Irrigation system design

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1 AUTOMATED IRRIGATION

Project deliverables

With any project it is good practise to set out the project delerables before starting. The objective for this project is to as far as possible automate all irrigation for a target garden (located in the south east of the UK), giving each plant the correct watering regime.

This document covers the horticulctural requirements, irrigation source, water to plant delivery systems and water distribution infrastructure.

1.1 Horticultural requirements

There are several limiting factors that may drive a degree of compromise in any irrigation system design, the first consideration being how much water will be needed, as a general rule of thumb lawns require 25mm per week (50mm in drought conditions), borders/trees and vegetables/fruit 50mm per week, pots and tomatoes needing about 0.5-1 litre per pot per day depending on size and conditions.

For the **target garden** this means automatic watering for;

Element	**Area** (m^2)	**Number**	**Water required**
Lawns	300		4 m^3 twice per week
Borders/trees	300		2 m^3 each day
Pots	_	30	0.03 m^3 each day
Vegetables/fruit	100		0.7 m^3 each day
Tomatoes	_	8	0.008 m^3 each day

Amount of water required per week	27 m^3 per week
Estimated amount for irrigation season	500m^3

The design to include automatically adjust the amount of watering delivered taking in to account natural rainfall and current conditions.

1.2 Irrigation source

The next question to address is where will the water be sourced from? The main options are a domestic water supply, grey water or harvested rain water.

Domestic water supply

The domestic water supply for the target garden has a zero flow pressure of 3 bar, a maximum flow (open pipe) of 14 l/m (litres per minute) and a cost of about £1.3/m^3 (supply only).

When flowing at full rate at one outlet the pressure is reduced for all other domestic uses seriously affecting their performance, thus ideally full flow should only be taken from say 10pm through to 6am, 8 hours of potential draw.

8 hours of draw per day would supply about 6.7 m^3, this is the practical limit of supply for this source, and is enough to supply the requirements for the proposed automated irrigation system.

Grey water

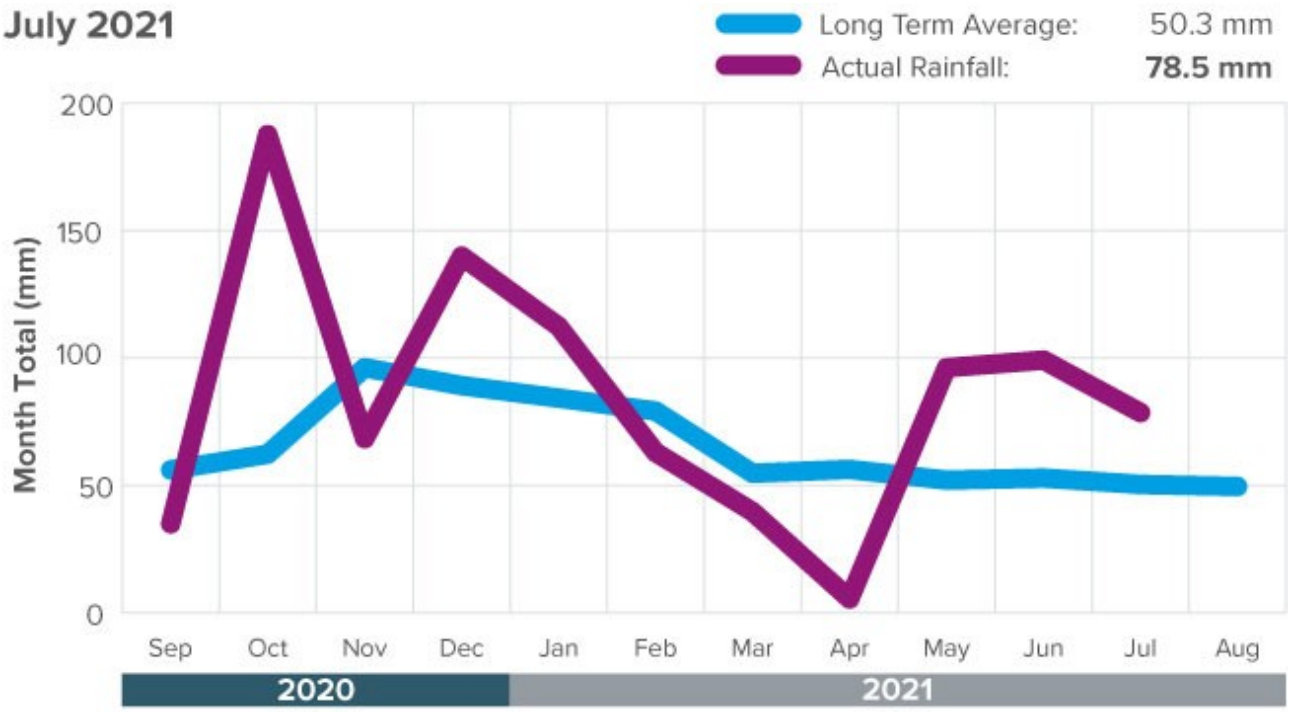
Grey water filters and catches water from baths, washing machines etc and stores the water in a tank for later use in non potable applications.

