Alternative Watering for Field Grazed Livestock II – Pumping Systems

SRDP Farm Advisory Service

National Advice Hub
T: 0300 323 0161
E: advice@fas.scot
W: www.fas.scot

SUMMARY

- **Mains or private water supply should be considered as the first choice to supply drinking water to livestock.**
- **Alternative watering systems provide an option for consideration for grazing livestock at remote sites, subject to water quality.**
- **Check the alternative watering system chosen is suitable for your site and meets stock drinking requirements.**
- **A single alternative watering system could form part of a larger gravity fed system to supply a number of drinking troughs.**
- **Keeping livestock out of wet and boggy water margins could reduce the risk from liver fluke.**
- **At some locations, provision of correctly sited alternative watering systems could reduce poaching risk and remove the need for additional fencing.**
- **Abstractions from a watercourse will need to adhere to the Water Environment (Controlled Activities) (Scotland) Amendment Regulations 2013 (CAR).**
- **Observe health and safety requirements when carrying out abstraction and installation work near watercourses.**
- **Poaching caused by livestock within 5m of a watercourse is no longer acceptable under the Water Environment (Diffuse Pollution) (Scotland) Regulations 2008.**

This Technical Note looks at the use of a number of alternative watering systems, based on findings from Scottish Government funded trial work on three farms in Scotland.

A second Technical Note TN 665 Alternative Watering for Field Grazed Livestock I – Abstraction Systems looks at two different designs for construction of an abstraction point to support an alternative watering system and should be read in conjunction with this Technical Note. It is available at www.fas.scot/publications/technical-notes/ and www.farmingandwaterscotland.org

All installations will differ, depending on site specific conditions. Therefore this Technical Note is intended as a guide only.

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Introduction

Following the introduction of the Diffuse Pollution General Binding Rules (DP GBRs) in 2008, significant livestock poaching and erosion within 5m of a watercourse is no longer acceptable (Box 1).

At heavily poached sites, fencing to exclude grazing livestock from the watercourse is seen as a desirable option, coupled with drinking troughs supplied by mains or private water supply. Mains or private water supply is also a good choice in terms of herd biosecurity.

At more remote sites, piping mains or private water to supply drinking troughs for field grazed livestock may be neither cost effective nor practical, requiring a different approach.

'Alternative drinking water systems' describes various options to abstract water from a watercourse to supply an in-field drinking trough or bowl. Examples of alternative watering systems include:

- Off stream gravity fed water troughs.
- Livestock operated pump (pasture or nose pump).
- Electrically powered pump (either mains, battery or powered by renewables).
- Ram or "papa" pump - using no external power source other than energy within the flow of water.
- Wind powered pump.

These pumps require a dedicated abstraction system and abstraction point to ensure an ongoing supply of water to the drinking trough, meeting the needs of livestock and protecting the watercourse. There is more information on abstraction systems and abstraction authorisation requirements in TN 665.

This Technical Note covers the pros and cons of a number of watering systems installed as part of a Scottish Government funded demonstration project, to provide drinking water for livestock at remote field sites.

The work was carried out in 2013; all prices quoted relate to cost at installation and are exclusive of VAT.

Gravity Fed Trough

Box 1 - Why is poaching a problem?

Poaching in and around watercourses gives rise to erosion, soil loss and introduces nutrients and faecal bacteria into the water, degrading water quality.

This increase in diffuse pollution can negatively affect habitats and amenity for water users further downstream, including an increase in faecal pollution at designated bathing water beaches. Although poaching at one site may seem to be a small source of diffuse pollution, the impact can be significant when coming from numerous sites along the length of a watercourse. Land managers are required to prevent erosion of the banks of water courses and watering points from overgrazing or heavy poaching by livestock as part of GAEC 5 Cross Compliance requirements.

Previously managed or constructed drinking points in watercourses are now no longer recommended; these have been demonstrated to concentrate poaching and dunging in one area, which can be easily mobilised during high water flows (creating a diffuse pollution 'hotspot').

