optimisation checks.**

8.2.4. Advice on freezing

A frozen brass head on the RP2 could result in serious damage that could cost up to 30% of the new RP2 to repair. A frozen pipe should not be an issue as the RP2 will see a pressure rise and stop (provided this feature was not disabled).
It is difficult to prevent freezing on sites where there is no power available at the time. Even though we can detect freezing temperatures (after sunrise) the damage will have already been done.

As the RP2 is intended for high lift sites using long pipes on farms we are of the view that wintertime water pumping needs will be minimal or not required at all.

This is our advice:

Areas that do not get frosts

- Install outside no extra protection is needed. Shade from excessive summer heat is still required.

Areas with very rare frost events no lower than -1°C

- Install outside on a concrete base to provide thermal mass, no extra protection is needed. Shade from excessive summer heat is still required.

Areas with occasional frosts no lower than -3°C

- Pontoon mounted – no freezing protection needed.
- Land mounted – install on a concrete base to provide thermal mass and install a small insulated secondary cover over the RP2 at the time of year when frosts can be expected. Ensure insulated cover does not prevent air flow through air vents in the fairing.

Areas with heavy frost no lower than -6°C

- Pontoon mounted – on a concrete base to provide thermal mass protection provided the water surface never freezes. Line the inside of the metal fairing with 12mm insulating foam.
- Land mounted – Install RP2 on an insulated concrete pad, fit a small insulated cover over RP2 and pad. An old chest freezer makes a great small, insulated building. This enclosure does need venting as the RP2 makes some heat. Only fit the insulated cover (close the chest freezer lid) at times of the year when it is needed to prevent frost, otherwise leave the lid open.

Areas with temperatures lower than -6°C

- RP2 not needed in winter time – disconnect suction and delivery pipes, run it for 10 seconds so water can clear the plunger chamber. Turn off the solar power. Dry the RP2. Wrap the RP2 in many layers of old wool blanket. Keep the RP2 in a warm dry building and do not reinstall until minimum night time temperatures are higher than -6°C
- Seek engineer's advice on the design of an insulated building and the laying of your pipes to prevent freezing. An old chest freezer makes a great small insulated building, but this does not help to prevent the long pipes from freezing. This level of detail is beyond the scope of this document.

8.2.5. Regular checks

The PowerSpout RP2 is a durable machine but can run for 1000s of hours each year, so regular checks and maintenance are advised. An RP2 may do more revolutions in 5 years than a car engine during the life of the car. A car engine has a filtered and pumped oil lubrication system, whereas a RP2 does not.

To maintain your RP2 in a good condition for years to come we recommend you keep a log book and make the following checks:

At least every month:

- Check RP2 flow output is normal for the season.
- Check you have surplus water at the intake and it is submerged.
- Check your intake screen is clean.
- If you have a filter bag on the RP2 suction line clean/exchange this regularly.
- Replace the oil after 1-2 weeks from new and top up the oil every month as needed.
- Check for any oil leaks.
- Check for any water leaks.
- Replace oil every 500 hours to obtain longest possible service life of oil lubricated parts.

Before every summer pumping season:

- Walk the delivery line and check for any damage to the pipe.
- Check bearing health by noting if there is any play on the Smart Drive motor rotor.
- In NZ you can return to RP2 to EcoInnovation for an annual service.
- Replace oil.
- Check for any water drips from the plunger seal weep holes. Drips indicate your RP2 needs new seals to be fitted. This is easy to do yourself (refer to the service videos).

As-required maintenance

We also suggest you be wary of complacency. Since these systems work and give free pumped water, owners often neglect to do any checks at all until the RP2 stops, they then run about trying to fix it quickly, but do not have the parts required on hand. A full set of consumable spares are supplied from new. Once you use them remember to re-order them.

If maintenance is not your thing, then return the RP2 to us, let us do the servicing for you (NZ only).

8.2.6. Spare parts

If you live in a remote part of the world, then you should consider having a full spare parts kit, BLDC and microprocessor on the shelf (or complete spare pump). This will mean that whatever the problem you can get your system going again quickly.

8.2.7. Lubricating the RP2

You must use SAE15W/40 oil (cSt at 40 ºC typically 120). The pump manufacture advises oils in the viscosity range SAE15W/40 to Shell 220 gear oil. The operating temperature on the RP2 will typically be in the range 10-50 ºC, this is much cooler than small fuel engines that run hot.

