Lowridge Onsite Technologies, LLC Continuous Flush

Subsurface Drip Design Manual, 1.0

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Preface

This manual is intended to provide the onsite wastewater industry with a method to design subsurface drip dispersal systems that are simple, cost effective, and can meet the intention of automatic flushing. This methodology is called *continuous flush.* With this method of design the drip tubing is flushed each time the dripfield is dosed, preventing slime and debris build-up from occurring.

Continuous Flush vs. Manual Flush:

Manual flushing means that an operator must manually open the flush valve to scour the drip tubing network. Continuous flushing is intended to prevent the accumulation of material on the interior tubing wall. The defining difference between *manual flushing* and *continuous flushing* is that manual flushing has no flushing velocity during the dose cycle while continuous flushing has a minimum velocity during the dose cycle at all points in the network. The other difference is location of the terminal end of the flush line. With *Continuous Flushing* the flush line must terminate in the pump chamber where the dripfield dose pump is located. With manual flush, the flush line can terminate either in the pump chamber or at the beginning of the system, such as the inlet of a septic tank. (See illustration below).

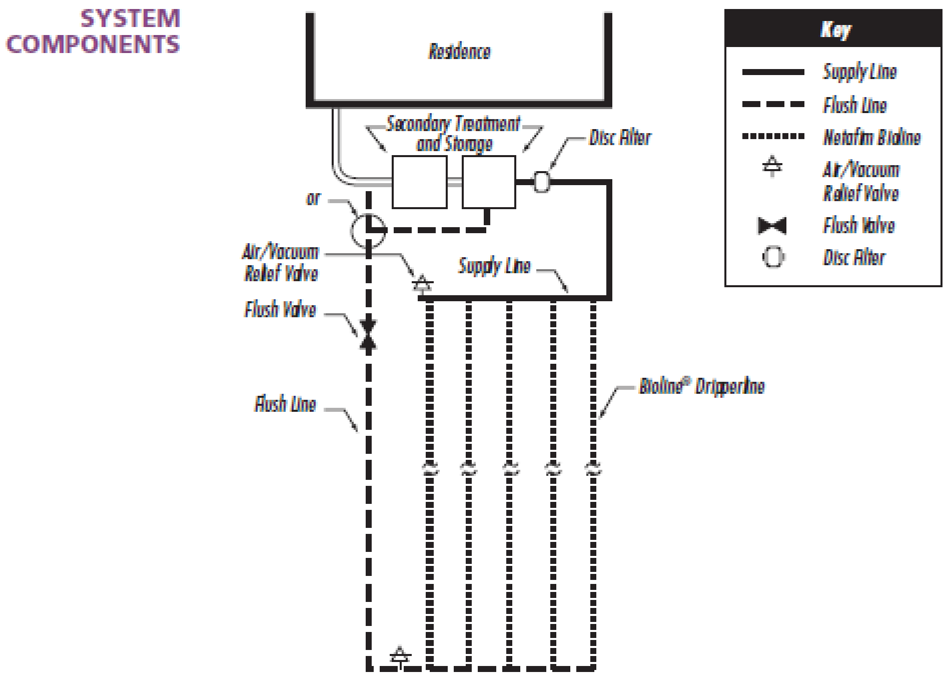


Illustration courtesy of *Netafim USA*

Overview

Subsurface drip dispersal systems are designed to hydraulically accomplish two objectives:

- Deliver a set volume of wastewater to the receiving soil or media and
- Flush the interior of the drip tubing network to remove accumulated biological slimes or "re-growth".

Most drip dispersal design manuals call for two distinctly different cycles - a dose cycle and a flush cycle. The two cycles are distinguishable by the position of a flush valve. When the flush valve is closed, the system will dose effluent into the dripfield at relatively high inlet pressure and low flow. When the flush valve is open, the system will flush the piping network at low inlet pressure and high flow rate.

In addition to the two types of cycles there are two traditional ways to accomplish the flush cycle: automatically or manually. Automatic flushing is accomplished using complex control equipment and electronic valves, synchronized with the pump. Flushing occurs automatically at prescribed time intervals. Manual flushing is accomplished with the use of simple ball valve(s) and requires an operator to periodically open and close the valve(s). A third option is called "*continuous flush*".

With *"continuous flushing"*, both the minimum pressure for dosing and the minimum flow for flushing are achieved during every dose cycle, simultaneously. (The emitters used in this application must be *pressure compensating*. Pressure compensating means that within a given pressure range (7 to 60 psi) each emitter will discharge at the same rate, within a very narrow range. The flush valve position is static and does not require any adjustment between the dosing and flushing cycles. Flushing velocities can vary from each system design from 1 to 3 ft/sec. Differing velocities can be used depending on the cleanliness of the effluent or other design consideration.