In many cases a suitably located trough fed from a permeable collector type abstraction point as described in TN665 will be the simplest and cheapest option. A float valve at the trough will ensure that flow ceases when the trough is full. Care should be taken to correctly size the supply pipe depending on the location of the trough in respect of the supply point. The pipe should fall consistantly to avoid air locks at any high points

Livestock operated pump

Livestock indirectly operate a mechanical pump and 'draw' water from an abstraction point, transferring water to an integral drinking bowl (Figure 1). This system is often referred to as a 'pasture pump' or 'nose pump'. A single pump is sufficient to meet the drinking requirements of around 15 head of beef cattle.

The lever above the bowl is operated by the drinking animal's nose forcing the pump to make a stroke as the animal drinks the water collected in the bowl. Water is drawn upon each pump stroke from the abstraction chamber via a pipe and 'non-return' valve, to the pump body. Water is simultaneously discharged from the previous stroke(s) into the drinking bowl.

Sheep would be unable to operate the lever to pump water on a standard pasture pump; however alternative systems are available.

Site suitability

Installation sites are limited by the maximum vacuum that the pump can operate at. This is governed by distance and height from the water. A total suction head of up to approximately 7.0m is possible, however the higher the head, the more force will be required to operate the pump. In practice it will be better to minimise the 'suction' head i.e. the height of the pump and drinker above the watercourse lowest level.

Figure 1: Pasture pump. As livestock drink from the water bowl, they push the lever to reach the water, which refills the bowl.

- Ensure your source of water is of suitable quality for livestock drinking and of enough flow during the summer months.
- When designing the installation, make sure that the pipe, end screen and non return valve can be easily removed from the abstraction sump chamber for inspection, maintenance and cleaning.
- Consider siting; make sure the drinking bowl is located at a distance to avoid any subsequent poaching within 5m of the watercourse.
- Establish appropriate performance criteria based on site requirements, for example:
    - Water requirement of stock.
    - Numbers of stock and units required to satisfy the maximum water demand.
    - Distance and height (head) required to reach identified site.

Two systems were installed as part of a Scottish Government funded demonstration site; a single pasture pump (case study 1) and a pasture pump cluster (case study 2).

Case study 1 - Single pasture pump

A single pasture pump was installed to provide for a proposed occasional stocking density of 20 beef cattle, which was within the capabilities of the pump chosen at this site (Figure 2).

An abstraction point was installed in the bank using the design outlined in TN 665 (permeable sump type).

Using masonry bolts, the pump was secured to heavy concrete mounting blocks. The pump/bowl unit was sited 10m from the watercourse which was already fenced.

Water was lifted to a total height of 1.2m to the bowl level, via an over ground pipe connection routed from the abstraction chamber to the pump inlet. A dirt screen and non-return valve assembly was fixed to the lower end pipe termination in the abstraction chamber.

Cost: 1 pasture pump - **£215**, Additional fittings and hose - **£125**

Figure 2: Pasture pump and abstraction point.
Arrows indicate abstraction point (1) and site of pump (2).

Case study 2 – Pasture pump cluster

As livestock often drink together, a ‘pasture pump cluster’ was designed and installed to supply water to around 50 beef cattle.

An abstraction point was installed in the bank using the design outlined in TN 665 (permeable sump type).

Three pumps were secured to a heavy concrete circular plinth located 10m from the watercourse abstraction point (Figure 3). Vertical lift was estimated as approximately 1.5m overall.

The suction hoses were routed from the abstraction chamber to the pump/bowls via a below-ground reinforced pipe (Figure 4). The suction hoses were each fitted at their lower end with a dirt screen and ‘non-return’ valve below abstraction water level.

Cost: 3 x Lister pasture pumps including fittings, hose and pipework - **£800**; Concrete manhole lid (used as base for pumps) and bolts - **£175**

Figure 3: Pasture pump cluster looking towards watercourse.
Arrow indicates position of abstraction point.

Figure 4: Installation of the underground transfer duct to protect suction hoses.

Solar powered pump systems

Solar panels can be used to either maintain a charge in a battery which powers a pump (case study 3) or provide energy to power the pump directly (case study 4).

Variations will occur between manufacturers and/or suppliers and equipment specification; for example output and efficiency of the solar panel(s), efficiency and type of control or management of the available energy, battery capacity, charge and discharge characteristics (where a battery was used) and pump performance specification (flow rate vs. head).

