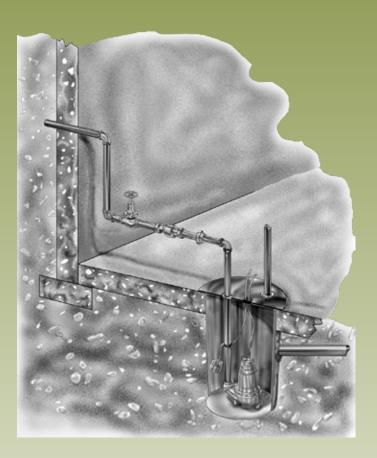
# *lastewater*

# **Guidelines for Sizing**



#### **Features**

 These guidelines cover the steps which need to be taken to accurately select the correct sewage pump and applicable systems to use in sewage ejectors.

Work through the five steps below to size the system:

- System capacity (gpm required)
- Total head
- Pump selection
  - Solids handling
- Basin size
- Simplex/Duplex system

#### **System Capacity**

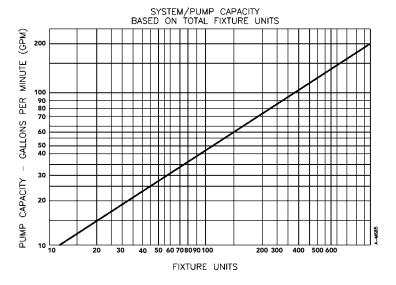
**System Capacity** refers to the rate of flow in gallons per minute (gpm) necessary to efficiently maintain the system. The "Fixture Unit" method is suggested for determining this figure. This approach assigns a relative value to each fixture or group of fixtures normally encountered. Determination of the required **System Capacity** is as follows:

- List all fixtures involved in the installation and using Figure 1, assign a Fixture Unit value to each. Add to obtain total.
- Referring to Figure 2, locate the total Fixture Unit amount along the horizontal axis of the graph and follow vertically until intersecting the plotted line. Read the **System** Capacity in gpm along the vertical axis.

Figure 1.

FIXTURE DESCRIPTION	UNIT VALUE	TOTAL USED
Bathroom group, consisting of lavatory, bathtub or shower and (direct flush) water closet	10	
Bathroom group, consisting of lavatory, bathtub or shower and (flush tank) water closet	6	
Bathtub with 1-1/2" trap	2	
Bathtub with 2" trap	3	
Bidet with 1-1/2" trap	3	
Dental unit or cuspidor	1	
Drinking fountain	1	
Dishwasher (domestic type)	2	
Kitchen sink (domestic)	2	
Kitchen sink (domestic with waste grinder)	3	
Lavatory with 1-1/2" trap	1	
Lavatory (barber or beauty shop)	2	
Laundry tray (2-compartment)	2	
Shower stall	2	
Shower (group), per head	3	
Sink (service type with floor drain)	3	
Sink (scullery)	4	
Sink (surgeons)	3	
Urinal (with flush valve)	8	
Urinal (with flush tank)	4	
Water closet (flush valve)	7	
Water closet (flush tank)	3	
Swimming pools (per 1000 gal. capacity)	1	
Unlisted fixture with 1-1/4" trap size	2	
Unlisted fixture with 1-1/2" trap size	3	
Unlisted fixture with 2" trap size	4	
Unlisted fixture with 2-1/2" trap size	5	
Unlisted fixture with 3" trap size	6	
Unlisted fixture with 4" trap size	7	
Water softener (domestic)	4	
Washing machine	2	
	TOTAL	

Figure 2.



#### **Total Head**

**Total Head** is a combination of two components — Static Head and Friction Head — and is expressed in feet (refer to Typical Installation illustration, Figure 3).

**Static Head** is the actual vertical distance measured from the minimum water level in the **Basin** to the highest point in the discharge piping.

**Friction Head** is the additional head created in the discharge system due to resistance to flow within its components. All straight pipe, fittings, valves, etc. have a friction factor which must be considered. These friction factors are converted to, and expressed as, equivalent feet of straight pipe, which can then be totaled and translated to Friction Head depending on the flow and pipe size. Basically, this is reduced to four steps.

