On-site Wastewater Management Training Course

Irrigation Systems

Componentry, Selection and Design

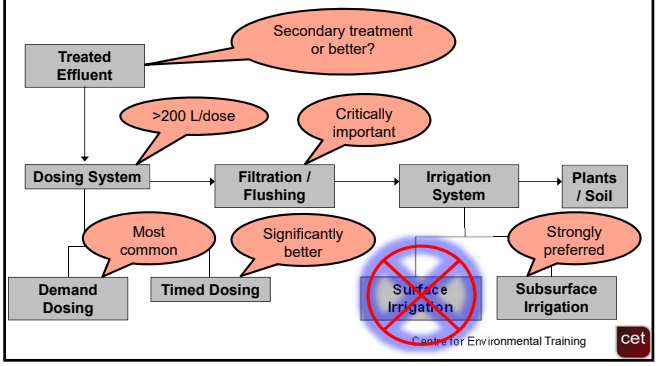
Irrigation Systems

- As effluent quality is not always consistent or compliant, irrigation must be managed to minimise public health and environmental risks, especially if irrigation is at the surface
- Whilst irrigation area sizing is important, it is equally important to design, select and configure the components of an irrigation system to ensure even distribution and effective operation

This Presentation

- Describes the components which commonly make up irrigation systems for effluent treated by on-site systems
- Discusses some selection issues
- Emphasises that components of a wastewater system must be matched and that irrigation systems require careful hydraulic design to ensure effective and compliant operation

What Makes Up an Irrigation System



System Components

- Wastewater source
- Treatment system
- Dosing mechanism
  - Pump
  - Flout or Siphon
- Non-return valve
- Pressure reducing valve
- Filter
- Mainline, submains
- Indexing (sequencing) valve
- Laterals
- Drippers or sprinklers
- Air/vacuum valves
- Dripper line non-leakage (DNL) valves
- Flush valves
- Flush line, field flush

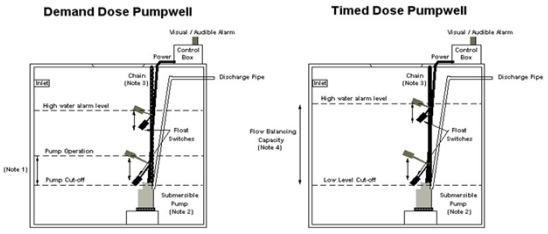
Dose and Dosing Mechanism

- AS/NZS1547:2012 recommends 200L minimum
- Should be 2-3 x the system fill volume
- Larger volumes result in better field distribution
- Technologies used for dosing:
  - Pump for pressure system
  - Flout or Siphon for low pressure (drilled pipe) system
- Tipping bucket not appropriate – dose too small

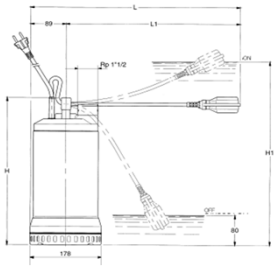
Ensuring Even Distribution

- Float switches do not balance shock wastewater loads
- Constrained sites may require a balance tank and timer controlled pump to ensure even distribution over time
- A high level alarm should be fitted to the system to warn of system failure

Demand Dosing vs Timed Dosing



Dose Volume



Cut in level

Cut out level

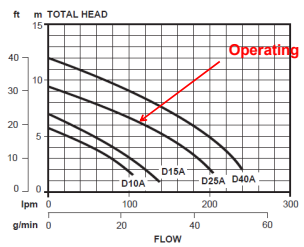
x Basal area of tank represents dose volume

Pump Selection

- Needs to be appropriate for wastewater
- Made of non-corrosive materials
- Correct hydraulic duty (Flow (Q) and Head (H)) for actual operating point of the system
- Operating point needs to be as close to optimum efficiency point (mid-point on pump curve) as possible
- Need to determine appropriate operating point
- Affordability – beware cheap pumps

Pump Selection

- Pump performance is described by a pump curve
- In terms of Head (H) and Flow (Q)



Pump Selection

- Surface irrigation systems using common domestic rotary sprinklers and spray heads operate correctly with ~4-10m head at the top of system, and flow rates of 2-6L/min for each sprinkler operating
- Sprinkler operating head + friction loss in the pipe will almost always require most if not all of this head capacity (leaving limited capacity for static lift)
- Subsurface irrigation systems typically require a 10-30m head operating pressure

