To assist with the selection of self-priming pumps, we have created the following hypothetical example. We believe the problem and its solution to be typical of a job that might confront engineers and users.

We shall assume there is a requirement for a wastewater collection system that will require a lift station to pump the wastewater to a pretreatment collection system. The following data were acquired by actual accurate measurements.

**SYSTEM REQUIREMENTS**

**Flow:**
200 gpm (12.6 lps) 17 gpm (10.6 lps)

**Solids:**
3" (76 mm)

**Configuration:**
Duplex, one pump for standby

**Site Elevation:**
52' 80" (1609.3 m) above sea level

**SYSTEM CONDITIONS**

**Static Suction Lift**
15' (4.6 m) vertical distance from low liquid level to center line of pump suction.

**Suction Pipe**
17' (5.2 m), 4" (100 mm) C.I. pipe. Measured from end of suction pipe to pump suction.

**90° L.R. elbow and 45° elbow equivalent to 11.5' (3.5 m) of 4" (100 mm) C.I. pipe (for friction loss calculation).**

**Static Discharge Head**
7.5' (2.3 m) vertical distance from center line of pump suction to invert of discharge outlet.

**Discharge Pipe**
500' (152.4 m), 4" (100 mm) C.I. pipe. Measured from pump discharge outlet.

**90° L.R. discharge elbow, check valve and gate valve equivalent to 49.8' (15.2 m) of 4" (100 mm) C.I. pipe (for friction loss calculation).**

**Priming Lift**
10' (3.0 m) measured from high liquid level to center line of pump suction.

The accumulation of the preceding data now permits calculating the Total Dynamic Suction Lift (TDSL), Total Discharge Head (TDH), and Net Positive Suction Head (NPSH) using the worksheets on the following pages.
**TOTAL DYNAMIC HEAD (TDH)**

### A. Static Suction Lift
- **A.1.** Static Suction Lift: 15.00' (4.6 m)

### B. Friction, Suction
- **B.1.** Pipe, Total Length: 4" (100 mm) C.I.: 17.00' (5.2 m)
- **B.2.** Fittings in Equivalent Length of Pipe:
  - One 90° L.R. Elbow, 4"–6.8' (100 mm–2.1 m): 11.50' (3.5 m)
  - One 45° Elbow, 4"–4.7' (100 mm–1.4 m): 3.50' (1.1 m)
- **B.3.** Total Pipe (Actual & Equivalent): 28.50' (8.7 m)
- **B.4.** Total Friction Loss: (.285' × 4.43' × .71')
  - 17.30' (5.3 m) (based on friction coefficient $C=100$, 4.43/100' and correction factor to $C=120 = .71$)

### C. Total Dynamic Suction Lift
- **C.1.** Total Dynamic Suction Lift: 15.90' (4.8 m)

### TOTAL DISCHARGE HEAD: D + E = F

### D. Static Discharge Head
- **D.1.** Static Discharge Head: 7.50' (2.3 m)

### E. Friction, Discharge or Force Main Line
- **E.1.** Pipe, Total Length: 4" (100 mm) C.I.: 500.00' (152.4 m)
- **E.2.** Fittings in Equivalent Length of Pipe:
  - One 90° L.R. Elbow, 4"–6.8' (100 mm–2.1 m): 11.50' (3.5 m)
  - One Check Valve, 4"–26' (100 mm–7.9 m): 49.80' (15.2 m)
  - One Plug Valve, 4"–17' (100 mm–5.2 m): 9.80' (3.0 m)
- **E.3.** Total Pipe (Actual & Equivalent): 549.80' (167.6 m)
- **E.4.** Total Friction Loss: (5.5' × 4.43' × .71')
  - 17.30' (5.3 m) (based on friction coefficient $C=100$, 4.43/100' and correction factor to $C=120 = .71$)

### F. Total Dynamic Discharge Head
- **F.1.** Total Dynamic Discharge Head: 24.80' (7.5 m)

### TOTAL DYNAMIC HEAD: C + F = TDH
- **F.2.** Total Dynamic Head: 40.70' (12.4 m)

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**NOTE:** Suction pipe must be properly supported.
**Selecting the Right Pump**