- 1. It will be necessary to determine the discharge pipe size. In order to ensure sufficient fluid velocity to carry solids, (generally accepted to be 2' per second), flows should be at least:
  - 9 gpm through 1-1/4" pipe
  - 13 gpm through 1-1/2" pipe
  - 21 gpm through 2" pipe
  - 30 gpm through 2-1/2" pipe
  - 46 gpm through 3" pipe
- 2. The length of the discharge piping is measured from the discharge opening of the pump to the point of final discharge, following all contours and bends.
- 3. To determine the equivalent length of discharge piping represented by the various fittings and valves, refer to Figure 5 and total all values. Add this to the measured length of discharge pipe and divide by 100 to determine the number of 100' increments.
- Refer to Figure 4 and find the required Pump Capacity (determined from Figure 2). Follow gallons per minute to pipe size being used. Multiply this number by the number of 100' increments.

Add the Static Head and Friction Head to determine **Total Head**.

Figure 3.

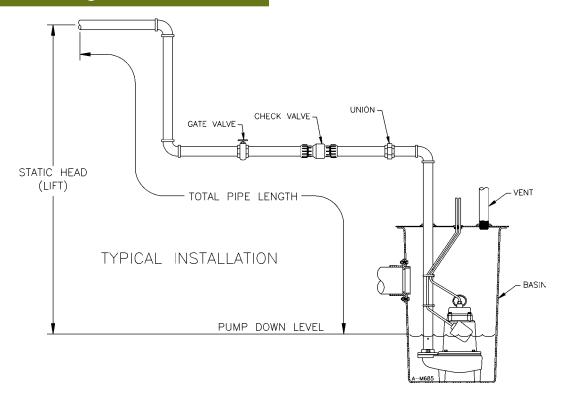


Figure 4.

PLASTIC PIPE: FRICTION LOSS (in feet of head) PER 100 FT										
REQ'D PUMP CAPACITY	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"				
GPM	ft	ft	ft	ft	ft	ft				
1	4.0									
2	.10									
3	.21	.10								
4	.35	.16								
5	.51	.24								
6	.71	.33	.10							
8	1.19	.55	.17							
10	1.78	.83	.25	.11						
15	3.75	1.74	.52	.22						
20	6.39	2.94	.86	.36	.13					
25	9.71	4.44	1.29	.54	.19					
30	13.62	6.26	1.81	.75	.26					
35	18.17	837	2.42	1.00	.35	.09				
40	23.55	10.70	3.11	1.28	.44	.12				
45	29.44	13.46	3.84	1.54	.55	.15				
50		16.45	4.67	1.93	.66	.17				
60		23.48	6.60	2.71	.93	.25				
70			8.83	3.66	1.24	.33				
80			11.43	4.67	1.58	.41				
90			14.26	5.82	1.98	.52				
100				7.11	2.42	.63				
125				10.83	3.80	.95				
150					5.15	1.33				
175					6.90	1.78				
200					8.90	2.27				
250						3.36				
300						4.85				
350						6.53				

Figure 5.

FRICTION FACTORS FOR PIPE FITTINGS IN TERMS OF EQUIVALENT FEET OF STRAIGHT PIPE											
NOMINAL PIPE SIZE	90° ELBOW	45° ELBOW	TEE (THROUGH FLOW)	TEE (BRANCH FLOW)	SWING CHECK VALVE	GATE VALVE					
1-1/4	3.5	1.8	2.3	6.9	11.5	0.9					
1-1/2	4.0	2.2	2.7	8.1	13.4	1.1					
2	5.2	2.8	3.5	10.3	17.2	1.4					
2-1/2	6.2	3.3	4.1	12.3	20.3	1.7					
3	7.7	4.1	5.1	15.3	25.5	2.0					

TOTAL HEAD R	EQUIRED	
(A) STATIC HEAL	)	
(B) TOTAL LENG	TH OF PIPING	
(C) TOTAL FRICT	TION FACTORS OF FITTINGS	
(D)	TOTAL (B+C)	
(E)	DIVIDED (D) BY 100	
(F) HEAD LOSS I	PER 100 FT. OF PIPE (from Figure 4)	
(G)	FRICTION HEAD (ExF)	
(H)	TOTAL HEAD (A+G)	

#### **Pump Selection**

Every centrifugal pump has a unique performance curve. This curve illustrates the relationship of flow **(gpm)** to pressure **(Total Head)** at any point. The pump will operate at any point along this performance curve.