An average 2 person household consumes 80m^3 per annum with no garden watering, and if we take away 20m^3 for toilet water then the maximum annual available volume of water would be 60m^3. Given that about 500m^3 is required and that this is during the irrigation season only, the grey water option is not viable for the target garden and dwelling.

Harvested rain water

Harvested water from roofs is stored in tanks as a source to feed the irrigation system. The south east precipitation rate during the summer months, is about 50mm/month, with potential periods of drought aligning with maximum water required from the water source.

Precipitation rate for the target garden area



If a double garage were used as the water collection area then an average of about 0.45 m^3 per week would be supplied, this is a small proportion of the water required.

If the water was stored over the non irrigation season to be used as an assistance during the summer months, then for a significant contribution 100m^3 plus would need to be stored, this is not really practical or economic.

It is therefore concluded that even if 10 double garages could be used as the catchment area, that water harvesting for full or assisted irrigation is not a viable option for the target garden.

For harvesting to work...

From the table above the average precipitation rate is about 12.5mm per week but we need to source about 50mm per week for an average garden, thus to fully source from harvested water the ratio of harvested collection area to irrigated area needs to be about 4:1. There would also need to be about 10 days of storage to ride through dry spells, although this can be offset with the use of a back up domestic supply.

Irrigation source conclusion

The domestic water supply has been chosen as the only viable irrigation source.

1.3 Irrigation to plant delivery

Basic rules for garden irrigation delivery

1 Water the earth directly and evenly, do not water the plant foliage and flowers.

2 Ensure when watering that the earth is properly watered so the water penetrates down to the roots, just wetting the surface frequently is ineffective.

3 Do not apply water faster than the soil/lawn can absorb the water applied, it will just run away.

4 Water most beds late in the evening and lawns early in the morning, do not water during the day when evaporation may prevent proper percolation.

5 Do not over water, water logging suppresses the breathing air of the roots out of the soil – the root cells drown without oxygen.

6 Arrange the physical water delivery system so that plants that require more (such as hydrangeas) get more and plants that require less (such as sedums) get less water.

7 Do not use sprinklers for flower beds, only for lawns.

8 Water outdoor container plants at least once per day.

9 Lawns should be watered with a 25-50mm application once or twice a week as required by conditions.

In order to meet the basic rules outlined above the following watering distribution methods have been chosen..