The main criteria to consider include:

- How much water do livestock need on a daily basis, both overall and peak flow requirements?
- What is the distance and height (head) required to allow siting of a drinking trough to remove the risk of poaching, erosion and faecal contamination of the watercourse? This will determine the pump specification for any site and in turn, affects the power supply equipment and arrangement.
- What is the overall energy/power available to satisfy the pump requirement, taking into account specific regard to possible variations in light levels?
- Cost relative to the potential benefits, possible alternative systems (e.g. mains or gravity, private supply?) and the actual financial margins related to the stock business.

A solar system could form part of a larger gravity fed system, supplying a main header tank linked to a number of troughs on the farm. A small wind turbine could also be considered as a renewable power source, but would need careful design to account for prolonged summer periods with high water demand and potentially low wind speeds.

Alternatively, larger solar panels could be used to increase available energy/power during lower light levels and together with electronic control of the pump, allow continued operation during lower panel 'output' (lower level light) periods. With an extended operational period plus large capacity troughs for water storage during periods of low and no light when livestock drinking will still be required, the system could be operated on solar power alone, removing the need for a battery (Figure 5).

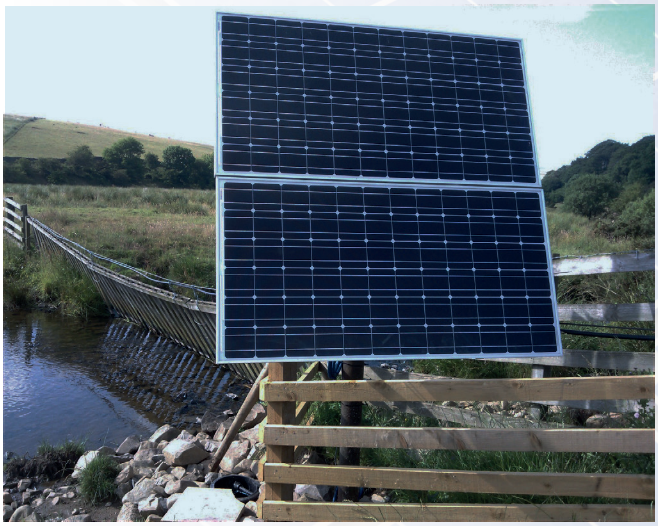

Figure 5: Solar panels used to power a pump.

Off the shelf packaged solar powered units are now available from a number of manufacturers which include a pump, solar panel, battery and controller all installed within a secure steel box (Figure 6). These come with pipe connection points and only require to be placed at a suitable location and connected to an abstraction point and water trough with float valve. The pump operates as soon as the float valve opens and pressure in the delivery pipe drops and stops when pressure increases after the float valve closes. Power from the pump comes from the battery which is kept charged by the solar panel. Protection of the pump from frost is required but the whole unit is easily disconnected and moved inside during the winter.

Figure 6: Packaged solar pump unit.

Case study 3 - Solar PV system with battery storage

This prototype system was based around an electric powered 'low voltage' submersible pump supplying water on demand to a locally sited trough. The field was stocked with a mixture of cattle, sheep and horses.

An abstraction point was installed in the bank using the design outlined in TN 665 (permeable sump type). A submersible pump was located in the abstraction sump chamber (Figure 7).

Figure 7: Open abstraction sump chamber for installation of submersible pump.

The pump was supplied by a low voltage, high capacity battery, voltage regulator and solar panel, which provided a charge current to the battery. Low voltage was utilised throughout this equipment (Figure 8).

An integral 'low level' sensor provided pump protection during times of low water, switching the pump off during water shortage at the abstraction sump. The water trough was fitted with a 'level' probe to control pump operation based on the level of water in the trough.

The battery and water storage capacity in the coupled trough provided a 'buffer' for varying demands during drinking and possible periods of reduced available 'solar charging' during periods of limited light.

Water entered the abstraction point, supplying the pump chamber/sump. Probes were installed in the drinking trough to indicate water level; a low level in the trough activated the pump.

The pump transferred water from the chamber to the trough. Once the water reached pre determined level, a high level probe in the trough switched the pump off.

In addition to the pump, the battery could also power an electric fence if required (permanent fencing is recommended to protect the solar panel and battery housing) (Figure 9).

