

HIGH SECURITY WITH LOW IMPACT

How vacuum plumbing boosts security and reduces water use at a Silver LEED project

In a prison, the plumbing gets a lot of attention. After all, something as simple as a clogged toilet often ends up being the result of an inmate's intentional act to create a disturbance and compromise safety. Hidden contraband, blockages and maintenance issues tax a facility's manpower and budget. For these reasons, correctional facilities must take careful steps in planning and designing a plumbing system.

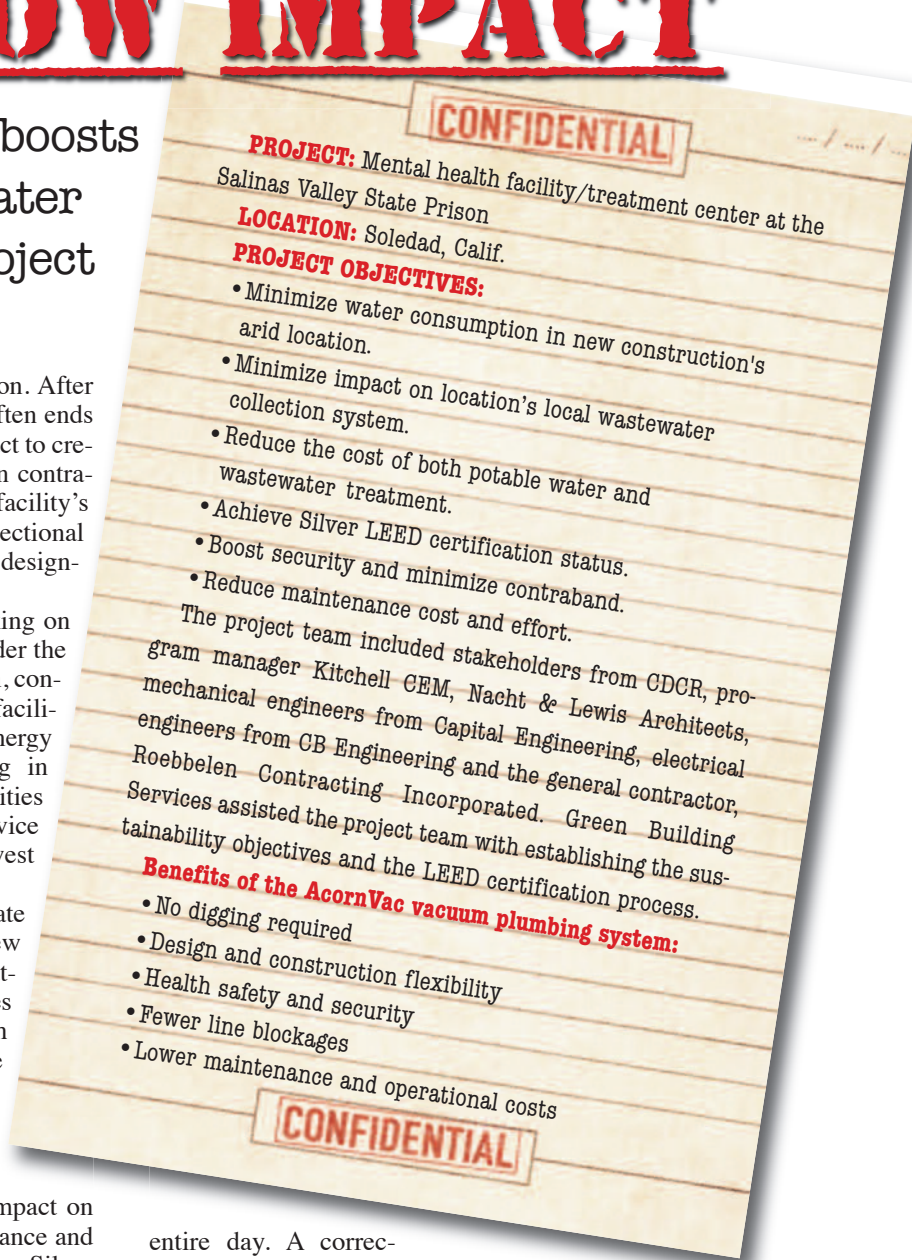
There is yet another challenge prisons are taking on today, especially in states such as California. Under the Governor's Executive Order #S-20-04, the design, construction and operation of all new state-owned facilities shall be certified under the Leadership in Energy and Environmental Design (LEED), beginning in January 2011. This means that not only will facilities be built to function at the highest levels of service and security but also that they will have the lowest impact possible on the environment.