Pump capacity is therefore the flow the pump will generate at any specific pressure. The object is to select a pump whose performance curve passes either through or close to the design condition, preferably above. Refer to Figure 7.

#### **Solids Handling**

**Solids Handling** requirements may be determined by local codes and/or by the type of application and types of solids anticipated. Unless otherwise stated by codes, a sewage pump should have the capability of handling spherical solids of at least 2" in diameter in installations involving a water closet.

#### **Basin Size**

Basin selection is best accomplished by relating to required **System Capacity** as determined by the **Fixture Unit** method.

Figure 6 shows recommended basin diameters, assuming the normal pump differential (distance in inches between turn-on and turn-off), and running time ranges from 15 seconds to 4 minutes. **Basin** depth, however, should be at least 24" below basin inlet for most pumps and deeper where greater pumping differentials are anticipated.

NOTE: Since basin size is directly related to frequency of pump operation, it is important to select a basin of sufficient size to ensure that the pump does not short cycle.

The question of whether to use a **Simplex** or **Duplex** system depends on the type of installation and/or local codes. Generally, a determination can be made using the following guidelines.

- 1. Domestic: Simplex System is usually adequate.
- 2. Commercial: **Optional** Depending on the type of business and the need for uninterrupted sanitary drainage facilities.
- 3. Public or Industrial: Duplex System is essential.

While you are sizing the system and before you select the pump, you will need to know and consider or make allowances for the following:

- Volts/Phase/Hertz What is available?
- Will the pump share a circuit?
- Does the home, business, etc. have circuit breakers or fuses?
- What is the breaker or fuse Amp rating? Make sure it is enough.
- Check local or state codes for:
  - Solid size requirements
  - Amp ratings/circuit cord size/ratings or type
  - Pipe material/size/depth to bury
  - Tank size/location
- Are there plans for future expansion? As in, adding upstairs bath, basement plumbing, washing machine, etc.

Figure 6.

**BASIN SIZING** 

			BA	SIN DIAM	ETER (inch	es)	
		18"	24"	30"	36"	42"	48"
	20						
	25						
	30						
	35						
Σ	40						
<u>©</u>	45						
SYSTEM CAPACITY (GPM)	50						
Å	60						
5	70						
E	80						
SYS	90						
	100						
	125						
	150						
	175						
	200						
	225						
GALLONS/FOOT OF BASIN DEPTH		13.2	23.9	36.7	52.9	72.0	94.0
GALLONS IN 2-1/2' OF BASIN DEPTH		33.0	59.7	91.7	132.2	180.0	235.0

Select minimum basin depth so that 2-1/2' of basin depth in gallons = Pump capacity in **gpm** = Acceptable basin size

#### **Example Sizing Problem**

What **Pump Capacity** would be required to handle the drainage from a 4 bathroom home, also including a dishwasher, a washer, a laundry tray, a kitchen sink, water softener, basement shower, a 13,000 gallon pool, and a bar sink (1-1/2" trap)?

#### 1. From Figure 1:

DESCRIPTION	FIXTURE UNITS
Four bathroom groups	24
Water softener	4
Dishwasher	2
Washing machine	2
Laundry tray	2
Kitchen sink with disposal	3
Basement shower	2
Swimming pool	13
Bar sink (unlisted 1-1/2")	3
FIXTURE UNITS TOTAL	55

#### 2. Refer to Figure 2:

Find 55 Fixture Units on the horizontal axis. Follow vertically until intersecting the line then horizontally to the left. The **Pump Capacity** on the vertical axis is 30 gpm.