Cost: Complete unit supplied; 1 x Pump & fittings including solar panels, battery and trough, plus installation (proto-type model supplied by PowerWash 2000). Solar powered system complete - **£1,500**

Figure 8: Solar system during installation. Covers removed showing battery compartment.

Figure 9: Livestock using trough. Fencing only part completed but prevents access to battery and panel.

Case study 4 - Solar PV system with no battery

This system was based on providing a larger solar panel area to increase available energy/power and together with electronic control of the pump, to allow continued operation during lower panel 'output' (lower level light) periods.

An abstraction point was installed using the design outlined in TN 665 (permeable sump type).

Figure 10: Solar System. The arrow shows secondary trough across watercourse. Primary trough installed in nearside field to right but out of shot.

Due to the extended operational period, a battery was not included in the system. Water storage capacity was increased by using two large capacity troughs for water storage during periods of low and no light when livestock drinking will still be required (Figure 10).

Water was pumped from the abstraction sump chamber to the primary trough, and then gravity fed to secondary trough on opposite side of the watercourse as required. Levels were controlled by float switches/valves.

The pump was located within the abstraction chamber. A low water level in the trough will switch the pump on and a high level in the trough will switch the pump off. The pump and controller were configured to allow a variable output from the solar panel to maintain operation of the pump over a range of light levels. This system was not fitted with a battery, so at very low light conditions the pump will not operate. At times of low flow, the high capacity troughs act as temporary water storage and provide drinking water for livestock.

Cost: x1 Solar powered unit **£2,280**, 2x 2,270l capacity drinking troughs (including delivery) **£620**, panel post, additional pipework and cables **£220**.

Ram pump

A ram pump operates on the principle that the energy within a 'flow' of water can be used to pressurise a small proportion of the flow.

Generally, these systems rely on a larger flow of water at a relatively low pressure (head), to pump a smaller proportion of this water at a higher pressure to fill a drinking trough or water tank. The larger proportion of water not pumped through the delivery system is put back into the watercourse, downstream from the abstraction point. The returned water is typically over 90% of the water abstracted.

The output (flow rate and delivery head) from the pump is dependent on the available supply head and water inflow rate. The 24hr flow requirement will be dependent on the stock type and numbers. The pump within the pumping chamber is shown in Figure 11.

Not all sites will be suitable for a ram pump; specific design criteria must be applied for the pump to operate effectively. Points to note include:

- The diameter of the supply pipe must be adequate to provide minimum acceptable pressure drop at the required flow rate.
- The installation of the supply pipe must be such that fall throughout is consistent and prevents the possibility of 'air locks' forming in the pipe. Pipe fall should be such that any entrained air rises to the top end of the pipe and escapes.
- The maximum length of the supply pipe must be limited to 10 times the supply head.

Case study 5 illustrates some of the considerations when fitting a ram pump system.

Figure 11. Ram pump within pumping chamber.

Case study 5 – Ram pump

A ram pump system was installed to supply two water troughs in two fields containing around 50 beef cattle and 100 sheep. The fields were split by a watercourse but run as one.

An abstraction point was installed in the bank using the design outlined in TN 665 (permeable collector type).

The supply of water at the required head was further away than the maximum supply pipe length would support to permit pump operation. An 'intermediate break chamber' was installed, acting as a temporary reservoir to provide a supply of water at the appropriate distance and level for pump operation (Figure 12).

Abstracted water was piped 130m via a 'solid' (not permeable) piped system to the concrete ring forming the intermediate chamber. The water level was maintained in the intermediate chamber to a level of 4m above the pump inlet level (this included an overflow pipe returning excess water directly to the watercourse). This provided the operational 4m head of water over the pump inlet. Water was transferred from the intermediate chamber to the pump via 40m of connected supply pipe.

The supply pipe was sized to allow adequate flow to enter the chamber from the abstraction with minimal head difference. Reinforced 100mm pipe was used and all joints and connections used a sealed coupler to prevent water leakage.

The pump was connected directly to the lower end of the supply pipe via a manual lever valve. The pump was also located within a concrete chamber below ground level; this enabled the water delivered to the pump to achieve the supply head and to provide protection for the pump.

As soon as a demand takes place (by opening of the float valve) water is supplied to the trough. The pump operates and exhausts water continuously, maintaining a delivery pressure on the discharge. Exhaust water from the pump was discharged onto the chamber floor and via a piped drain was returned to the watercourse. A stone head wall protected the bank from erosion at the point of discharge.