It was with this goal that the Salinas Valley State Prison (SVSP) underwent construction on a new 64-bed, 36,400-sq.-ft. mental health housing/treatment facility in Soledad, Calif. The facility houses male inmates requiring inpatient mental health care at level IV security (the most violent). The project aimed to achieve the first LEED certification for the state's prison system, ahead of the 2011 mandate. To accomplish this, the new addition to SVSP specified the AcornVac Vacuum Plumbing System. AcornVac reduces impact on all of the facility's resources' time, cost, maintenance and precious water and ultimately contributed to a Silver LEED certification.

"When the LEED Silver requirement was added to the project, we proposed the vacuum plumbing system as a way to achieve points associated with domestic water use reduction, wastewater reduction and an innovation point for the exemplary reduction of water," said Anthony Colacchia, M.E., principal, Capital Engineering Consultants Inc.

LEEDing the way

A toilet in a prison cell is used and abused in multiple ways; it can be used to dispose of trash, to hide contraband or to create distractions. A single inmate may flush his or her toilet more than an average household flushes in an



entire day. A correctional facility operating at full occupancy uses a lot of water and it generates a lot of waste. In arid climates such as Soledad, Calif., water consumption is important and so is the volume of wastewater generated. Treatment costs for both are high.

Although the performance specification for the vacuum plumbing system did not specify a manufacturer, Dean Barchacky, correctional business manager, and plant manager at the time of construction, together with plant operations and project stakeholders, felt that AcornVac best met the requirements, in addition to obtaining the LEED points potential. AcornVac uses the combined energies of atmosphere and vacuum pressure to move waste through a

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small-diameter piping network. As a result, it requires only 0.5 gallon of water per flush to effectively remove waste, as opposed to the 1.6 gallons typically required with a traditional gravity plumbing system.

Overall water consumption is thus reduced by as much as 68 percent, far exceeding the 20 percent required under the Executive Order for LEED credits on this project. Additionally, all buildings at the SVSP employ electronic valve metering (Master-Trol) from Acorn Engineering to control the number or duration between flushes and to control how long a shower can run. When combined with AcornVac's 0.5-gallon flush, this system further reduces water consumption.

The fixtures were calibrated and confirmed at startup testing to use only the required 0.5-gallons per flush, and, though the proof of water use reduction hasn't been pre-



The Vacuum Center at the Salinas Valley State Prison.

cisely metered, the incredible reduction of water use and wastewater was immediately evident in the lowered cost of water treatment. The CDCR pays the city of Soledad to

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Vacuum sewage and plumbing systems

At the heart of a vacuum drainage system are the vacuum interface components that allow waste to be efficiently introduced into the vacuum waste piping network or conveyance system and transported through the system for eventual discharge into sanitary sewer lines or waste treatment equipment. These components include a normally closed vacuum interface valve (Extraction Valve) which separates the vacuum in the piping network from atmospheric pressure surrounding the fixture, and a control device (Controller) which operates the vacuum interface valve.