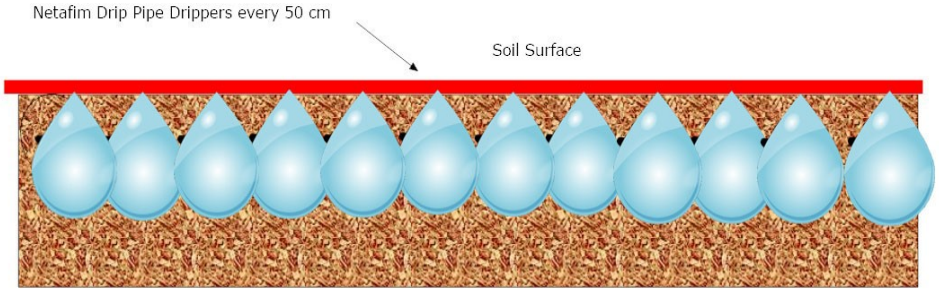
1 Pop-up sprinklers for lawns

2 Pressure compensated dripper line for borders

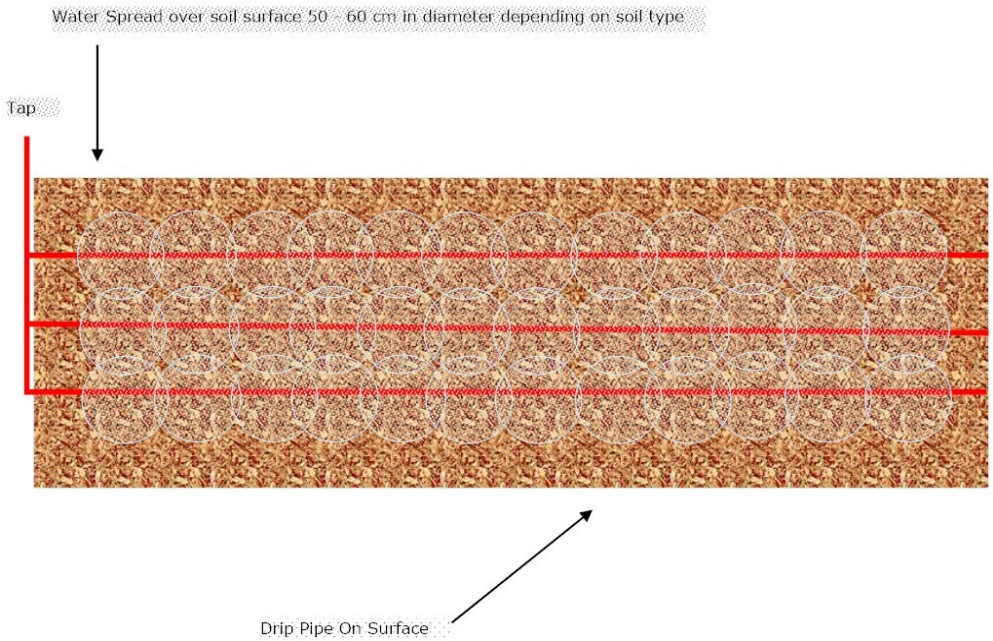
3 Pressure compensated dripper terminals for pots

Pressure compensated dripper line operation..

Cross section of PC dripper line on soil



Plan view of PC dripper line on soil



Drip irrigation should be used for 30 minutes every day. The reason is the soil is being used like a sponge. If you take a dry sponge and pop it under running water you will see that most of the water runs off. Now get the same sponge soak it with water and ring it out. Pop the sponge back under the flowing water and you will see that most of the water is absorbed by the sponge

Although it may seem very satisfying to water by hand, if you dig into the soil when you're finished you will find only the top inch or so is wet. Most of us don't have the patience or time to water properly by hand. Giving a 20x3-foot vegetable bed the inch or more of water it needs during the heat of summer would leave you holding the hose for almost a half an hour (assuming your hose can deliver 2 gallons per minute). Even if you had the patience required, the water flows so fast, much of it runs off along the soil's surface rather than sinking in.

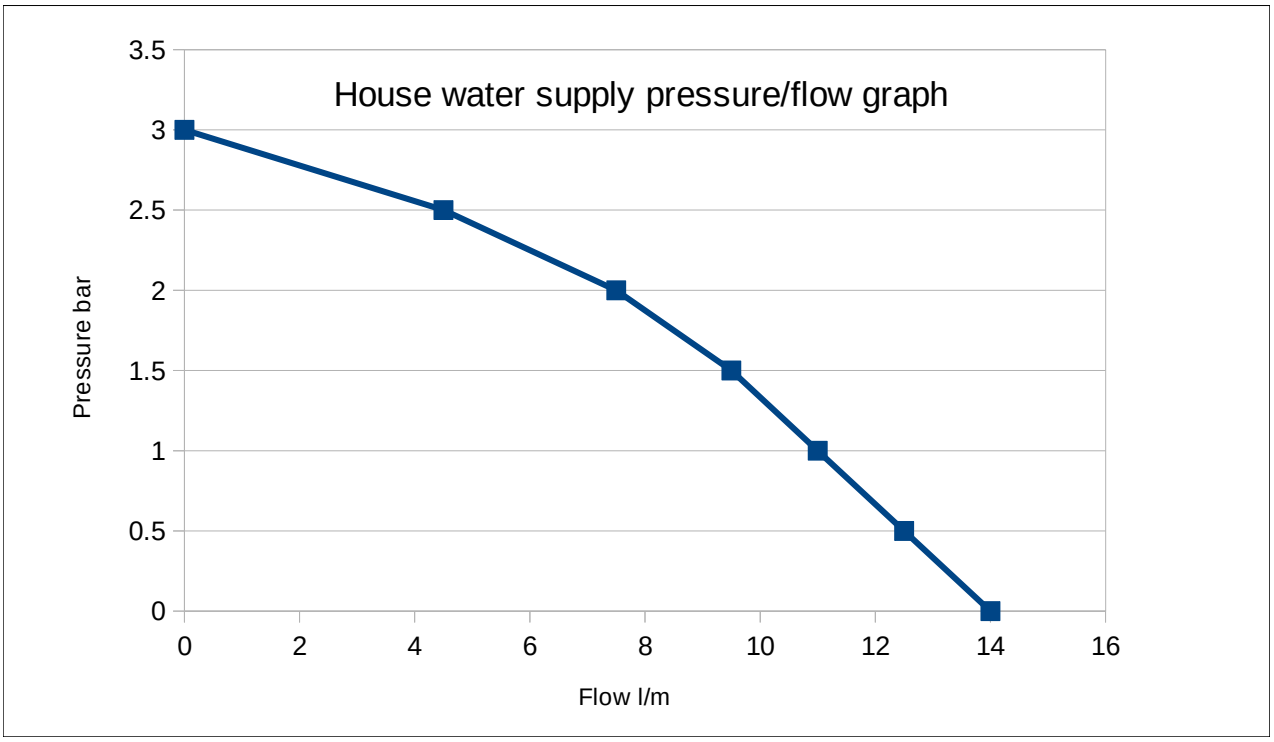
PC drippers used to irragate pots work in exactly the same way.