Regardless of the flushing method (manual, automatic, or continuous) all systems must be designed to accomplish a dose and flush cycle. The number of emitters, zones, laterals within each zone and lateral lengths are all factors that determine the pump and supply line size and can affect the system's ability to adequately prevent or remove slime build-up from the interior walls of the piping network.

The *Lowridge* continuous flush process has several basic parameters for design and operation. For virtually all single family residence designs, the same headworks, pump, and dripline 0.42 gph Netafim Bioline® are used.

Pump: The same sized pump can be used when the maximum number of emitters is limited to 1000 per zone. One type of pump that fits most residential application is a 20 gpm turbine pump, such as an Orenco PF200511. This pump can deliver the flows necessary for flushing and simultaneously supply the minimum pressures needed for dosing.

Design Aids:

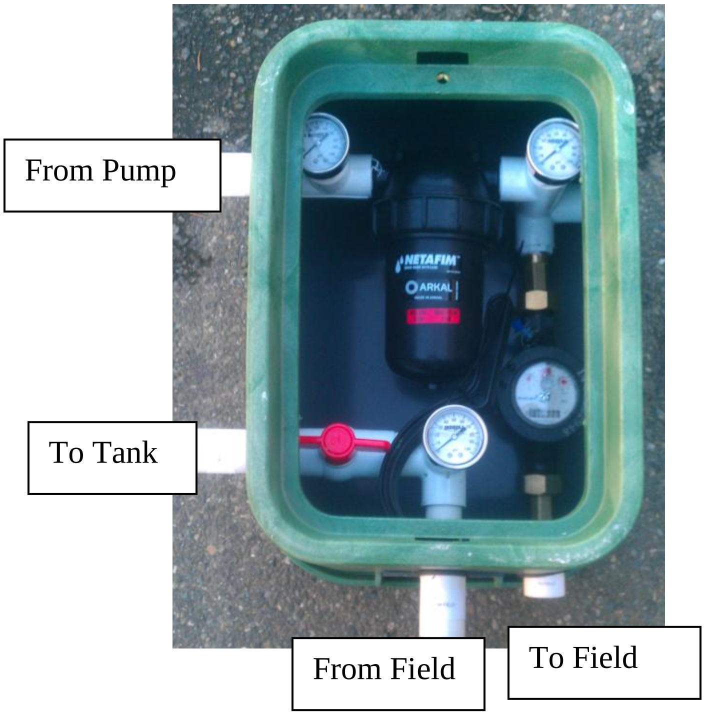
Residential Calculator: The calculator is an .xls format design aid that allows the engineer/designer to manipulate a number of input design variables to determine the total amount of tubing and emitters, minimum and maximum number of laterals, length of tubing per lateral, pump "on" and "off" times per cycle per zone, dripfield area requirements, and pump flow rates and total dynamic head (TDH) while maintaining minimum scouring velocity throughout the piping network. The calculator produces TDH and flow values for both dosing and flushing, simultaneously. The calculator can be found at www.lowridgetech.com. Click on the "Drip Dispersal" link.

In the appendices of this manual, you will find a worksheet for hand calculations and two design examples. It is suggested to master the *continuous flush* design method by hand before trying to use the .xls calculator.

For design flows greater than a single family residence, contact *Lowridge Onsite Technologies, LLC* for assistance.

Headworks Operation: The *Lowridge Onsite Technologies, LLC Continuous Flush Headworks* will forward flush the dripline while maintaining the designated flushing velocity during each dose event. To adjust the headwork for continuous flush operation, use the following steps:

1. Open the field flush valve and flush the entire piping network of construction debris by running the pump for several minutes.
2. Shut off the pump and clean the disk filter of accumulated debris and replace disc cartridge. It may be necessary to repeat this step to insure there is no debris accumulating on the disk cartridges.
3. Turn the pump on. With the pump running, slowly close the field flush valve. Once the needles on the pressure gauges stabilize, record the flow rate through the flow meter for one minute. This will be the actual dose flow rate of the drip tubing and this flow rate will be needed to calculate the dose volume settings.
4. Calculate the flushing flow rate by multiplying the number of supply manifold connections by the flushing flow rate factor: 1.6 gpm (2 ft/sec) for septic tank effluent or 0.8 gpm (1 ft/sec) for secondary treated effluent. Add the dosing flow rate from step 2 to the flushing flow rate. This new accumulative, minimum flow rate is the minimum flow rate needed to achieve adequate scouring velocity in the entire system when the system is dosed.
5. With the pump running, open the field flush valve slowly until the return pressure gauge reads 10 psi.
6. Record the flow rate through the flow meter. It should be greater than the new accumulated flow rate required in step 3. More is better.



