SIZING GUIDELINES

For New or Replacement Sewage Pumps

Sump and Sewage Pump Manufacturers Association
CONTENTS

- **Pump Capacity** How much flow do you need?
- **Total Dynamic Head (TDH)** of the installation
- **Solids-Handling** Requirements
- **Basin** Selecting the right size
- **Simplex or Duplex** System?
- **Sizing Example**
PUMP CAPACITY

- Refers to the rate of flow in **gallons per minute (GPM)** which is necessary to efficiently maintain the system.

- Most practical approach to determine this figure is the *Fixture Unit method*. This method assigns a relative value to each fixture, or group of fixtures that flow into the pump system.
To determine the required PUMP CAPACITY, follow these 2 steps:

Step 1: Determine Total Fixture Units
Step 2: Find resulting Pump Capacity
**Step 1**

List all fixtures involved in the installation and, using Figure A, assign a Fixture Unit value to each. Determine the **Total Fixture Units**.

<table>
<thead>
<tr>
<th>Fixture Description</th>
<th>Fixture Unit Value</th>
<th>Fixure Unit Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathtub, 1 1/2&quot; trap</td>
<td>2</td>
<td>Sink, service type</td>
</tr>
<tr>
<td>Bathtub, 2&quot; trap</td>
<td>3</td>
<td>Sink, scullery</td>
</tr>
<tr>
<td>Bidet, 1 1/2&quot; trap</td>
<td>3</td>
<td>Sink, surgeons</td>
</tr>
<tr>
<td>Dental unit or cuspidor</td>
<td>1</td>
<td>Swimming pool (per 1000 gal)</td>
</tr>
<tr>
<td>Drinking fountain</td>
<td>1</td>
<td>Urinal</td>
</tr>
<tr>
<td>Dishwasher, domestic</td>
<td>2</td>
<td>Washing machine</td>
</tr>
<tr>
<td>Kitchen sink</td>
<td>2</td>
<td>Water closet</td>
</tr>
<tr>
<td>Kitchen sink with disposal</td>
<td>3</td>
<td>Water softener</td>
</tr>
<tr>
<td>Lavatory, 1 1/2&quot; trap</td>
<td>1</td>
<td>Unlisted fixture, 1 1/4&quot; trap</td>
</tr>
<tr>
<td>Lavatory, barber/beautician</td>
<td>2</td>
<td>Unlisted fixture, 1 1/2&quot; trap</td>
</tr>
<tr>
<td>Laundry tray</td>
<td>2</td>
<td>Unlisted fixture, 2&quot; trap</td>
</tr>
<tr>
<td>Shower</td>
<td>2</td>
<td>Unlisted fixture, 2 1/2&quot; trap</td>
</tr>
<tr>
<td>Shower, group (per head)</td>
<td>3</td>
<td>Unlisted fixture, 3&quot; trap</td>
</tr>
<tr>
<td>Bathroom group consisting of lavatory, bathtub or shower, and water closet</td>
<td>6**</td>
<td></td>
</tr>
</tbody>
</table>

*Graph data taken from ASPE Handbook, Uniform Plumbing Code, Cameron Hydraulic Data and Plastic Pipe Institute.

** Add 4 fixture units for each flush valve fixture
Step 2

- Refer to Figure B, locate the total Fixture Unit amount along the horizontal axis of the graph. Follow vertically along until the intersecting plotted line. Follow this intersection point horizontally and read the PUMP CAPACITY in GPM on the vertical axis.

34 Fixture units require a 22 GPM capacity.

Using 34 fixture units as an example.
TDH is a combination of **Static Head** and **Friction Head** and is expressed in feet.

**TDH = Static Head + Friction Head**

- **Static Head** is the actual vertical distance measured from the minimum water level in the BASIN to the point of discharge. Refer to Figure C.
Static Head

FIGURE C
The point of discharge *may not* be the highest point in the piping system. A pump must be selected that has a shut-off head greater than the highest point in the pipe system.
Friction Head

- 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, and expressed as equivalent feet of straight pipe, which can be totaled and translated into feet of head.
Step 1 in calculating Friction Head

- First determine the discharge pipe size.
- 2” or 3” diameter is common on solids-handling sewage applications in residential / light commercial.
- In order to ensure sufficient fluid velocity to carry solids (which is generally accepted to be 2 feet per second), the following are minimum required flows - even if the GPM required for the fixture units is less.

**MINIMUM FLOW REQUIREMENTS**

2 feet per second =
- 21 GPM through 2” pipe
- 46 GPM through 3” pipe
- 78 GPM through 4” pipe

If you don’t have these minimums – you won’t move the solids!
Step 2 in calculating friction head

- 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.
Step 3

Consider all fittings - elbows, gate valves, check valves used in the installation...

(2) …..2” 90 degree elbows = 5.2 x 2 elbows in our example = 10.4 feet of pipe
(1) ....2” check valve = 17.2 feet of pipe
Added all up....... 27.6 feet (or 28 feet)

Now add this 28’ (equivalent feet) to the existing 200’ length of discharge piping for a total of 228’.
Step 4

Refer to Figure E. Using the required PUMP CAPACITY (GPM) in the left column, follow across to the number below the pipe size being used. This number represents the Friction Head per 100 feet of pipe. Multiply this number by the number of 100ft increments to determine Friction Head.

Our Example required 22 GPM

FRICTION
Using a 2" line with flow of 25 GPM, we have 1.3 feet of head for every 100 feet of pipe. For our example with 228’ of equivalent length of pipe...

