Airvac

Vacuum 101

A FREE introductory guide to vacuum sewer systems

A brand of
Aqseptence Group

Thank you for taking the time to learn about Airvac® and vacuum sewer systems.

What is a vacuum sewer?

A vacuum sewer system is a mechanized method of transporting wastewater. Differential air pressure creates flow rather than gravity or pressure. Essentially, a vacuum sewer system is a negative pressure sewer system.

Vacuum sewer systems require a vacuum station similar to a gravity lift station or pumping station. Unlike a lift station, vacuum pumps maintain vacuum on the collection mains. To maintain this vacuum, a valve at each sewage input point seals the system. The valve opens automatically when a given quantity of sewage accumulates in a collection sump. This valve is entirely pneumatic in its control and operation. Differential pressure between local atmospheric pressure and the vacuum pressure provides the thrust needed for liquid transportation.

Vacuum systems are applicable when these conditions exist:

- Failing septic tanks causing pollution.
- At least 25 connections. We also have systems serving more than 10,000 connections!
- Primarily residential connections. Commercial connections are also possible.
- Private developments.
- Flat topography or moderate elevation change.
- Subsurface difficulties to overcome including high groundwater table, sandy and unstable soils, rock, restricted construction conditions, and sensitive eco-systems.

How do vacuum sewers work?

A traditional **gravity line** (A) carries wastewater from the customer to an Airvac **valve pit** (B).

The Airvac vacuum valve opens when 10 gallons of sewage collects in the sump and then differential pressure propels the contents into a **vacuum main** (C). An **air terminal** (D) is installed to provide a source of atmospheric air, which is necessary for liquid transport.

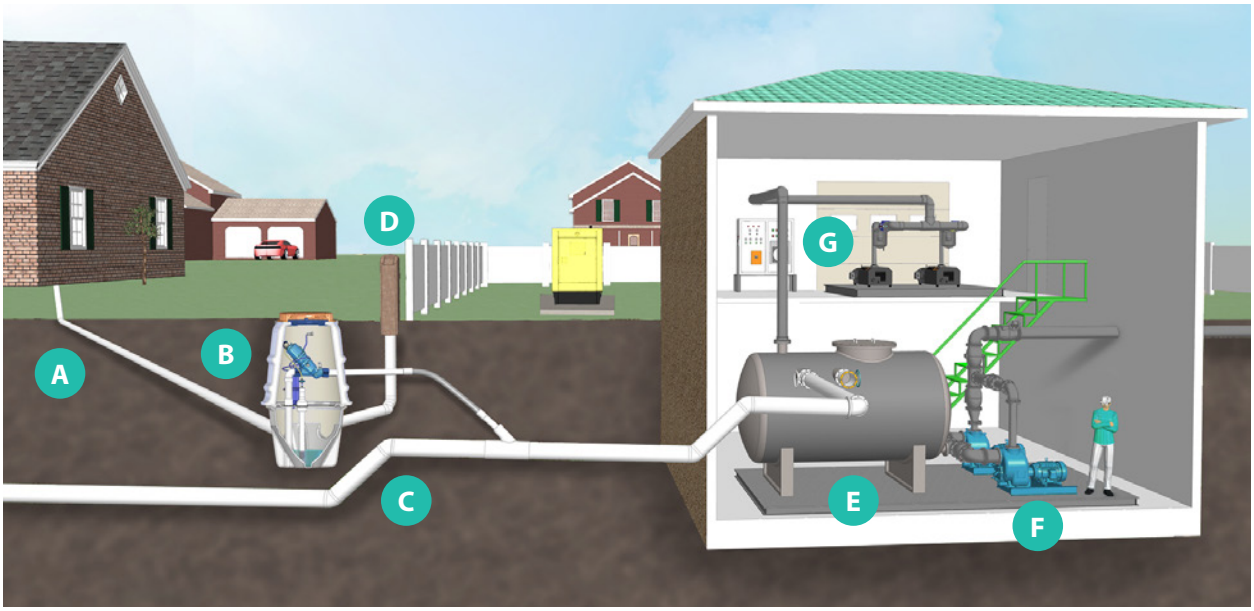
Wastewater travels at 15 to 18 fps in the vacuum main, which is laid in a sawtooth fashion to insure adequate vacuum levels at the end of each line. The speed of the wastewater helps scour the line and break up solids.