Lowridge Onsite Technologies' Continuous Flush Headwork

The main components of the headworks are:

- 1"disk filter with 120 mesh, 130 micron rings
- Three pressure gauges
- Flow meter
- One ball valve

The disk filter has been upsized from what would normally be required for up to 1000 emitters at 0.42 gph flow rate for better performance. Upsizing the filter also increases the service interval and mitigates the need to "backflush" the filter between service calls.

Appendix A

<u>O&M Requirements:</u>

Operation and maintenance shall be provided at twelve (12) month intervals. Servicing shall include:

1.) Physically removing filter cartridge and washing all debris from all disks whenever the pressure differential across the filter is 5 psi or greater,

2.) Flushing the dripfield,
3.) Verifying dosing flow rate,
4.) Checking for wet spots in dripfield,
5.) Checking operation of air relief valves,
6.) Verifying and checking operating pressure.

The service provider must have been trained in servicing procedures for this particular headworks and system arrangement.

Appendix B

Design Guide for Residential Applications

Design Flow: ___________gpd
Soil Type: __________
Number of Emitters:_____________
Emitter spacing: _____ ft.
Total Drip line: ______ (# of emitters x emitter spacing in feet)
Number of Zones: _____
Number of Emitters per Zone: ______ (total number of emitters / number of zones)
Emitter discharge rate per Zone: _______ gpm (emitter discharge rate gph x # emitters / 60)

Select Inlet Pressure and Max Lateral Length: ______ psi, lateral length:_____ft. (see Bioline Flushing Chart on page 14).
Determine Maximum Number of Laterals: ______ (pump discharge rate – zone discharge rate gpm) / 1.6 for septic tank effluent or 0.8 for treated effluent.

Pump Selection:

TDH

Dripfield pressure (psi x 2.31= ft head): _______ ft. head
Disk Filter loss: ______
Elevation: ________
Friction loss through pipe network: ________
Valves (hydrotech): _________

Total head loss: ___________

Flow rates:

Dosing: __________ gpm (from above)
Flushing: _________ gpm (# of supply manifold connections x desired flow rate)
Total flow: _________ gpm (dosing + flushing flow rate)

Appendix C

Maximum Emitter Discharge Rate Table

Soil Type	1	2	3	4	5	6
Max emitter discharge rate/day (GPD)	1	1	0.8	0.8	0.5	0.25

Appendix D

<u>Flush Velocity vs. Flow Rate per Lateral</u>

Type of System	Recommended Flush Velocity	Add'l. flow Required per Lateral
Septic Tank	2 FPS	1.6 GPM
Treatment System	1 FPS	0.8 GPM

Appendix E

FRICTION LOSS CHARACTERISTICS PVC SCHEDULE 40 IPS PLASTIC PIPE

(1120, 1220)

C=150

Sizes ½" to 6"

Flows 1 to 900 GPM

PSI Loss of 100 Feet of Pipe (psi per 100 feet)