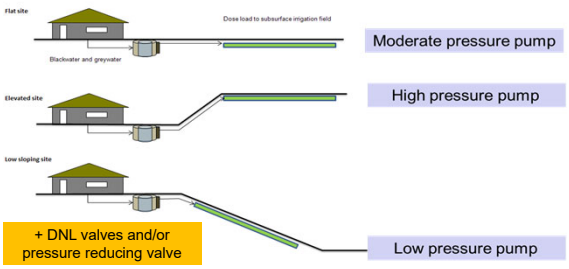
Pump Selection

- Typical pumps in many accredited AWTS/STS have:
  - 6-12m maximum head capacity
  - 33-130L/min maximum flow rate
- Pumps supplied are often of insufficient capacity to uniformly irrigate correctly sized irrigation areas (based on appropriate DIR for soil type and/or water and nutrient balances), even when divided into a number of smaller sections or zones

Pump Selection

- Uneven effluent distribution is a significant contributor to poor AWTS performance, or failure
- Irrigation area sizing requirements may create need for a bigger pump than typically supplied
- A one size fits all approach to pumps is not practical
- Pump should be selected to meet specific requirements of each site

Pump Selection



Low Pressure Dosing Devices

Siphon

Flout

Filters

- Filtration of effluent is essential for effective irrigation
- Cylindrical mesh filters are usually sufficient for surface irrigation systems (typically 150 mesh, 100 micron rated filters)
- Disc filters are more suitable for subsurface irrigation systems
- Need regular cleaning as part of each service
- If filter clogs frequently, need to investigate and solve treatment system problem

Filters

Mesh filter

Disc filter

Mainlines, Submains

- Typically 25mm or larger diameter PVC or polyethylene piping
- Manifold and laterals should be buried
- In older systems, may sit on ground surface
- Most Councils no longer allow laterals to be on the surface
- Surface exposure increases potential for damage (e.g. mowers, animals) and degradation (e.g. exposure to UV)

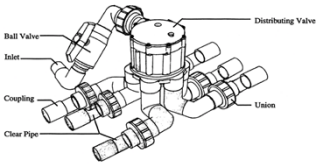
Mainlines, Submains

Pipe selection is part of hydraulic design. Need to consider:

- Energy losses in pipe
- Flushing velocity required to entrain air and sediment >0.8m/sec (some >0.3m/sec)
- Pressure rating - AS/NZS requires pipes to be rated at 150% of the shut off head (of the pump)
- Consider cost, including fittings

Indexing (Sequencing) Valves

- Used to automate and sequentially deliver doses to each zone
- Improves hydraulic performance of the irrigation field and reduces demand on pump

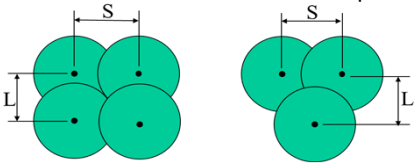


Surface Irrigation

- Wide variety of spray heads (rotary, impact, spray nozzles, drippers) and risers (fixed, spike, pop-up)
- There are only a limited range of spray heads specifically designed for domestic effluent irrigation (larger orifices), but many for clean water (smaller orifices which readily block)
- Sprays must not generate aerosols and should have a throw and plume height that is suitable for the site

Sprinkler Layout and Recommended Overlap

Average conditions:
S = L = 60% of the wetted diameter of sprinkler
Windy or exposed conditions:
S = L = 50 % of the wetted diameter of sprinkler



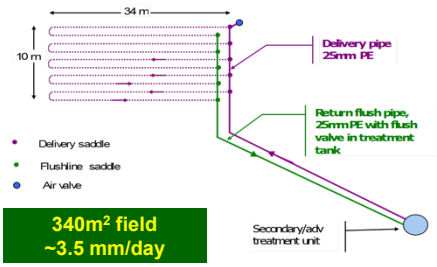
Subsurface Irrigation

- Significant developments in subsurface drip technology for effluent irrigation makes subsurface irrigation the industry standard
- Involves pressure dosing of 16mm pipe fitted with turbulent flow or pressure compensating emitters
- Built-in or dosed protection against root intrusion and biofilm development (Trifluralin)

Subsurface Irrigation

- Places effluent directly in the root zone and prevents surface runoff during rainfall
- Allows more use of and ease of maintenance of an irrigation area
- Careful hydraulic design and layout is essential (effluent filtration, line flushing, vacuum release valves, correct spacing of laterals/emitters etc.); though this is often not undertaken