Determine the **Total Head** of the installation illustrated in Figure 3, the Typical Installation Illustration:

- 1. That Static Head in this instance is 7'.
- 2. Friction Head:
  - a. Since the required **Pump Capacity** in this illustration of 30 gpm is less than the 46 gpm necessary to carry solids through 3" pipe, 2" or 2-1/2" pipe should be used. If 3" pipe is preferred or required, a **Pump Capacity** of at least 46 gpm is required.
  - Measurement of the length of the discharge pipe totals 200'.

c. Refer to Figure 6 and note the friction factor in equivalent feet for each fitting:

3 - 90° elbows, 2"
1 - gate valve, 2"
1 - swing check valve, 2"
17 - equivalent feet
34 - equivalent feet

Adding 34' to the measured pipe length, the total effective pipe length becomes 234' or 2.34 100' increments.

- d. Refer to Figure 4, find the 30 gpm required **Pump Capacity** on the left scale and follow over to the 2" PVC pipe size column. Friction Head is  $1.8 \times 2.34 = 4.2$ '.
- 3. Total Head Required:

Total Head = Static Head + Friction Head Example:

Total Head = 7 + 4.2 Total Head = 11.2

Due to the existence of water closets in this installation, a pump with 2" **Solids Handling** capacity should be used unless otherwise specifically stated by applicable codes. Use Figure 7 to select pump.

To determine the **Basin** size, find the **Pump Capacity** (30 gpm) in the column on the left of Figure 6. Any **Basin** diameter of 18" or greater is acceptable.

Since this application is domestic, a **Simplex System** is sufficient.

**Summary:** Recommended selections for this installation would be a **Simplex System** utilizing an 18" or greater diameter **Basin** and a 2" **Solids Handling** pump capable of delivering at least 30 gpm at 11'.

Summa	ary Worksheet
Number of Fixture Units	
Flow Rate - Gallons Per Minute	
Total Head Required	
Pump Selection	

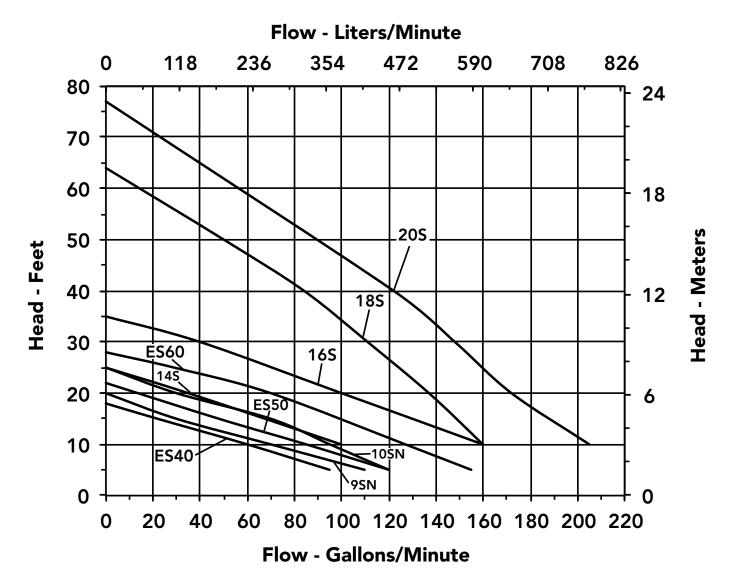
#### **Typical Single Family Dwelling Sewage Pump Chart**

Note: The data contained herein is for reference only. Proper sizing and selection of sewage pumps requires consideration of many factors. Always consult applicable local codes before installing any equipment. This chart is based on a residential application with not more than 34 fixture units (values assigned to each plumbing fixture). The TDH (Total Dynamic Head) of the system is calculated based on total vertical lift, horizontal length of discharge piping, and the friction losses for 2" diameter plastic pipe (3" diameter plastic pipe where the 16S pump is shown).