SIZE		½"		¾"		1"		1 ¼"		1 ½"		2"		2 ½"		3"		4"		6"	
I.D.		0.622"		0.824"		1.049"		1.380"		1.610"		2.067"		2.469"		3.068"		4.026"		6.065"	
O.D.		0.840"		1.050"		1.315"		1.660"		1.900"		2.375"		2.875"		3.500"		4.500"		6.625"	
Wall Thk		0.109"		0.113"		0.133"		0.140"		0.145"		0.154"		0.203"		0.216"		0.237"		0.280"	
Flow GPM	Flow GPM	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss
1	60	1.06	0.43	0.60	0.11	0.37	0.03	0.21	0.01	0.16	0.00	0.10	0.00	0.07	0.00	0.04	0.00	0.03	0.00	0.01	0.00
2	120	2.11	1.55	1.20	0.39	0.74	0.12	0.43	0.03	0.32	0.02	0.19	0.00	0.13	0.00	0.09	0.00	0.05	0.00	0.02	0.00
3	180	3.17	3.28	1.80	0.84	1.11	0.26	0.64	0.07	0.47	0.03	0.29	0.01	0.20	0.00	0.13	0.00	0.08	0.00	0.03	0.00
4	240	4.22	5.59	2.41	1.42	1.48	0.44	0.86	0.12	0.63	0.05	0.38	0.02	0.27	0.01	0.17	0.00	0.10	0.00	0.04	0.00
5	300	5.28	8.45	3.01	2.15	1.86	0.66	1.07	0.17	0.79	0.08	0.48	0.02	0.34	0.01	0.22	0.00	0.13	0.00	0.06	0.00
6	360	6.34	11.85	3.61	3.02	2.23	0.93	1.29	0.25	0.95	0.12	0.57	0.03	0.40	0.01	0.26	0.01	0.15	0.00	0.07	0.00
7	420	7.39	15.76	4.21	4.01	2.60	1.24	1.50	0.33	1.10	0.15	0.67	0.05	0.47	0.02	0.30	0.01	0.18	0.00	0.08	0.00
8	480	8.45	20.18	4.81	5.14	2.97	1.59	1.72	0.42	1.26	0.20	0.76	0.06	0.54	0.02	0.35	0.01	0.20	0.00	0.09	0.00
9	540	9.50	25.10	5.41	6.39	3.34	1.97	1.93	0.52	1.42	0.25	0.86	0.07	0.60	0.03	0.39	0.01	0.23	0.00	0.10	0.00
10	600	10.56	30.51	6.02	7.77	3.71	2.40	2.15	0.63	1.58	0.30	0.96	0.09	0.67	0.04	0.43	0.01	0.25	0.00	0.11	0.00
11	660	11.61	36.40	6.62	9.26	4.08	2.86	2.36	0.75	1.73	0.36	1.05	0.11	0.74	0.04	0.48	0.02	0.28	0.00	0.12	0.00
12	720	12.67	42.77	7.22	10.88	4.45	3.36	2.57	0.89	1.89	0.42	1.15	0.12	0.80	0.05	0.52	0.02	0.30	0.00	0.13	0.00
14	840			8.42	14.48	5.20	4.47	3.00	1.18	2.21	0.56	1.34	0.16	0.94	0.07	0.61	0.02	0.35	0.01	0.16	0.00
16	960			9.63	18.54	5.94	5.73	3.43	1.51	2.52	0.71	1.53	0.21	1.07	0.09	0.69	0.03	0.40	0.01	0.18	0.00
18	1,080			10.83	23.06	6.68	7.12	3.86	1.88	2.84	0.89	1.72	0.26	1.21	0.11	0.78	0.04	0.45	0.01	0.20	0.00
20	1,200			12.03	28.03	7.42	8.66	4.29	2.28	3.15	1.08	1.91	0.32	1.34	0.13	0.87	0.05	0.50	0.01	0.22	0.00
22	1,320			13.24	33.44	8.17	10.33	4.72	2.72	3.47	1.28	2.10	0.38	1.47	0.16	0.95	0.06	0.55	0.01	0.24	0.00
24	1,440					8.91	12.14	5.15	3.20	3.78	1.51	2.29	0.45	1.61	0.19	1.04	0.07	0.60	0.02	0.27	0.00
26	1,560					9.65	14.08	5.58	3.71	4.10	1.75	2.49	0.52	1.74	0.22	1.13	0.08	0.66	0.02	0.29	0.00
28	1,680					10.39	16.15	6.01	4.25	4.41	2.01	2.68	0.60	1.88	0.25	1.22	0.09	0.71	0.02	0.31	0.00
30	1,800					11.14	18.35	6.44	4.83	4.73	2.28	2.87	0.68	2.01	0.28	1.30	0.10	0.76	0.03	0.33	0.00
35	2,100					12.99	24.41	7.51	6.43	5.52	3.04	3.35	0.90	2.35	0.38	1.52	0.13	0.88	0.04	0.39	0.00