SSI Setup for 1,200L/day System on Category 4 Soil



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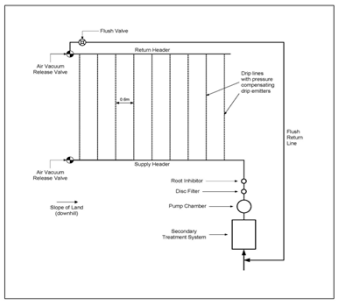
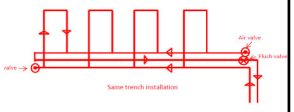
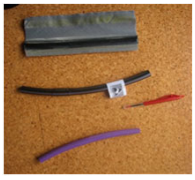
Subsurface Irrigation System Layout



Revised Figure M1
Page 167
AS/NZS1547:2012 to ensure even pressure in lines for effective distribution and flushing



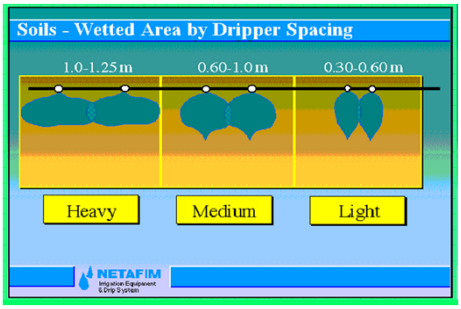
Dripper Lines



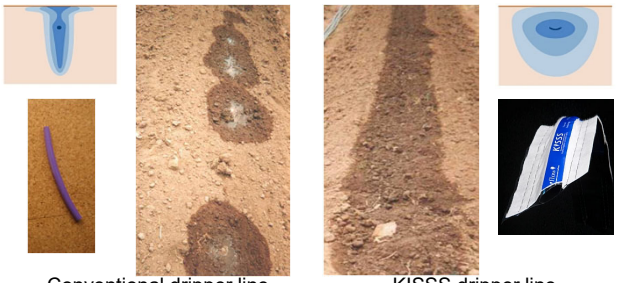
Dripper Laterals

- Typically buried at 100-150mm depth
- May be placed on surface beneath mulch
- Commonly pressure compensating (PC) and anti-siphon (AS) for sloping sites, or
- Non-pressure compensating for flat sites
- Laterals commonly spaced 0.6-1.0m apart depending on soil texture
- Space laterals more widely at bottom of slope
- Maximum 100m dripper line run length

Dripper Spacing



Dripper Line Selection



Conventional dripper line

KISSS dripper line

Pressure Compensation

- Flowrate from the drippers remains constant for varying in-line pressures. Why is this important?

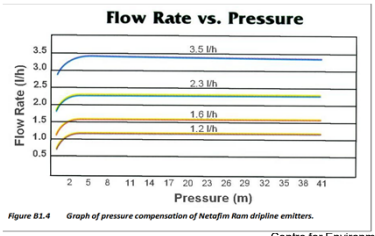
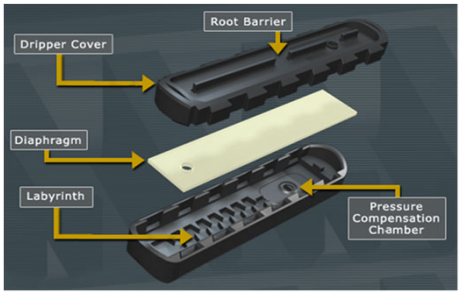


Figure B1.4 Graph of pressure compensation of Netafim Ram dripline emitters.

Pressure-compensating Emitters



Operating Pressure and Flowrate

- Typical operating pressures - 5 to 40m.head
- Typical flow rate - 1.5 to 4.0L/hr per dripper (some specify per metre)
- What factors should be considered when selecting emitter pressure and flowrate?