In general, 220 grade oils designed for splash lubrication for triplex plunger pumps have a viscosity, cSt at 40 ºC of 220, examples are:

- Exon sparton EP 220
- Texaco Meropa 220
- Shell Omala 220
- Chevron NL gear oil 220

These 220 oils should only be used once the pump has been run in for over 500 hours.
If the pump noise increases over time and towards end of pump life, then we suggest you change from SAE15W/40 to Shell 220 gear oil.

8.2.8. Changing the seals

These service videos will help you to service the RP2 seals.
Removing the 3 oil side seals requires skill, care and precision.

The RP2 comes with a seal removal drilling jig which really helps and allows you to do a perfect job.

If you are not able to do this work yourself, you will need to engage a person who can (please show them this manual and our YouTube servicing videos) or return the RP2 to EcoInnovation for service:

EcoInnovation Limited
671 Kent Road
New Plymouth 4371

Our indicative charges (at time of writing) to service a RP2 (consumable parts only) from an NZ client is as follows:

- Parts required (refer to web site for prices).
- 3.0-3.5 hours labour at $100/hour (unpack, replace all seals and ceramic plungers, test and repack).
- Plus return freight at $40-75 depending on location in NZ.

All prices exclude GST.

8.2.9. Changing the bearings

It is not viable in time and cost to replace the internal bearings. Bearings will last many years provided that correct **lubrication level is maintained at all times**. When bearing surfaces fail (or become worn so that new seals leak) you will at this time need to buy a new pump body. A new body is about 25-30% of the cost of a new RP2.

9. Warranty and disclaimer

All RP2s have a 24-month warranty (which only covers non consumable parts) on condition they have been correctly installed and serviced and that the owner/installer has completed the online registration form within 6-months of sale. **RP2s that are not registered within 6-month of sale will default to a 1-year warranty.**

Dealers on selling this product must facilitate warranty claims with the final client.
Trade on-sellers in NZ who purchased from EcoInnovation may refer the client directly to EcoInnovation for service support.

EcoInnovation will only deal with the dealer for all sales made via a dealer.

Consumable parts on your RP2 are not covered under warranty as these parts may need to be replaced from time to time. The life of these parts is related to the cleanliness of your water resource and the run time hours.

9.1.1. What we require from the customer

Our warranty is valid provided the RP2 has been correctly installed, commissioned and maintained over the duration of its use with regular oil checks and top-ups as needed. EcoInnovation may request to see the logbook and pictures of the installation and failed components prior to processing any warranty claim. The claimant must respond promptly to any information request to ensure speedy processing of your claim. The claimant must complete the claim form here.

To avoid any doubt:

- Warranty starts from the date of sale as stated on the invoice from EcoInnovation to the buyer or dealer. Where dealers hold stock warranty starts within 12 months of purchased from us or at the time the dealer makes the sale (whichever comes first).
- The limited warranty does not apply to any product or part thereof damaged by:
    a) alteration or disassembly
    b) accident or abuse
    c) corrosion
    d) lightning
    e) reverse polarity
    f) flooding or submersion
    g) repair or service
    h) operation or installation contrary to instructions pertaining to the product
    i) failure to add or maintain the correct oil level at all times
    j) unnoticed transit damage

- EcoInnovation's liability for any defective product or any part thereof shall be limited to the repair, replacement, or refund of full amount paid for the RP2, at EcoInnovation's discretion. EcoInnovation does not warrant or guarantee the workmanship performed by any person or firm installing the RP2. Workmanship warranty applies when the RP2 is serviced/repaired at our NZ factory. If you have your RP2 serviced by a local provider, check their terms of service, this work is not covered by our terms of service.

Warranty is conditional on the product being correctly installed, used for the intended purpose and maintained as evidenced by your logbook, commissioning records, online warranty information and installation pictures.

9.1.2. How to make a claim

Bear in mind that claims are handled through the dealer that sold you your RP2. You must start by completing a claim form here.

If your claim is valid we will fix it by:

- Dispatching a replacement part to you promptly for clients outside NZ.
- Asking for the RP2 to be returned to our factory for inspection and repair if in NZ or by sending out a replacement part if the client prefers and if this is appropriate to fix the problem.

No travel costs to fit part(s) to your RP2 are included under this warranty. The warranty is limited to:

- The supply of replacement parts for clients outside NZ.
- Receive, repair, replace & return the RP2 for clients inside NZ.

9.1.3. Claim form

You can make an online warranty claim here. If you registered your RP2 within 6 months of sale then you have a 2-year warranty on non-consumable parts, otherwise you default to a 1-year warranty on non-consumable parts.

10. Exclusion and liability

The manufacturer can neither monitor the compliance with this manual nor the conditions or methods during the installation, operation, usage and maintenance of the RP2. Improper installation may result in damage to the RP2, property and injury.