40	2,400							8.58	8.23	6.30	3.89	3.82	1.15	2.68	0.49	1.74	0.17	1.01	0.04	0.44	0.01
45	2,700							9.65	10.24	7.09	4.83	4.30	1.43	3.02	0.60	1.95	0.21	1.13	0.06	0.50	0.01
50	3,000							10.73	12.44	7.88	5.88	4.78	1.74	3.35	0.73	2.17	0.25	1.26	0.07	0.56	0.01
55	3,300							11.80	14.84	8.67	7.01	5.26	2.08	3.69	0.88	2.39	0.30	1.39	0.08	0.61	0.01
60	3,600							12.87	17.44	9.46	8.24	5.74	2.44	4.02	1.03	2.60	0.36	1.51	0.10	0.67	0.01
65	3,900							13.94	20.23	10.24	9.55	6.21	2.83	4.36	1.19	2.82	0.41	1.64	0.11	0.72	0.02
70	4,200									11.03	10.96	6.69	3.25	4.69	1.37	3.04	0.48	1.76	0.13	0.78	0.02
75	4,500									11.82	12.45	7.17	3.69	5.03	1.55	3.25	0.54	1.89	0.14	0.83	0.02
80	4,800									12.61	14.03	7.65	4.16	5.36	1.75	3.47	0.61	2.02	0.16	0.89	0.02
85	5,100									13.40	15.70	8.13	4.65	5.70	1.96	3.69	0.68	2.14	0.18	0.94	0.02
90	5,400											8.61	5.17	6.03	2.18	3.91	0.76	2.27	0.20	1.00	0.03
95	5,700											9.08	5.72	6.37	2.41	4.12	0.84	2.39	0.22	1.06	0.03
100	6,000											9.56	6.29	6.70	2.65	4.34	0.92	2.52	0.25	1.11	0.03
110	6,600											10.52	7.50	7.37	3.16	4.77	1.10	2.77	0.29	1.22	0.04
120	7,200											11.47	8.82	8.04	3.71	5.21	1.29	3.02	0.34	1.33	0.05
130	7,800											12.43	10.22	8.71	4.31	5.64	1.50	3.28	0.40	1.44	0.05
140	8,400											13.39	11.73	9.38	4.94	6.08	1.72	3.53	0.46	1.55	0.06
150	9,000													10.05	5.61	6.51	1.95	3.78	0.52	1.67	0.07
160	9,600													10.72	6.33	6.94	2.20	4.03	0.59	1.78	0.08
170	10,200													11.39	7.08	7.38	2.46	4.28	0.66	1.89	0.09
180	10,800													12.06	7.87	7.81	2.73	4.54	0.73	2.00	0.10
190	11,400													12.73	8.70	8.25	3.02	4.79	0.81	2.11	0.11
200	12,000													13.40	9.56	8.68	3.32	5.04	0.89	2.22	0.12
225	13,500															9.76	4.13	5.67	1.10	2.50	0.15
250	15,000															10.85	5.02	6.30	1.34	2.78	0.18
275	16,500															11.93	5.99	6.93	1.60	3.05	0.22
300	18,000															13.02	7.04	7.56	1.88	3.33	0.26
325	19,500																	8.19	2.18	3.61	0.30
350	21,000																	8.82	2.50	3.89	0.34
375	22,500																	9.45	2.84	4.16	0.39
400	24,000																	10.08	3.20	4.44	0.44
425	25,500																	10.71	3.58	4.72	0.49
450	27,000																	11.34	3.98	5.00	0.54
475	28,500																	11.97	4.40	5.28	0.60
500	30,000																	12.60	4.83	5.55	0.66
550	33,000																	13.86	5.77	6.11	0.79
600	36,000																			6.66	0.92
650	39,000																			7.22	1.07
700	42,000																			7.77	1.23
750	45,000																			8.33	1.39
800	48,000																			8.88	1.57
850	51,000																			9.44	1.76
900	54,000																			9.99	1.95