Wastewater enters the **collection tank** (E) and fills to a predetermined level. **Sewage pumps** (F) transfer the contents to the treatment plant via a force main.

Vacuum pumps (G) cycle to maintain a constant level of vacuum on the entire collection system.

For a quick overview video

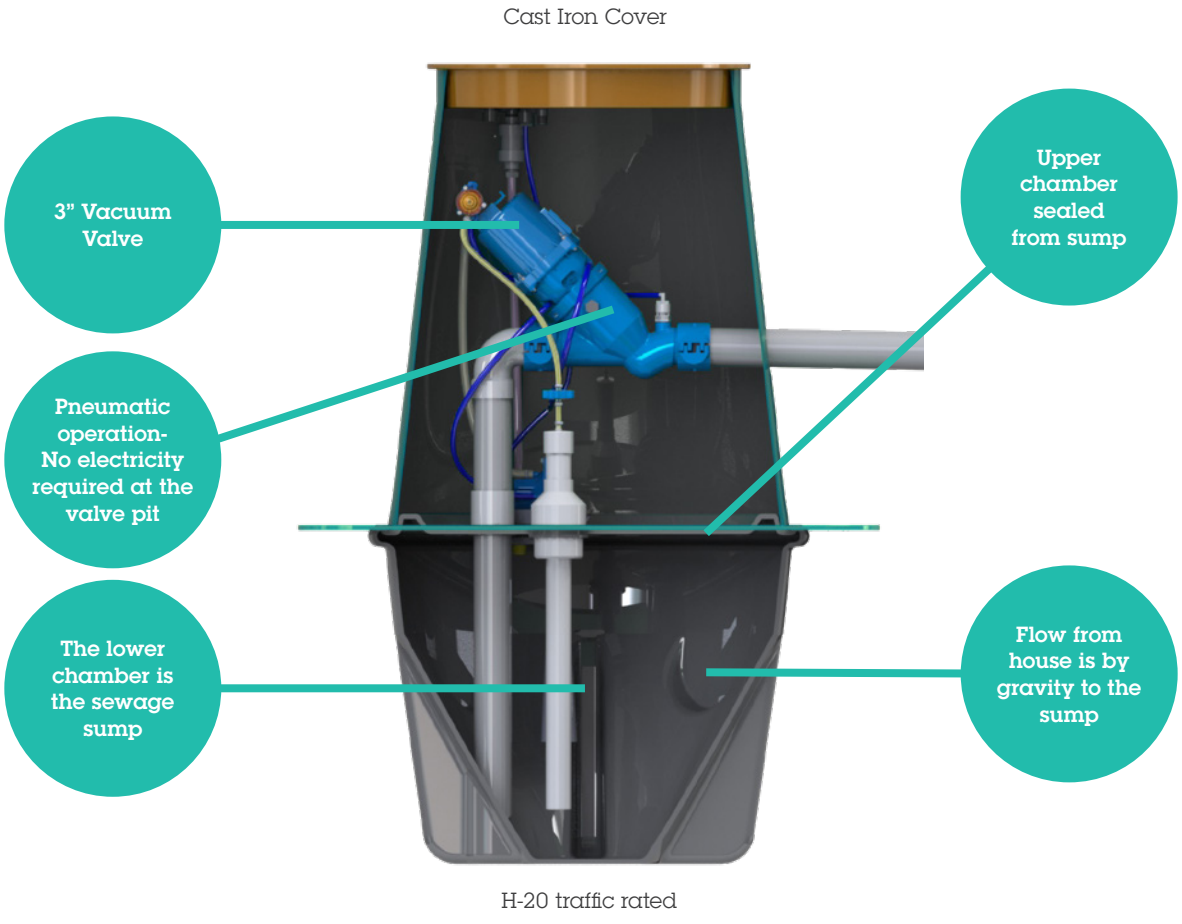
Scan the QR Code with your mobile device.