Water flowed to the two large capacity troughs via a pressure vessel (to buffer pressure variation and improve system efficiency) and a non return valve controlled by float valve to allow filling and prevent overflow. The delivery flow from the pump was based on a 24hr flow rate; the delivery system must include appropriate water storage capacity to allow water to be 'accumulated' through the 24hr period and to facilitate high demand flow rates at drinking (Figure 13).

This system also had the potential to pump water uphill to a holding tank to support a gravity feed supply across a number of fields on the farm.
The arrangement will vary from site to site; pump specifications, basic requirements and guidelines will be provided in the pump

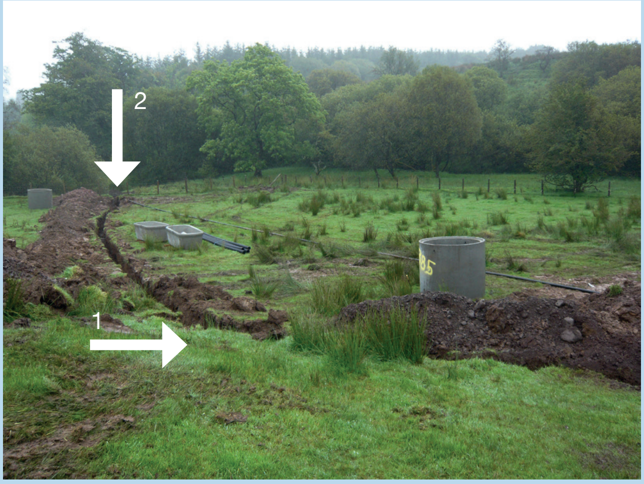

Figure 12: During installation. Note the site for the intermediate break chamber (1) and location of pump and discharge to watercourse (2). Abstraction point is 130m behind photographer.

The arrangement will vary from site to site; pump specifications, basic requirements and guidelines will be provided in the pump manual.

Cost: 1 x Papa Pump, fittings, pressure vessel and carriage - **£650**, All pipes, concrete rings, connectors, geotextile etc. plus installation of chambers and pipes and associated ground works carried out by a contractor - **£4,800**, Abstraction Registration (<50m^3 per day) (SEPA) - **£78**

Figure 13: Water trough supplied by ram pump. Arrow indicates position of second trough.

Wind powered pump

Directly driven water pumps from wind driven rotors have been used across the world for many years for supplying water for agriculture and this remains an option today. For livestock watering there is a need to combine these with a large storage tank to ensure a plentiful supply during extended periods of light or no wind. This could still be an option for well exposed sites.

Pumping systems – key points:

Pasture pump:

- Simplest option for many sites.
- Suitable abstraction point required.
- Pipe run should fall consistently from abstraction to trough.
- Pipe sizing important.
- Float valve at trough.

Pasture pump:

- Easy to install.
- Portable; can relocate or remove.
- No power requirement; livestock operated.
- Cluster arrangement allows a number of stock to drink at once.
- Mechanical operation; few moving parts to go wrong.
- Livestock learn to operate equipment within a couple of days, however drinking bowls must be kept full and livestock discouraged from drinking from other sources if possible.
- Relatively cheap solution.
- Site specific; will not be suitable for all sites.
- Casing may be prone to splitting if exposed to heavy and prolonged cold temperatures; unit will need to be drained or removed over the winter months if not in use.

Solar powered systems:

- Uses renewables as main energy source.
- Battery back up allows for continued operation in low light conditions.
- Could be configured to power an electric fence.
- Selecting a large trough capacity allows for additional storage of water.
- Could support a larger gravity fed system.
- Site specific; will not be suitable for all sites.
- Cost effectiveness should be assessed on a site by site basis.
- Depending on daily abstraction volumes, authorisation could fall under General Binding Rule (no paperwork; under $10m^3$ per day) or Registration/Licence (application to SEPA if abstracting over 10m3/day). See SEPA website for details.