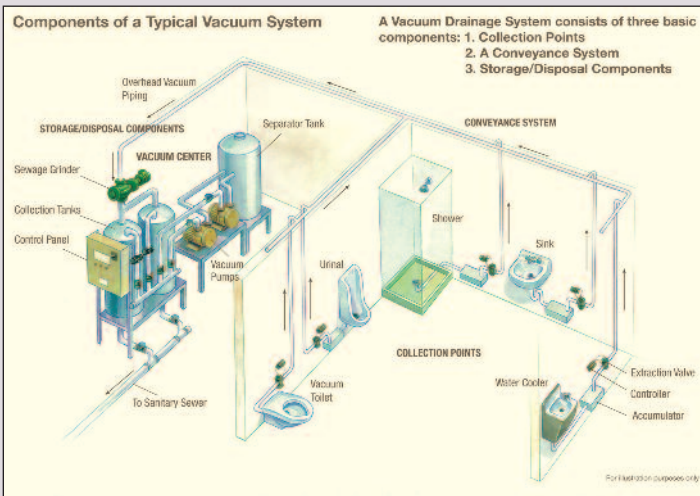
In the case of water closets, the Extraction Valve is connected to the toilet waste outlet, effectively separating the toilet from the closed vacuumized piping network. When the vacuum flush valve is activated, either by push button or sensor, a signal is received at the Controller which opens the Extraction Valve, creating an interface between atmospheric pressure at the toilet bowl and vacuum pressure in the waste piping network. Air around and outside the fixture, rushes into the toilet bowl pushing the waste and water to the toilet waste outlet, through the open Extraction Valve and into the vacuum waste piping. Because air is used to transport wastewater from the toilet bowl to the waste piping network, no water is required to initiate the flush cycle. In coordination with opening the Extraction Valve, the Controller also activates the flush water valve which provides both rinse and re-fill of the bowl using less than 1/2 gallon of water. The opening and closing of the Extraction Valve is precisely controlled so that all waste is completely removed from the bowl before the Extraction Valve is closed.

Due to the extremely low water volume required to achieve this highly efficient flush, AcornVac toilets provide a significant reduction in

water use and sewage output. Similar to conventional flushing mechanisms, the vacuum flush valve assembly includes a water supply valve, check stop and vacuum breaker along with the Controller. However, since only 1/2 gallon of water per flush is required, water supply line sizing can be significantly smaller than the supply line required for 1.28 or 1.6 gallon flush valves. In addition, because the movement of waste water is achieved by the use of differential pressures, atmospheric pressure entering the system is carried through the system and conventional waste venting within the waste piping network is not required.

In the case of urinals, flushing sinks and any other non-flushing plumbing fixture or equipment, the waste drainage process is similar, but typically includes the use of an intermediate waste collection point, or Accumulator. As waste drains via gravity from the fixture or equipment, it is temporarily collected at the Accumulator. The Accumulator may be a "purpose made" collection point, or simply an offset in the waste piping. As waste fills the Accumulator, a signal is automatically generated, which allows the Controller to open the normally closed Extraction Valve, creating an interface between atmospheric pressure at the Accumulator and vacuum pressure within the waste piping network. This pressure differential causes air to enter the Accumulator, mixing with the waste, and transporting the resultant emulsion into the piping network. The waste removal cycle typically lasts between 2 and 4 seconds, or until the collected or incoming waste has been cleared from the accumulator and transported into the vacuum waste piping.

The vacuum waste piping or conveyance system is a closed piping network that is typically maintained under a continuous vacuum pressure of 16" - 18" Hg. (54 - 60 kPa) and is generally fabricated out of standard pressure rated PVC, Copper, or other smooth bore, non-porous material. The piping network consists of "risers" or "droppers" that transport the collected waste vertically from the point of origin to horizontal mains and branches leading to the Vacuum Center. Much like conventional waste piping, the mains and branches are typically installed with a slope of 1/4" per foot toward the Vacuum Center allowing the movement of waste to be assisted by gravity. However, unlike conventional waste piping, continuous slope to the Vacuum Center does not need to be maintained. The vacuum waste piping network can be offset to recover grade, which allows the piping network to route horizontally over long distance in very shallow space. In addition, the vertical or horizontal piping can be easily offset to route around obstacles in it's pathway toward the Vacuum Center. This feature can provide a significant benefit to the designer and installer when mechanical space is limited or when a conventional waste piping network can't be readily accommodated or installed.