The Valve Pit

The Airvac valve pit provides the interface between the vacuum collection system and the house. The top chamber of the valve pit houses the Airvac vacuum valve and the bottom chamber is a sewage sump into which the gravity lateral from the house connects. The two chambers are sealed from each other, preventing maintenance personnel from being exposed to raw sewage.

Each valve pit can accommodate sewage for up to four homes, although the most common configuration is one valve pit serving two adjacent houses. No special plumbing fixtures are required by the homeowner.



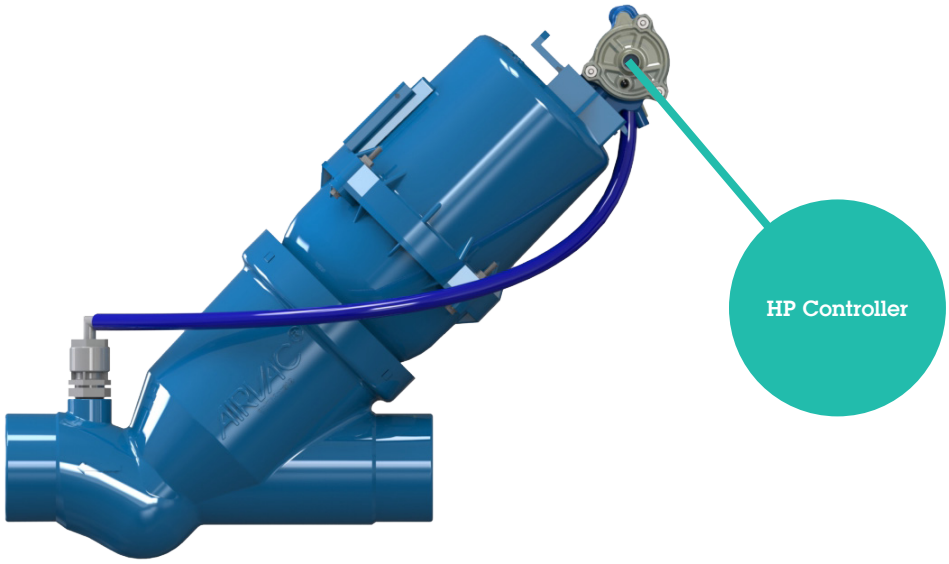
The
3” Vacuum Valve

The Airvac 3” vacuum valve is vacuum operated on opening and spring assisted on closing. System vacuum ensures positive valve seating. The valve has a 3-inch full-port opening, is made of glass filled polypropylene, and has a stainless steel shaft, delrin bearing and elastomer seals.

The 3” vacuum valve is equipped with a rolling diaphragm-type vacuum operator and is capable of overcoming all sealing forces; and opening using vacuum from the downstream side of the valve. All materials of the valve are chemically resistant to normal domestic sewage constituents
and gases.

The driving force in a vacuum system is the pressure differential that exists between atmosphere and vacuum in the system, which occurs when the valve opens. As a result, the only place to impart energy in a vacuum system is at the valve itself. Any loss through the valve further depletes this energy resulting in less energy available for transport within the pipeline. This is especially critical considering that this loss occurs at every valve and during each valve cycle. The flow coefficient (Cv factor) is the flow rate in gpm which would yield a head loss of 1 psi. The Airvac valve is produced with an internal geometry that results in a high Cv factor which keeps friction loss to an absolute minimum.

Vacuum valves are also available in 1.25”, 1.5”, and 2” models, which can be used for specific applications.