Note: Shaded areas of the chart indicate velocities over 5 Ft/Sec. Use with Caution.

Velocities are calculated using the general equation:
V = (0.4085 * (Q / d^2)

Friction Losses are calculated using the Hazen-Williams Equation:
Hf = 0.2083 * (100 / C)^1.852 * (Q^1.852 / d^4.866)

V = FPS (feet per second)

Hf = PSI/100 Ft. (pounds per square inch per 100 feet)

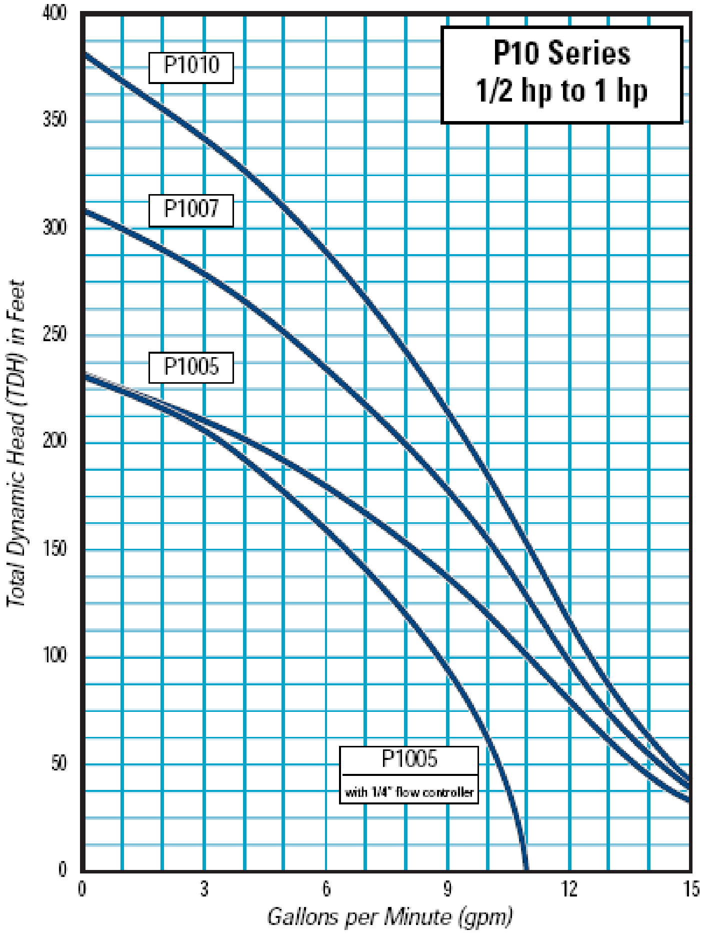
C = 150

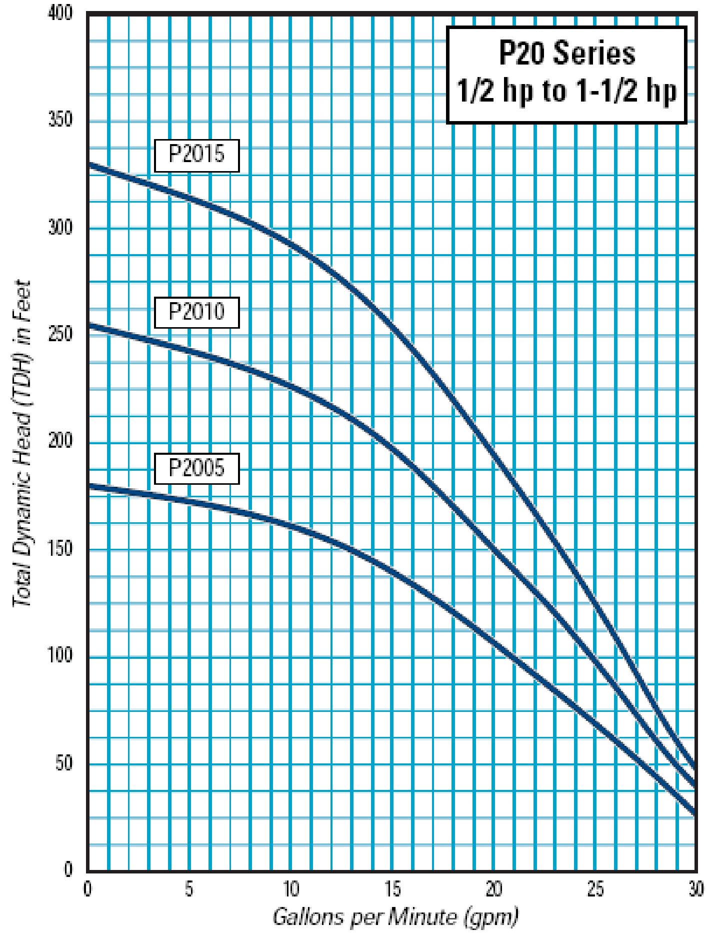
Q = GPM (gallons per minute)

d = ID (inside diameter)

Chart courtesy of Netafim USA

Appendix F, Sample pump curves.





Appendix G: Design Steps

Properly sizing a drip dispersal system requires addressing a number of factors: total number of emitters, inlet pressure, number of zones, number of laterals within each zone, and desired flushing velocity. Use Appendix A as a guide for the steps listed.

<u>Step 1. Determine the Number of Emitters:</u>

The number of emitters is determined by soil type and design flow rate in gallons per day.

<u>Step 2. Determine Maximum Lateral Lengths:</u>

Refer to *Netafim's* design manual. Always use the flushing chart to determine lateral lengths. **DO NOT USE** the ***<u>Dosing lateral laterals!</u>***

Step 3. Calculate the Number of Laterals:

The number of laterals is determined by dividing the lateral length into the total amount of tubing within the zone. For all fractional results, round up to the next whole number. An adjustment to the lateral length as a function of the number of laterals will be required. Divide the number of laterals into the total number of emitters required will result in a new, shorter, lateral length.

Step 4. Calculate Minimum Flow Rate:

Two flow rates, dosing and flush, are combined to determine the minimum flow rate.

Dosing flow rate:

$$\frac{\text{Total number of emitters in one zone x emitter discharge rate (gph)}}{\text{60 minutes/hour}} = \textbf{dosing flow in gpm}$$

Flushing flow rate for 2 ft/sec:
Number of laterals per zone x 1.6 gpm (septic tank effluent) = **flushing flow gpm**
or
Number of laterals per zone x 0.8 gpm (treated effluent) = **flushing flow gpm**

Minimum flow rate = flushing flow + dosing flow

Step 5. Determine Friction Loss in Supply Line and Supply Line Size:

Refer to friction loss chart in the appendix. Select the pipe size that provides between 2 to 5 ft/sec velocity. Note the fiction loss.