#### **Total Length of Discharge Pipe in Feet**

TOTAL	100'	150'	200'	250'	300'	350'	400'	450'	500'	550'	600'	650'	700'	750'	800'
VERT. LIFT	TDH PUMP GPM														
5'	6.3'	7.0'	7.5'	8.3'	8.9'	9.6'	10.2'	10.9'	11.5'	12.2'	12.8'	13.5'	14.1'	14.8'	15.4'
	9SN														
	97 gpm	95 gpm	92 gpm	88 gpm	82 gpm	77 gpm	72 gpm	67 gpm	61 gpm	54 gpm	48 gpm	43 gpm	38 gpm	32 gpm	27 gpm
6'	7.3'	8.0'	8.6'	9.3'	9.9'	10.6'	11.2'	11.9'	12.5'	13.5'	13.8'	14.5'	15.1'	15.8'	16.4'
	9SN	10SN													
	93 gpm	89 gpm	83 gpm	78 gpm	75 gpm	69 gpm	63 gpm	57 gpm	52 gpm	43 gpm	40 gpm	33 gpm	29 gpm	25 gpm	57 gpm
7'	8.3'	9.0'	9.6'	10.3'	10.9'	11.6'	12.2'	12.9'	13.5'	14.2'	14.8'	15.5'	16.1'	16.8'	17.4'
	9SN	10SN	10SN	10SN											
	88 gpm	81 gpm	77 gpm	70 gpm	67 gpm	59 gpm	54 gpm	47 gpm	43 gpm	36 gpm	32 gpm	26 gpm	62 gpm	54 gpm	48 gpm
8'	9.3'	10.0'	10.6'	11.3'	11.9'	12.6'	13.2'	13.9'	14.5'	15.2'	15.8'	16.5'	17.1'	17.8'	18.4'
	9SN	10SN	10SN	10SN	10SN										
	78 gpm	76 gpm	69 gpm	62 gpm	57 gpm	50 gpm	45 gpm	39 gpm	33 gpm	28 gpm	25 gpm	56 gpm	52 gpm	46 gpm	41 gpm
9'	10.3'	11.0'	11.6'	12.3'	12.9'	13.4'	14.2'	14.9'	15.5'	16.2'	16.8'	17.5'	18.1'	18.8'	19.4'
	9SN	10SN	10SN	10SN	10SN	10SN	10SN								
	70 gpm	65 gpm	59 gpm	53 gpm	47 gpm	44 gpm	36 gpm	30 gpm	26 gpm	60 gpm	54 gpm	48 gpm	42 gpm	39 gpm	33 gpm
10'	11.3'	12.0'	12.6'	13.3'	13.9'	14.6'	15.2'	15.9'	16.5'	17.2'	17.8'	18.5'	19.1'	19.8'	20.4'
	9SN	10SN													
	62 gpm	56 gpm	50 gpm	44 gpm	39 gpm	33 gpm	28 gpm	62 gpm	56 gpm	50 gpm	46 gpm	40 gpm	35 gpm	32 gpm	27 gpm
11'	12.3'	13.0'	13.6'	14.3'	14.9'	15.6'	16.2'	16.9' 1	17.5'	18.2'	18.8'	19.5'	20.1'	20.8'	21.4'
	9SN	9SN	9SN	9SN	9SN	9SN	10SN	14S							
	53 gpm	46 gpm	42 gpm	35 gpm	30 gpm	25 gpm	60 gpm	53 gpm	48 gpm	42 gpm	39 gpm	33 gpm	29 gpm	25 gpm	27 gpm
12'	13.3'	14.0'	14.6'	15.3'	15.9'	16.6'	17.2'	17.9'	18.5'	19.2'	19.8'	20.5'	21.1'	21.8'	16.4'
	9SN	9SN	9SN	9SN	10SN	14S	14S	16S							
	44 gpm	40 gpm	33 gpm	27 gpm	62 gpm	55 gpm	50 gpm	45 gpm	40 gpm	34 gpm	32 gpm	26 gpm	30 gpm	26 gpm	120 gpm*
13'	14.3'	15.0'	15.6'	16.3'	16.9'	17.6'	18.2'	18.9'	19.5'	20.2'	20.8'	22.0'	17.6'	17.9'	18.2'