2.28 x 1.3 = 2.96 feet of head.
(round up to 3’ of Friction Head)
**TOTAL DYNAMIC HEAD (TDH) IS?**

\[
\text{TDH} = \text{Static Head} + \text{Friction Head}
\]

- Static Head = 7 Feet
- Friction Head = 3 Feet

**Total Dynamic Head = 10 Feet**

Now look at pump curves in Figure F.....
At 10 feet of head, we need a pump that can give us a minimum of 22 GPM.
Pump Selection

The pump is required to deliver at least 22 gpm at 10 feet of TDH.

Pump C & D are also adequate. But are they too large?

At 10 Feet of TDH, Pump A produces 20 GPM - Not Enough To Move Solids! Pump B will produce more than enough gpm. Probably the best fit. Pump C & D are also adequate. But are they too large?

Gallons Per Minute

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Oversizing the Pump?

- The most efficient part of the curve is usually in the middle of the curve, away from maximum head or flow.
- More horsepower or flow is not always better – especially in smaller basins.
- Short cycling may reduce the life of the pump. A longer pumping cycle will be better for pump longevity.
Solids-Handling requirements may be determined by local codes and/or by the type of application and types of solids.

Unless otherwise specifically stated, SSPMA recommends that a sewage pump should have the capacity of handling spherical solids of at least 2” diameter.
Selection of the basin is best accomplished by relating to the required Pump Capacity as determined by the Fixture Unit method.

Figure G shows the recommended Basin Diameters assuming a pump differential of 8” (Distance between pump turn-on and turn-off).

Other factors such as pump size, controls, and accessories may impact the required basin size.

Basin depth should normally be at least 24” for most pumps, and deeper where greater pumping differentials are anticipated.
**Recommended BASIN Diameters**

<table>
<thead>
<tr>
<th>GPM</th>
<th>18&quot;</th>
<th>24&quot;</th>
<th>30&quot;</th>
<th>36&quot;</th>
<th>48&quot;</th>
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<tr>
<td>20</td>
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<td>250</td>
<td></td>
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</tr>
</tbody>
</table>

*Our Example required 22 GPM*

*Any Basin 18" in diameter or greater may be acceptable*
The question of whether to use a **Simplex** (one pump) or **Duplex** (two pump) System depends on the type of installation and/or local codes requirements.

- **Domestic/Residential Use:** **Simplex** System is adequate in most instances; however if entire residence is on the system, duplex may be required.

- **Public/Commercial Use:** **Duplex** System is essential.
Simplex or Duplex System?

Duplex systems make use of special controls in order to alternate the usage of two pumps. Duplex systems provide several advantages over Simplex systems:

- The pumps alternate and therefore share the load.
- The lag pump is activated in the event of failure or lockage of the lead pump.
- The second pump is activated along with the lead pump in instances of unusually high inflow.
Using the pump curves from Figure F, fill out the Sewage Pump Sizing Worksheet and find a suitable pump to serve a 4 bathroom home, including a dishwasher, kitchen sink with disposal, washing machine, laundry tray, and a water softener.

- The Static Head is 15 feet
- The discharge pipe is 2” diameter
- The discharge piping is 500 feet long
- The discharge piping will include (1) check valve, (3) 90 degree elbows, (2) 45 degree elbows, and (1) gate valve.
Example: Pump Capacity

**Step 1: Determine Total Fixture Units**

(Reference Figure A)

- (4) Bathroom Groups  6 Fixture Units each  X4  = 24 Fixture Units
- (1) Dishwasher  = 2 Fixture Units
- (1) Kitchen sink w/ disposal  = 3 Fixture Units
- (1) Washing Machine  = 2 Fixture Units
- (1) Laundry Tray  = 2 Fixture Units
- (1) Water Softener  = 4 Fixture Units

Total  = 37 Fixture Units
Step 2

Pump Capacity based on total Fixture Units

37 Fixture units require a 23.5 GPM capacity.

37 fixture units per the example.

FIGURE B
Example: Pump Capacity

Step 2: Find resulting Pump Capacity

(Reference Figure B)

37 Fixture Units = 23.5 Gallons per Minute
Minimum flow for = 21 Gallons per Minute
2” diameter pipe  Minimum GPM = 23.5 Gallons per Minute
for this example

Round up to 24 Gallons per Minute
TDH = Static Head + Friction Head = 22 feet

Static Head = 15 feet
Friction Head = ? feet

<table>
<thead>
<tr>
<th>Friction Factors</th>
<th>Equivalent feet (Reference Figure D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3) 90 degree 2” elbows = 5.2 X 3</td>
<td>15.6</td>
</tr>
<tr>
<td>(2) 45 degree 2” elbows = 2.8 X 2</td>
<td>5.6</td>
</tr>
<tr>
<td>(1) 2” Gate valve = 1.4 X 1</td>
<td>1.4</td>
</tr>
<tr>
<td>(1) 2” Swing Check valve = 17.2 X 1</td>
<td>17.2</td>
</tr>
</tbody>
</table>

+ 500’ straight pipe = 39.8 equivalent ft

539.8 ft X 1.3/per 100 ft = 7.02 ft. of friction head
Example: Pump Selection

The pump is required to deliver at least 24 gpm at 22 feet of TDH.

Pump C will be the best choice, it would perform towards the middle of the pump curve for best efficiency.

The pump must deliver at least 24 gpm at 22 feet of TDH.
Questions?

Thank You
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Barnes Pump/Crane Pumps & Systems
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Glentronics, Inc.
Goulds Water Technology
Liberty Pumps
Little Giant/Franklin Electric
Pentair Water
Superior Pump
Wayne Water Systems
Zoeller Company

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Campbell Manufacturing, Inc.
John Crane, Inc.
Metropolitan Industries
Motor Protection Electronics, Inc.
SJE-Rhombus
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