Step 6. Calculate Total Dynamic Head (TDH):

Add the values for:
- Inlet pressure
- Elevation lift
- Supply line friction loss
- Misc. fittings and valves

Step 7. Select pump:

With the values in Steps 4 and 6 (minimum flow and TDH), select the pump that best matches the flow and pressure requirements.

Examples of the basic design for continuous flush:

Example 1:

Four (4) bedroom design flow, 480 gpd.
Soil type 5 (0.5 g/emitter/day)
Supply line length 60 ft.
Elevation change, 25 ft.

Step 1. Determine total number of emitters:

480 gpd/ .5 gpd/emitter (see appendix H) = 960 emitters @ 12" spacing = **960 ft.**

Step 2. Maximum lateral length:

Use the 0.42 gph emitter discharge rate at 12" spacing. Select **35 psi** inlet pressure from *Bioline Flushing Chart* (page 14). Maximum laterals length is **260 ft**.

Step 3. Calculate the number of laterals:

Number of laterals = 960 emitters / 260 ft = 3.69 laterals, round up to **4**.

Lateral lengths = 960 ft / 4 = 240 ft.

Step 4. Calculate minimum flow rate:

Dosing flow rate = 960 emitters x 0.42 gph / 60 minutes / hour = **6.72 gpm**

Flushing flow rate = 4 laterals x 1.6 gpm/lateral = **6.4 gpm**

Minimum flow rate = **6.72 gpm** + **6.4 gpm** = **13.12 gpm**

Step 5. Determine friction loss in supply line and supply line size:

To achieve between 2 and 5 ft/sec velocities in the supply line, see appendix F. At 13.12 gpm (rounded up to 14 gpm) a **1.25"** diameter pipe provides a velocity of **3** ft/sec and a fiction loss of 1.18 psi (**2.7 ft** of head) per 100 feet.

Step 6. Calculate Total Dynamic Head (TDH):

Inlet pressure	35 psi = 81 ft	
Elevation lift	25 ft	
Supply line friction loss (.6 x 2.7 ft)	1.6 ft	
Misc. fittings and valves	10 ft	Total= **117.6 ft.**

Step 7. Select pump:

With the values in Steps 4 and 6 (minimum flow and TDH), select the pump that best matches the flow and pressure requirements.

TDH = 117.6
Minimum flow= 13.12 gpm

Refer to appendix I, sample pump curves.

Example 2.

Four bedrooms, 480 gpd flow rate
Soil type 2, 1.0 gal/emitter/day
Elevation difference = 45 ft.
Supply line length, 120 ft.

Step 1. Determine the number of emitters:

480 / 1.0 g/emitter/day = 480 emitters

Step 2. Determine maximum lateral lengths:

15 psi inlet pressure, maximum lateral length, 115 feet

Step 3. Calculate the number of laterals:

480 feet of Bioline/ 115 ft = 4.17, round up to 5 laterals
New lateral length, 480 / 5 = 96 ft.

Step 4. Calculate minimum flow rate:

Dosing flow rate:
480 emitters x 0.42 gph/ 60 minutes/hour = **3.36 gpm**

Flushing flow rate for 2 ft/sec:
5 laterals x 1.6 gpm/lateral= **8 gpm**

Minimum flow rate = **3.36** + **8** = **1.36 gpm**

Step 5. Determine friction loss in supply line and supply line size:

A 1" diameter pipe at 11.36gpm rounded up to 12 gpm has a velocity of **4.45** ft/sec and a fiction loss of 4 psi or **9.3 ft of head**.

Step 6. Calculate Total Dynamic Head (TDH):

Add the values for:

Inlet pressure = 35 ft.
Elevation lift = 45
Supply line friction loss = 9.3 ft.
Misc. fittings and valves = 5 ft.

TDH = **94.3 ft head**

Step 7. Select pump:

Minimum flow = 11.36 gpm
TDH = 94.3

In the examples given, the number of emitters and laterals are significantly different. Yet, the flow and head requirements are met by the same pump curve.