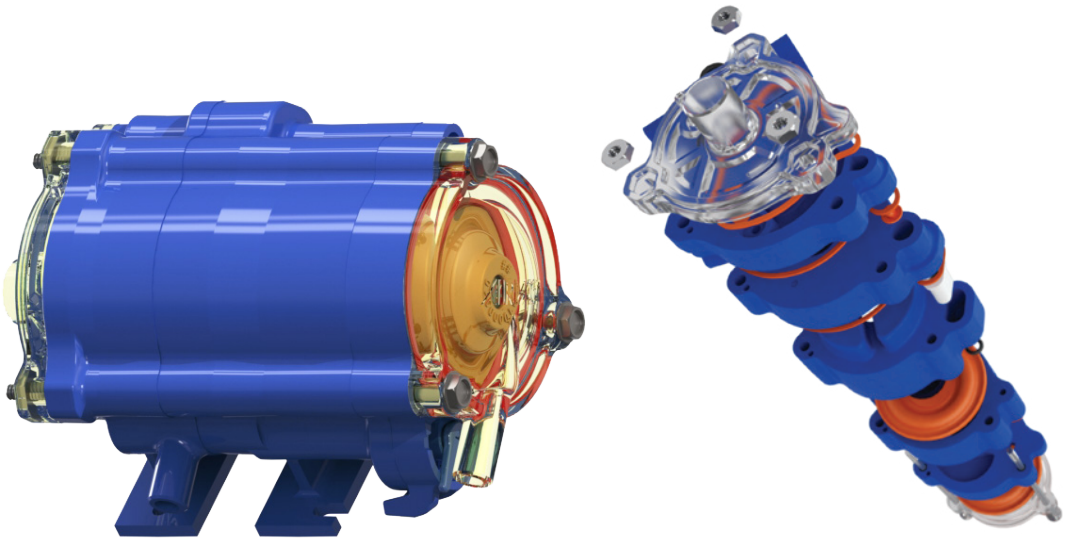


The HP Controller

The Airvac valve pit was designed so that a very repeatable, specific amount of liquid is withdrawn each cycle. This in turn helps control the Air to Liquid (A/L) ratio ensuring proper system operation. The HP Controller is the key component of the Airvac 3" vacuum valve that provides this function. The HP Controller is chemically resistant to sewer gases and is capable of operating when submerged in water.

The HP Controller relies on three forces for its operation: pressure, vacuum, and atmosphere.

As the sewage level rises in the valve pit sump, it compresses air in the sensor tube. This pressure initiates the opening of the valve by overcoming spring tension in the controller and activates a three-way valve. Once opened, the three-way valve allows the controller to take vacuum from the downstream side of the valve and apply it to the actuator chamber to fully open the valve. After the preset time period has elapsed, atmospheric air is admitted to the actuator chamber permitting spring assisted closing of the valve.



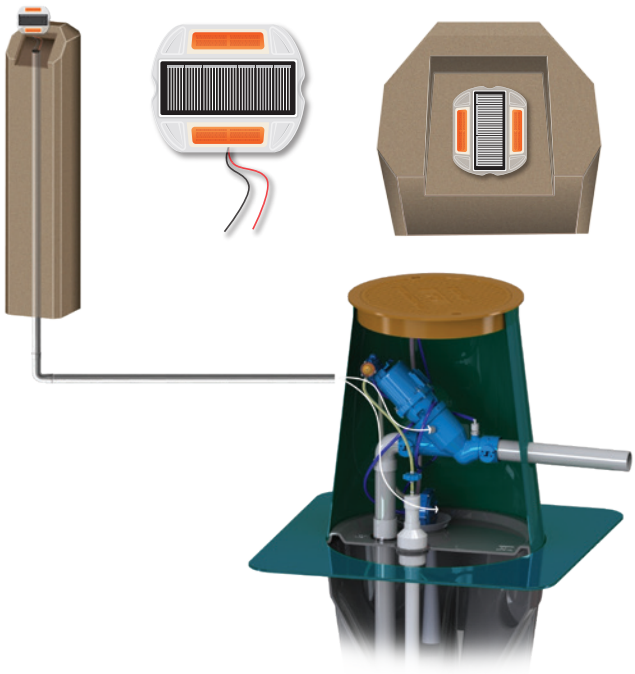
In addition to having fewer parts than other controllers, the HP controller features higher quality materials which will result in a longer life expectancy.

The Air Terminal

The air terminal provides the system with a source of atmospheric air, which is necessary for liquid transport. Airvac's 6-inch Air Terminal consists of a molded housing that is placed on 6-inch piping connected directly to a valve pit sump. The Air Terminal was designed to look like other utility boxes/structures typically seen in rights-of-way. The Air Terminal is supplied by Airvac and is installed by the contractor during the construction phase as part of the valve pit installation.