1.4 Water distribution infrastructure

The first issue to address is whether the domestic water is capable to directly feed the various water to plant delivery methods split into zones controlled by valves, for example a zone could comprise several lawn sprinkers connected in parallel.

In order to answer this we need to consider the water requirements of each delivery method against the capability of the house supply.

House supply No flow 3bar and max flow at 0bar of 14ltr/min (no other concurrent draw)



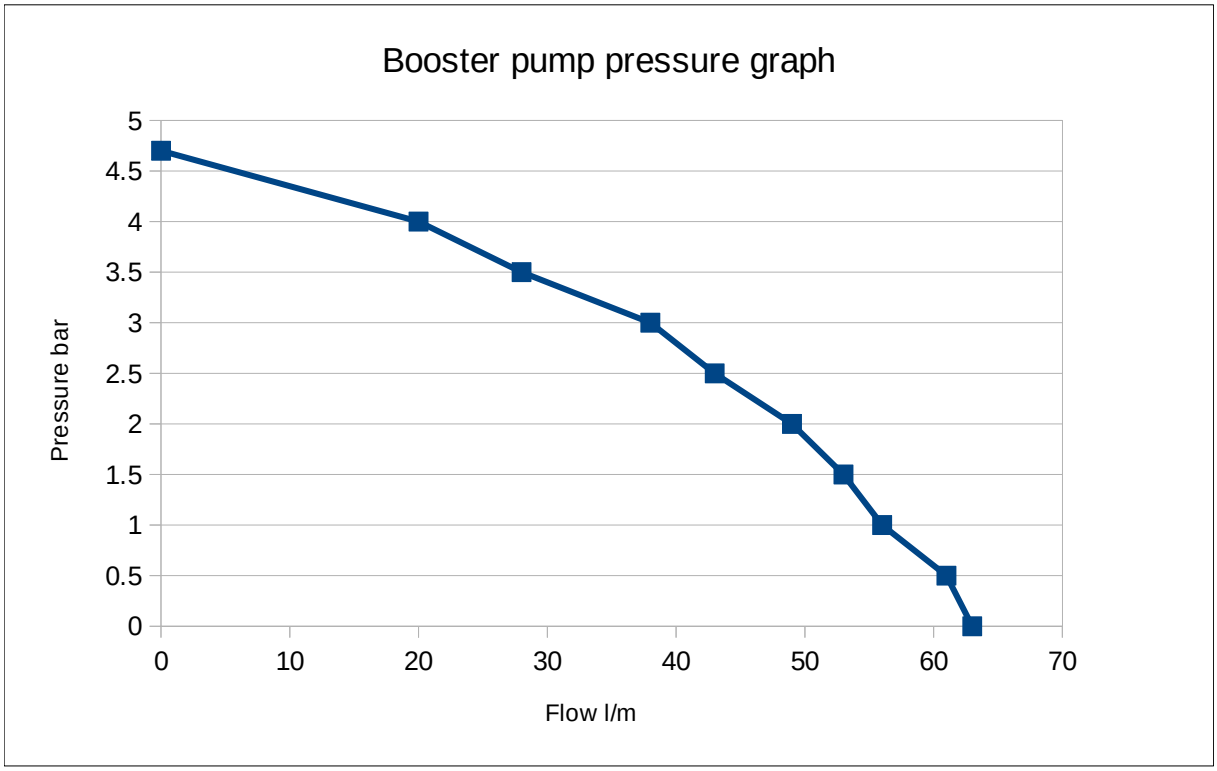
Lawn sprinklers Require 3bar at about 6ltr/min for 1 sprinkler

PC dripper line Require 0.5-2.5bar at about 0.1ltr/min for 1m of line

PC drippers Require 0.5-2.5bar at about 2ltr/hour

It can be seen by inspection that the house supply simply does not have enough pressure at the required flow rate to directly supply even 1 lawn sprinkler, while it is possible to drive up to about 80m of PC dripper line and many PC drippers.

The conclusion is therefore that a booster pump fed from an intermmediate storage tank is required to be able to drive the lawn sprinklers, and that if such a source is present less zones of higher flow could be used for the other watering elements. Another benefit of a pump would be to eliminate the affect of other house draws affecting the irrigation system, similar to the effect on a main water fed shower when a tap is turned on.


Booster pump pressure graph
Pressure bar
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
Flow l/m