Dripper Line (Tube) Non-leakage Valve (DNL/TNL)

- Shuts off flow through the valve when line pressure drops below 2, 4 or 6m.head
- Opens and allows flow when the line pressure exceeds 8, 12 or 16m.head

Model	Shut-off pressure (m) **	Minimum Operating Pressure (m) **	Max. working Pressure (m)	Recommended Flow rate range (l/hr)
RED	2.0m *(2.0m)*	8.0m *(4.0m)*	40m	0-1,000
BLACK	4.0m *(4.0m)*	12.0m *(7.0m)*	40m	0-1,000
BROWN	6.0m *(8.0m)*	16.0m *(11.0m)*	40m	0-1,000

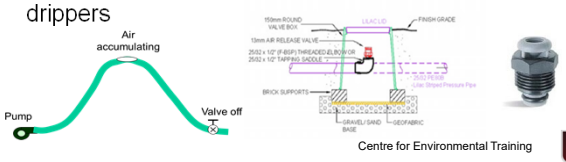
DNL/TNL Valve

- Eliminates the need for the irrigation system to refill at the beginning of each irrigation cycle by holding pressure in the irrigation lines and thus keeping them filled. This ensures the system reaches operating pressure in the minimum of time
- The DNL valve prevents draining of the system to the lowest point where the system is installed on a slope, thus providing a more uniform distribution of effluent

Airlocks / Air (Release) Valve

Installed at high points to:

- Evacuate air from the laterals during system start-up, and
- Prevent a vacuum from occurring after pump turns off, thus avoiding debris intrusion into the drippers



Flushing / Flush Valve

- Can return flush line to the treatment system, or field flush to a soak away (gravel pit)
- Flush valves can be automatic or manual
- Automatic flush on start-up; flushes ~4 litres


automatic


manual

Flush Valve Operation

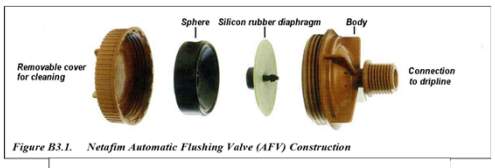


Figure B3.1. Netafim Automatic Flushing Valve (AFV) Construction

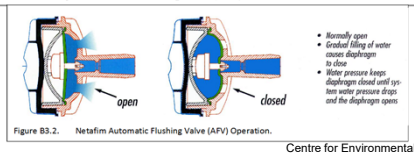
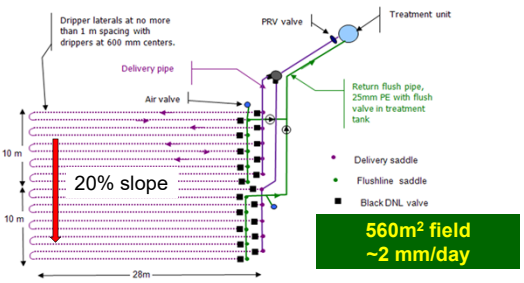


Figure B3.2. Netafim Automatic Flushing Valve (AFV) Operation.

Flushing Velocity

- Flushing velocity can be calculated using the continuity equation (part of hydraulic design)
- Must be sufficient to entrain air and sediment in lines
- Typically >0.8m/sec required
- Some driplines rated >0.3m/sec

SSI Setup for 1,200L/day System on Category 6 Soil



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Installation – Critical Phase

- Clear and detailed specifications
- Competent and experienced installers
- Follow manufacturers instructions / manuals
- Pipe installation to AS/NZS standards
- May need to rotary hoe or improve ground
- Protect against future damage
- Divert run-on stormwater
- Erect warning signs
- Fence off
- Observe OH&S requirements
- Make good

Commissioning

- Check pumps and aerators
- Fill pump well with clean water
- Pressure test all pipelines
- Check for leaks
- Check flush lines
- Check alarm system
- System should be inspected by regulator at this stage

Management of Irrigation Systems

- Do not irrigate low growing crops which are not cooked before eating
- Avoid vehicular and animal traffic
- Keep clear of sensitive receptors such as; clotheslines, swimming pools, barbeques, children's play equipment, open windows etc.

Operation, Maintenance and Servicing Manuals

1. For home owner
2. For servicing agent:
   - Flushing – automated/manual
   - Regular monitoring and cleaning of filter(s)
   - Regular check for blockages, leaks and surface ponding
   - Desludging monitoring
   - Power outage procedures
   - Record keeping:
     - File as-built plans
     - Record location of pipelines
     - Record failures and problems
     - Service report to Council and copy to owner

Summary

Design requires application of understanding of:

- Site specific details (soils, slope, flood and/or frost risk, landscape requirements, local regulations etc.)
- Nature of effluent being handled
- Equipment performance and interaction of components
- Clear understanding of required outcomes
- Careful hydraulic design to match components and ensure satisfactory hydraulic performance