Ram Pump:

- Not all farms will be able to support a ram pump system; this could be due to head requirements or length of pipework required.
- Most expensive system trialled, but potentially the most versatile if a suitable site is identified on farm.
- Can lift larger volumes of water over long distances. Has the ability to supply a number of troughs and can also support a gravity fed system. These could be on the same farm or in partnership with neighbours, depending on site characteristics.
- Potential to abstract over $50m^3$ per day; these larger volumes may be required to enable function. Currently this will require a licence from SEPA even though only a fraction of the water abstracted is actually being used.
- Identified watercourse may not support a ram system. The possible effect of reduced water flow in the watercourse between the abstraction (inlet) and discharge (outlet) may be significant on some sites, especially where the required pump inflow is high compared to stream flow available.
- Can be tricky to start, but demonstrated to be robust and reliable technology once operational.

General considerations when planning an alternative watering system

Mains or borehole water should be the first choice as a watering supply for livestock. When researching an alternative watering system, there are additional points to consider:

- **Water quality.** Is the quality of the water good enough at the identified site to allow livestock drinking?
- **Site**. Will water levels at your chosen location support the type of abstraction system you are considering?
- **Authorisation requirements**. The SEPA website will indicate which level of authorisation is required, depending on daily abstraction volumes.
- **Flooding risk.** Is your site at risk of flooding? Concrete fixtures were used in place of wooden sleepers on the pasture pump site to reduce the risk of equipment loss, should flooding occur.
- **Consider site access.** Steeply sloping fields, heavy troughs and machinery required for ground works coupled with wet weather could make the site difficult to access, increase erosion risk and damage farm soils.
- **Siting drinking troughs in relation to abstraction point.**
    - o The distance and height to which troughs can be located will depend on establishing the existing pump performance characteristics.
    - o Once a system had been designed, it is important to make sure that the location of the drinking trough and subsequent poaching at the site don't create a new source of diffuse pollution.
- **Vandalism/theft risk.** Location of equipment in terms of vandalism or theft may be a consideration; the report by Swanson (2007) gives more information on reducing damage by vandalism.
- **Timing of installation.** Care should be taken to avoid installation at times of poor weather and/or ground conditions.
- **Maintenance.** All systems should be checked on a regular basis to ensure that water is freely available in line with livestock demand.
- **Frost protection.** Some types of equipment will require protection frost either by insulating, draining down during the winter or removing to a frost free location.

Further information

- Controlled Activities Regulations (CAR) - The Water Environment (Controlled Activities) (Scotland) Amendment Regulations 2013 www.legislation.gov.uk/ssi/2011/209/contents/made
- CAR Practical Guide; includes requirements for authorisation under CAR www.sepa.org.uk/water/water_regulation/regimes.aspx
- Grazing Animals Project (2007). Watering stock on sites – information leaflet 13 www.grazinganimalsproject.org.uk/stock_management.html
- Papa Pump (version at July 2013) www.papapump.com
- Sniffer (2002). Off stream water provision for livestock. Report number SR(02)01F www.fwr.org/snifrprt.htm
- SRUC Technical Note TN 665. Alternative Watering for Field Grazed Livestock I – Abstraction Systems www.fas.scot/publications/technical-notes/
- Farming and Water Scotland. Website hosting information on Alternative Watering plus a range of information to help reduce diffuse pollution risks. www.farmingandwaterscotland.org

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Harry Kirkwood, PowerWash 2000, Stirling
powerwash2000@aol.com

Stephen Field and Lucy Filby, SEPA Ayr Office, 31 Miller Road, Ayr KA7 2AX

Authors

Rebecca Audsley, SAC Consulting, Auchincruive, Ayrshire, KA6 5HW
Rebecca.Audsley@sac.co.uk

Donald Dunbar, SAC Consulting, Greycrook, St Boswells, Roxburghshire, TD6 0EU
Donald.Dunbar@sac.co.uk

Brian Laird, SAC Consulting, Auchincruive, Ayrshire, KA6 5HW

Adrian Jones, A&M Jones Consulting, Ayr
Adrian@amjonesconsulting.co.uk

Chris McDonald, SAC Consulting, 2 Technopole Centre, Bush Estate, Penicuik Midlothian EH26 0PJ
Chris.McDonald@sac.co.uk

Robert Ramsay, SAC Consulting, Auchincruive, Ayrshire KA6 5HW
Robert.Ramsay@sac.co.uk

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