**How to Compute the Net Positive Suction Head (NPSH)**

1. Atmospheric pressure (at sea level)
   - 33.90' (10.3 m)

2. Atmospheric pressure corrected to 2800' (1609 m) [site elevation]
   - 28.20' (8.6 m)

3. Available atmospheric pressure at job site (G–H)
   - 28.20' (8.6 m)

4. Total deductions from available atmospheric pressure:
   - 1. Total dynamic suction lift
     - 15.90' (4.8 m)
   - 2. Vapor pressure 74° liquid
     - 1.00' (.30 m)
   - 3. Safety factor (may vary based on local regulations)
     - 2.00' (.61 m)

5. Total net deductions from available atmospheric pressure (1+ 2+ 3)
   - 18.90' (5.7 m)

6. NPSH Available (J – K)
   - 9.30' (2.8 m)

7. NPSH Required (see performance curves)
   - – 5.00' (–1.5 m)

8. NPSH Excess Available, or excess atmospheric pressure (L– M)
   - 4.30' (1.3 m)

**Note:** Items M and N cannot be determined until pumps are selected.

**How to Determine the Priming Lift**

1. Priming Lift
   - 10.00' (3.0 m)

**Note:** Priming lift is measured from the highest point from under the center line of the pump suction. Priming lift is necessary to set pump suction level.

**Diagram:**

- Diagram showing the components and connections relevant to calculating NPSH and determining the priming lift.
After you've made the necessary calculations, you are ready to choose the correct pump for the application.

The 3” (76 mm) spherical solids requirement suggests a model T4AS-B. A typical Super T curve is shown. A 9-3/4” (250 mm) diameter impeller, turning at 1150 RPM, would be the correct selection. This is a standard motor on 60 cycle frequency. It may be flex-coupled to the pump; however, for versatility, it may be v-belt driven. Note NPSH requirement of 5’ (1.5 m) well within the available NPSH of 9.30’ (2.8 m). The priming characteristic of the 9-3/4” (250 mm) diameter impeller at 1150 RPM is 24’ (7.3 m) (see priming performance data on each curve). We require only 10’ (3 m) of priming lift.

CONCLUSION:
Model T4AS-B pump, equipped with a 9-3/4” (250 mm) diameter impeller, turning at 1150 RPM, is the correct selection.
SELECTING THE CORRECT MOTOR

Calculating the correct motor size for a pump involves the use of a complicated formula. To make this process easier, many manufacturers add horsepower (or kilowatt) lines to their performance curves. Referring to the curve, the closest non-overloading horsepower line represents 5 brake horsepower (BHP) or 3.7 kW.

A good rule of thumb to use when selecting motors is to apply a motor which will provide sufficient power to cover the entire length of the selected pump curve (a practice which results in a “non-overloading” motor selection). Using our example, the selected operating speed of the pump is 1150 RPM. The performance of a pump will follow along this speed curve but will vary due to normal pump wear and changes in sump level. The calculation below accounts for the sump level change between pump on and off levels.

TDH AT THIS LEVEL 35.70' (10.9 m)

\[ 40.70' (12.4 m) - 5.00' (-1.5 m) = 35.70' (10.9 m) \]

or:

36' (11.0 m) TDH at point on curve.

TDH AT THIS LEVEL 40.70' (12.4 m)

The change shown above is basically a change in static head. The actual performance of the pump is illustrated on the curve where the 1150 RPM curve and hydraulic system curve intersects (this is noted on the curve as point). The difference in flow rate between point is the band our selected pump will operate within from the beginning to the end of the pumping cycle.

Taking all this information into consideration, the best course of action is to select a 7½ HP (5.6 kW) motor to ensure non-overloading operation throughout the pump’s operating range.

NOTE: Suction pipe must be properly supported.
Self-priming pumps are a sensible solution for industrial and municipal applications. They require very little attention, resulting in significant savings of maintenance time and money. Gorman-Rupp self-priming centrifugal pumps are easy to install and easy to service. Because they're self-priming, they can be mounted high and dry at floor level with only the suction line in the liquid – there's never a need for service personnel to enter the sump. When service or maintenance is required, it can be completed easily with common hand tools. There are no long drive shafts to install and align, and no hoists or cranes are required.