A solar light monitor is mounted on the air terminal and connects to the internal breather and the vacuum valve. The monitor can signal a high sewage sump level via the breather or a valve failure via the vacuum valve. The light is easily visible from a long distance, avoiding the need for operators to physically check every vacuum valve in the system.

6" air terminal



A solar light monitor is mounted on the air terminal and connects to the internal breather and the vacuum valve.

Vacuum Mains

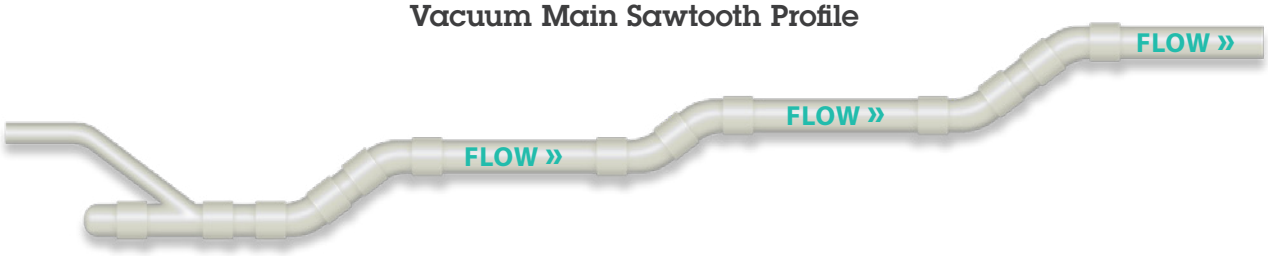
Traditional gravity sewer system installations can be very disruptive to a community, often shutting down roads completely for long periods of time.

Vacuum mains use small diameter pipes installed in shallow, narrow trenches (usually 3 to 6 ft below the surface). Because of these factors, the mains are typically installed adjacent to the pavement. This results in significantly reduced construction costs, road restoration and time savings.

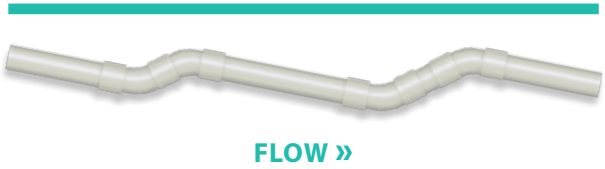
Airvac's fast and simple excavation requires not only smaller trenches, but smaller excavation equipment as well. Roads can remain fully or partially open, creating far less disruption to the people in your community.

The sawtooth profile of the vacuum main is the industry standard for vacuum sewer systems. It was originally patented by Airvac in 1979. It ensures adequate vacuum levels are maintained at every point along the line.

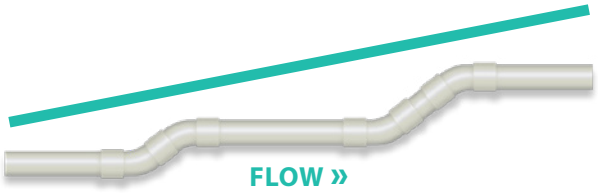
Vacuum Main Sawtooth Profile



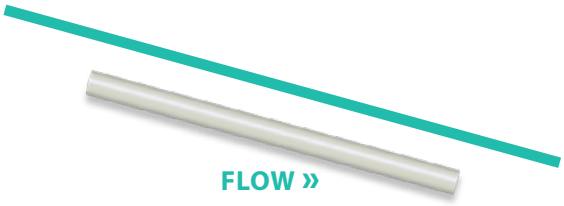
Level, Uphill & Downhill Transport



Level – use "lifts" to maintain same elevation.



Uphill – space lifts closer together.



Downhill – follow ground slope.

The Vacuum Station

A vacuum station is the heart of a vacuum system.

Major components include a **collection tank** (A), **sewage pumps** (B), **vacuum pumps** (C) and a **control panel** (D). The vacuum station skid is housed in a protective structure and a **standby generator** (E) keeps the vacuum system in operation during extended power outages.

Sewage enters a collection tank and discharge pumps transfer the sewage through a force main to the treatment plant. Vacuum pumps create negative pressure on the collection tank which is then transferred to the entire piping network via the vacuum mains.