	9SN	9SN	9SN	10SN	14S	16S	16S	16S							
	35 gpm	29 gpm	25 gpm	58 gpm	53 gpm	47 gpm	42 gpm	37 gpm	33 gpm	28 gpm	25 gpm	25 gpm	113 gpm*	112 gpm*	111 gpm*
14'	15.3'	16.0'	16.6'	17.3'	17.9'	18.6'	19.2'	19.9'	20.5'	21.2'	21.8'	17.6'	17.9'	18.2'	18.4'
	9SN	10SN	10SN	10SN	10SN	14S	10SN	10SN	10SN	14S	14S	16S	16S	16S	16S
	27 gpm	61 gpm	55 gpm	49 gpm	45 gpm	39 gpm	34 gpm	31 gpm	26 gpm	29 gpm	26 gpm	113 gpm*	112 gpm*	111 gpm*	110 gpm*
15'	16.3'	17.0'	17.6'	18.3'	18.9'	19.6'	20.2'	20.9'	21.5'	22.2'	18.3'	18.6'	18.9'	19.2'	19.4'
	10SN	14S	14S	16S	16S	16S	16S	16S							
	58 gpm	52 gpm	47 gpm	41 gpm	37 gpm	33 gpm	28 gpm	25 gpm	27 gpm	25 gpm	110 gpm*	109 gpm*	107 gpm*	105 gpm*	104 gpm*
16'	17.3'	18.0'	18.6'	19.3'	19.9'	20.6'	21.2'	21.9'	18.8'	19.1'	19.3'	19.6'	19.9'	20.2'	21.2'
	10SN	10SN	10SN	10SN	10SN	10SN	14S	14S	16S						
	49 gpm	44 gpm	39 gpm	33 gpm	31 gpm	25 gpm	29 gpm	26 gpm	107 gpm*	105 gpm*	104 gpm*	103 gpm*	101 gpm*	98 gpm*	95 gpm*
17'	18.3'	19.0'	19.6'	20.3'	20.9'	21.6'	22.2'	19.5'	19.8'	20.0'	20.3'	20.6'	20.9'	21.2'	22.4'
	10SN	10SN	10SN	10SN	10SN	14S	14S	16S							
	41 gpm	36 gpm	33 gpm	27 gpm	25 gpm	26 gpm	25 gpm	103 gpm*	102 gpm*	100 gpm*	99 gpm*	98 gpm*	97 gpm*	95 gpm*	95 gpm*
18'	19.3'	20.0'	20.6'	21.3'	21.9'	19.9'	20.2'	20.5'	20.8'	21.1'	21.3'	22.6'	21.9'	22.2'	22.4'
	10SN	10SN	10SN	14S	14S	16S									
	33 gpm	30 gpm	25 gpm	28 gpm	26 gpm	101 gpm*	98 gpm*	98 gpm*	97 gpm*	96 gpm*	95 gpm*	93 gpm*	91 gpm*	90 gpm*	89 gpm*
19'	20.3'	21.0'	21.6'	22.3'	20.7'	21.0'	21.2'	22.5'	21.8'	22.1'	22.3'	22.6'	22.9'	23.2'	23.4'
	10SN	14S	14S	14S	16S										
	27 gpm	30 gpm	26 gpm	25 gpm	98 gpm*	96 gpm*	95 gpm*	94 gpm*	92 gpm*	91 gpm*	90 gpm	86 gpm*	84 gpm*	82 gpm*	81 gpm*
20'	21.3'	22.0'	21.6'	21.9'	22.2'	22.5'	22.8'	23.1'	23.4'	23.7'	24.0'	24.3'	24.6'	24.9'	25.2'
	14S	14S	16S												
	28 gpm	25 gpm	95 gpm*	95 gpm*	95 gpm*	88 gpm*	85 gpm*	83 gpm*	81 gpm*	80 gpm*	79 gpm*	78 gpm*	77 gpm*	76 gpm*	75 gpm*

Figure 7.





Oklahoma City, OK 73157-2010 Phone: 1.800.701.7894 Fax: 1.800.678.7867 www.LittleGiantPump.com