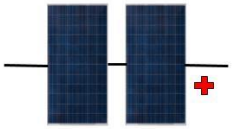
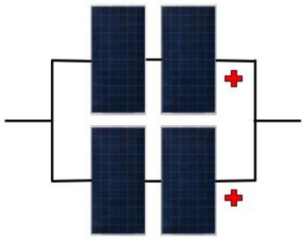
Therefore, the manufacturer assumes no responsibility and liability for loss, damages or costs which result from or are in any way related to incorrect installation, improper operation, incorrect execution of installation work and incorrect usage and maintenance.

11. Contacts

In the case of complaints or faults, please contact the local dealer from whom you purchased the product. They will help you with any issues you may have.

12. Product Specifications and Performance

12.1.1. RP2 Electrical Input Specifications

Maximum input voltage calculated at the sites minimum temperature	90 VDC
Minimum operational voltage	50 VDC
Target MPPV voltage for attached PV array	60-80 VDC
Minimum PV array size to operate for heads less than 50m Always facing midday sun, or on shaded sites position midway in the shade-free zone.	800Wp +/- 100W. Example 2 x 400W in series 
Recommended PV array size. Can be installed facing midday sun but an East/West truss is advised. **Note 4 PV panels (as shown) must be installed for heads > 50 m**	1600Wp +/- 200W Example 4 x 400W series pairs in parallel 
Maximum voltage each PV panel (Voc must not exceed 45V at the lowest temperature expected at the installation site.)	45 VDC
Nominal MPPV per panel	30-40 VDC
Nominal PV panel size	400W +/- 50W
Max voltage drop in cable from PV to RP2	3% (up to 5% also OK)

12.1.2. RP2 Specifications

Maximum dynamic head (including pipe loss)	160m 16 bar (or 300m 30 bar for HP version)
Maximum approved suction head	**1.5m on a 3m length of 25mm ID hose. Operation above 1.5m of suction head may be possible - but is not covered by warranty or supported. Proceed at your own risk.**
Rated static head	160m (300m for HP) maximum (exclude pipe friction head.)
Maximum flow l/min per RP2	up to 15.8 l/min (depends on head)
Maximum unloaded rpm	1200 rpm (HP is limited to 900 rpm)
Typical operating rpm loaded range	100-1200 rpm (HP 100-900 rpm)
Maximum pressure stop setting	300m (30 Bar)
Minimum pressure stop setting	30m (3 Bar)
Input fitting size	25mm hose-tail for suction hose. Fittings can be removed leaving a 3/4” BSP (20mm) female thread to connect onto.
Output fitting size	No pipe fitting supplier. Pump fitting is 3/4” BSP (20mm) female thread to connect onto. Both input and output thread sizes are the same
Gross weight export (DHL carton)	<30kg (with extra items items)
Gross weight NZ (by NZ courier)	<25kg (with limited extra items). For orders above 25kg a 2nd box is sent
Boxed DHL carton dimension	54w x 44d x 42h cm
Boxed NZ carton dimension	47w x 47d x 37h cm
Warranty	2-years on non consumable parts, provided the RP2 has been installed and serviced correctly with proof (such as written log book or video dated record). Pump must have been registered here within 6-months or sale **otherwise only a 1-year warranty applies.**
Oil required	Up to 0.6 litre SAE15W/40 or 220 grade gear oil. Check and top up on a regular basis (every two weeks) and replace oil every 500 hours. The pump LED will warn you when the oil needs to be replaced - 500 running hours has been reached.

13. Installation details log

We recommend you take note of the final system details (as below) for future reference and to help with ordering replacements or upgrading the system.

If you ever make a warranty claim we will ask to see pictures to prove it was installed correctly, you may want to do this now. You can register your installed RP2 online here.

Installation details	Serial number _____
Date purchased	
Date installed	
Date for next service check	
Location of installation	
Delivery pipe inside diameter	mm or inch
Delivery pipe length	m or ft
Suction pipe inside diameter	mm or inch
Suction pipe length	m or ft
Static delivery pressure (RP2 off)	kPa or PSI
Dynamic delivery pressure(RP2 running)	kPa or PSI
Suction pipe lift or state “gravity feed”	m or ft
Performance data	
Flow rate of water to tank	l/s or gal/min
	l/day of gal/day
Supplier contact details	
Installer contact details	

We would also like you to let us know (via an email to your sales person) your performance data so that we can determine conversion efficiency at your site. This helps us refine our calculations for future clients. As every site is different, average pumped flows will vary from site to site. Feel free to send us pictures of your installation, we will contact you if we can see improvements that can be made to your installation ☺.

DATE	NOTES