BIOLINE DOSING CHART **Maximum Length** *(feet)* **of a Single Lateral** *(0.5 & 1.0 fps)*

Dripper Spacing		12"			18"			24"		
Dripper Flow Rate (GPH)		0.4	0.6	0.9	0.4	0.6	0.9	0.4	0.6	0.9
Flushing Velocity (fps)		0.5 / 1.0	0.5 / 1.0	0.5 / 1.0	0.5 / 1.0	0.5 / 1.0	0.5 / 1.0	0.5 / 1.0	0.5 / 1.0	0.5 / 1.0
Inlet Pressure (psi)	15	301 / 248	242 / 205	188 / 163	422 / 344	341 / 285	265 / 228	531 / 427	429 / 355	335 / 285
	25	369 / 315	296 / 258	228 / 203	520 / 440	418 / 361	323 / 286	655 / 549	527 / 453	409 / 359
	35	421 / 367	337 / 299	260 / 234	595 / 513	476 / 419	368 / 331	749 / 643	603 / 527	467 / 417
	40	443 / 389	354 / 316	273 / 248	626 / 545	501 / 445	387 / 350	790 / 683	635 / 559	491 / 441
	45	464 / 409	371 / 332	285 / 260	656 / 574	524 / 468	404 / 367	829 / 721	665 / 589	513 / 463
Flow per 100' (GPM/GPH)		0.67 / 40	1.02 / 61	1.53 / 92	0.44 / 26.67	0.68 / 41	1.02 / 61	0.34 / 20	0.51 / 31	0.77 / 46

Additional flow of 0.4 GPM required per lateral to achieve 0.5 fps.
Additional flow of 0.8 GPM required per lateral to achieve 1.0 fps.

BIOLINE DOSING CHART **Maximum Length** *(feet)* **of a Single Lateral** *(1.5 & 2.0 fps)*

Dripper Spacing		12"			18"			24"		
Dripper Flow Rate (GPH)		0.4	0.6	0.9	0.4	0.6	0.9	0.4	0.6	0.9
Flushing Velocity (fps)		1.5 / 2.0	1.5 / 2.0	1.5 / 2.0	1.5 / 2.0	1.5 / 2.0	1.5 / 2.0	1.5 / 2.0	1.5 / 2.0	1.5 / 2.0
Inlet Pressure (psi)	15	201 / 161	171 / 141	140 / 119	275 / 217	235 / 191	194 / 164	337 / 263	289 / 233	241 / 201
	25	266 / 221	222 / 190	179 / 157	366 / 302	308 / 261	251 / 218	453 / 369	383 / 321	313 / 270
	35	316 / 269	262 / 229	210 / 187	437 / 370	365 / 316	295 / 260	543 / 455	455 / 391	369 / 324
	40	337 / 290	280 / 246	223 / 200	469 / 399	391 / 340	313 / 278	583 / 493	487 / 421	393 / 347
	45	358 / 310	296 / 261	235 / 212	497 / 427	413 / 362	331 / 296	619 / 527	517 / 449	415 / 369
Flow per 100' (GPM/GPH)		0.67 / 40	1.02 / 61	1.53 / 92	0.44 / 26.67	0.68 / 41	1.02 / 61	0.34 / 20	0.51 / 31	0.77 / 46

Additional flow of 1.2 GPM required per lateral to achieve 1.5 fps.
Additional flow of 1.6 GPM required per lateral to achieve 2.0 fps.

BIOLINE DOSING CHART **Maximum Length** *(feet)* **of a Single Lateral** *(2.5 & 3.0 fps)*

Dripper Spacing		12"			18"			24"		
Dripper Flow Rate (GPH)		0.4	0.6	0.9	0.4	0.6	0.9	0.4	0.6	0.9
Flushing Velocity (fps)		2.5 / 3.0	2.5 / 3.0	2.5 / 3.0	2.5 / 3.0	2.5 / 3.0	2.5 / 3.0	2.5 / 3.0	2.5 / 3.0	2.5 / 3.0
Inlet Pressure (psi)	15	128 / 102	115 / 94	100 / 84	172 / 136	155 / 127	136 / 113	205 / 161	187 / 151	165 / 137
	25	183 / 151	161 / 136	137 / 118	248 / 203	220 / 184	188 / 161	301 / 245	268 / 223	231 / 197
	35	228 / 193	198 / 171	166 / 146	310 / 260	272 / 232	229 / 200	379 / 315	333 / 283	283 / 245
	40	248 / 211	214 / 186	178 / 158	338 / 286	295 / 254	247 / 218	413 / 347	362 / 311	305 / 267
	45	266 / 228	229 / 200	190 / 169	364 / 310	316 / 274	263 / 233	447 / 377	389 / 335	327 / 287
Flow per 100' (GPM/GPH)		0.67 / 40	1.02 / 61	1.53 / 92	0.44 / 26.67	0.68 / 41	1.02 / 61	0.34 / 20	0.51 / 31	0.77 / 46

Additional flow of 2.0 GPM required per lateral to achieve 2.5 fps.
Additional flow of 2.3 GPM required per lateral to achieve 3.0 fps.

Table 11 - Maximum Length of a Single Lateral of Bioline Based on Flushing Velocity