Gorman-Rupp self-priming pumps are available as basic units for connection to your power source or may be flex-coupled, v-belt driven or engine mounted. Automatic priming means dependable performance. All that's needed is an initial priming and the pump will continue to reprime automatically. In fact, our trash handling pumps will reprime with only a partially filled pump casing and a completely dry suction line!

Our reputation for quality has made Gorman-Rupp the world's leader in self-priming centrifugal pumps. In addition, it makes us your best solution – meeting all of your industrial or municipal waste handling needs.

**Drive Variations:**
- Basic
- V-Belt
- Flexible Coupled
- Engine-Driven

**80 Series®**
- Limited Solids and Corrosive Liquids
  - Self-priming pumps are designed for high-efficiency, non-stop workloads. Straight-in suction design allows them to operate on higher suction levels than standard self-priming centrifugals.
  - **Size:** 1.25” (32 mm) to 10” (250 mm)
  - **Max. Capacity:** 2800 gpm (177 lps)
  - **Max. Head:** 205’ (62 m)
  - **Max. Solids:** 2.5” (60.3 mm)

**10 Series®**
- Solids and Corrosive Liquids
  - Self-priming pumps have only two moving parts – impeller and shaft – so maintenance problems are minimal.
  - **Size:** 1.5” (37.5 mm) to 12” (300 mm)
  - **Max. Capacity:** 6000 gpm (378.6 lps)
  - **Max. Head:** 170’ (51.8 m)
  - **Max. Solids:** 3” (76.2 mm)

**0 Series®**
- Clear Liquids
  - Self-priming pumps feature straight-in suction which eliminates entrance restrictions and provides better suction performance when handling solvents, petroleum products and similar liquids.
  - **Size:** 2” (50 mm) to 6” (150 mm)
  - **Max. Capacity:** 1350 gpm (85.2 lps)
  - **Max. Head:** 400’ (121.9 m)
  - **Max. Solids:** .688” (17 mm)

**Super U Series®**
- High Efficiency Solids and Corrosive Liquids
  - Self-priming pumps are among the most efficient solids-handling, self-priming pumps available (up to 75%). Open, multivane impeller will handle solids up to 1-1/4” (31.8 mm) in diameter.
  - **Size:** 3” (75 mm) to 6” (150 mm)
  - **Max. Capacity:** 1500 gpm (95 lps)
  - **Max. Head:** 207’ (63.1 m)
  - **Max. Solids:** 1.25” (31.8 mm)

**Super T Series®**
- Solids-Laden Liquids and Slurries
  - Self-priming pumps feature a large volute design which allow them to reprime automatically in a completely open system without the need for suction or discharge check valves – and they can do it with the pump casing only partially filled with liquid and a completely dry suction line.
  - **Size:** 2” (50 mm)* to 10” (250 mm)
  - **Max. Capacity:** 3400 gpm (214.5 lps)
  - **Max. Head:** 130’ (39.6 m)
  - **Max Solids:** 3” (76.2 mm)
  - *2” available in T Series only

**Ultra V Series®**
- High-Heads Solids-Handling
  - Self-priming, centrifugal trash pumps handle 200% more pressure and provide 60% increased flow. Self-cleaning features, reduced footprint and unique configuration capabilities allow these pumps to excel in high-head situations where traditional pumps fall short.
  - **Size:** 3” (75 mm) to 6” (150 mm)
  - **Max. Capacity:** 1900 gpm (123 lps)
  - **Max. Head:** 168’ (51 m)
  - **Max. Solids:** 3” (76.2 mm)
Although the pump is the heart of a pumping station, other elements should be considered when designing a system. This example identifies some of the items that can make up a system.

1. Pump (2)
2. Discharge Pipe
3. Suction Pipe
4. 3-Way Valve (1)
5. Air Release Valve (2)
6. Discharge Check Valve (2)
7. Gauge Kit – Suction and Discharge (2)
8. Control Panel
9. Electric Motor (2)
10. Base
11. Inlet Pipe
12. Discharge/Force Main
13. Sump/Wet Well
14. Suction Flare
15. Entrance to Sump/Wet Well
16. Pump Drain Kit
17. Pump Station Enclosure

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