A vacuum station is about the size of a large shed and can serve houses up to two miles away.

Airvac offers several types of vacuum station equipment packages designed to accommodate a wide range of customer needs including the Airvac PacVac and various Airvac Engineered Custom stations.

Vacuum Station Models

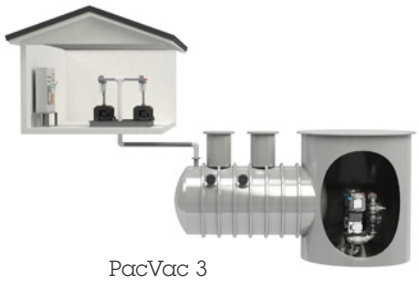
Airvac vacuum station models are ideally suited for small to medium-sized projects serving less than 550 connections and/or peak flows less than 350 gpm. Generally, the mechanical and electrical components are located on skids including the vacuum pumps, sewage pumps, collection tank and control panel. The skids are housed in a prefabricated building that can be supplied by Airvac.

An engineered custom vacuum station is ideally suited for larger systems with more than 550 connections and peak flows greater than 350 gpm but can be used with smaller systems as well. With an engineered custom vacuum station, Airvac provides all of the internal components on a skid(s) which are housed in a building custom designed by an engineering firm. Prefabricated options are also available. The Airvac skid(s) is typically housed in a two story structure with the vacuum pumps and control panel located on the top floor and the collection tank and sewage pumps on the lower floor.

For customers who need an inexpensive, small vacuum station for an initial phase of a larger system, Airvac also can house the vacuum station in a shipping container and make this available on a short term lease basis.

PacVac 1

PacVac 2



PacVac 3

Type 360

Container Station

Vacuum Pump Modulation

Modulation is a patent pending program logic that improves the manner in which your vacuum system functions. Previous designs required vacuum pumps to turn on at 16"Hg and off at 20" Hg regardless of the situation within the vacuum system.

The modulation sequence controls the speed of the vacuum pumps to maintain a tighter vacuum range and speeds up and slows down depending on the demand of the vacuum system.

It is unusual for the pumps to ever operate at full speed.

Since the pumps are not turning on and off as frequently, it also significantly reduces the overall power consumption and creates less heat and noise.

Wireless Monitoring

The Airvac Wireless Valve Pit Monitoring System is a wireless system that transmits valve pit and vacuum main operating data back to our dedicated central scada system, which is typically housed within the vacuum station. With this system, the operating personnel can see exactly how each valve pit is functioning in real time. In addition, all pertinent data from each valve pit is collected and saved to allow for analysis and adjustment if necessary.

A wiring harness is installed in the valve pit and connects to a cable running to the air terminal. A wireless radio unit is installed in the air terminal or in a utility box next to the pit. It is programmed to monitor valve opening and closing operations and monitors liquid levels in the holding sump. The pit radios used are the latest design, longest range, lowest power consumption models available. Signals are collected by the wireless unit and transmitted at set intervals.

Batteries were selected for the wireless radio unit that are tolerant of low temperatures and meet the long life requirements of the application. Battery conserving methods are also used without sacrificing the ability to receive alarms.

The "trend" feature tracks the operation of each valve pit and notifies the operator of imbalances within the system. This notification allows the operator to proactively address potential problems before they occur.An additional feature is the ability to pin point a problem when it occurs. An alert will be sent to the operator and the exact location of the failure will be identified. This results in quicker operators response time, fewer homeowner disruptions and lower operation and maintenance costs.

Valve Pit

S.M.A.R.T.

Strategic Monitoring for Advanced Remote Transfer

Vacuum Station

About Airvac

We are Airvac. We create solutions to ecologically and economically move liquids and wastewater for millions of people globally.

Our legacy is built on industry leading innovations and outstanding customer service.

Based on customer insights, we continually create proven solutions that are safe, efficient, and reliable.

Our support services include:

- Free layouts and estimates
- Design assistance
- Onsite assistance during construction
- Operation and Maintenance Service
- In-person and remote training
- Documentation and troubleshooting tools via the Airvac App
- Dedicated technicians for preventative maintenance and on-site repair
- Customized Service offerings

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Let's discuss your solution!

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