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treat its wastewater, and the new mental health facility would have sent a lot more waste to a treatment plant already operating at full capacity. In addition, it's necessary to pump potable water from the ground to a reverse osmosis treatment plant, an expensive task in itself. "Pumping costs are down, wastewater is down. The initial installation cost might be a little more, but we feel that the benefits will outweigh this with its payback," said Barchacky.

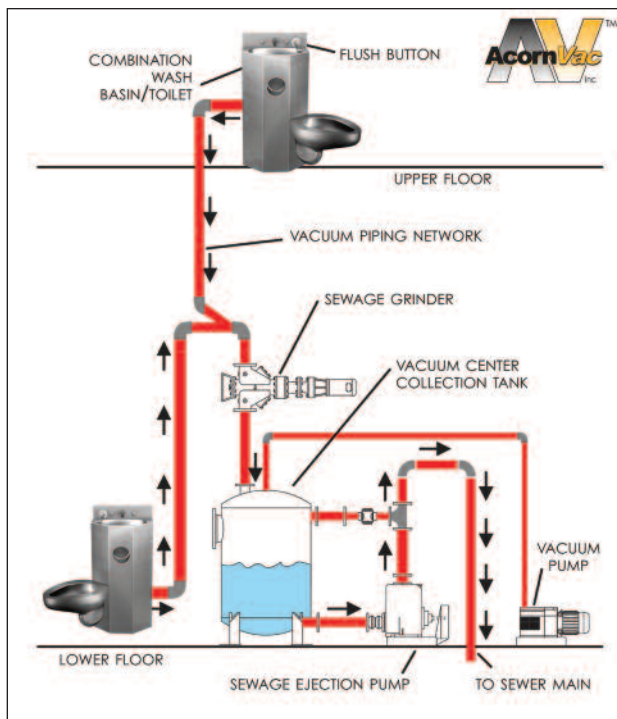
As reported by the California Department of Corrections, AcornVac, in combination with other conservation efforts throughout the new facility, contributes to a reduction in potable water use by a remarkable 56 percent and lowered sewage conveyance by nearly 70 percent.

Customer service

The building at Salinas is one of the few prison facilities in the United States to use vacuum plumbing and the first in CDCR's system. Two crews of supervisors and maintenance staff assigned to the facility met with the experts at AcornVac at the company's headquarters in Chino, Calif., for live training and hands-on experience. AcornVac coordinated with the manufacturer of a particular system component to ensure the correct installation that was required in the specifics of the SVSP project. They provided the SVSP's maintenance staff with all the necessary operations documentation that enabled them to troubleshoot any problems they may encounter with the system's maintenance. So far, they haven't needed it.

Low maintenance

The AcornVac system not only saves water but also proves to be very low maintenance, due in large part to its



Vacuum plumbing equipped for a combination wash basin/toilet system.



A "combi" vacuum plumbing system at a state prison.

design. The system efficiently isolates every cell from the waste-piping network by means of a normally closed valve separating the toilet in the cell from the rest of the toilets in the facility. Leaks and mainline clogs are virtually eliminated. Sam Ochoa, who assumed the role as plant manager after Barchacky, said he's pleased with fewer maintenance calls. "There have hardly been any problems raised to my level of attention. I have no mainline blockages to report, and I haven't had to order any replacement parts so far," he said. "It's been a big benefit having this type of system at our facility." Barchacky says, "We have had hardly any costs in maintenance. If something plugs up, it's right there at the fixture, making it easy to isolate and fix. This is a big asset in a correctional environment."

Enhanced security

A combination toilet and lavatory, or "combi," is often one of the few items in a cell, and an inmate spends a lot of time with it. They flush anything they can use to clog a fixture and create a flood and a dangerous distraction.

Gravity plumbing is an open network of pipes leading down to a central waste pipe that drains to the sewer system. With traditional toilets in a correctional facility, communication is possible between all toilets sharing the same line. It is possible, for example, to speak or pass contraband through the toilets. Inmates may tie a string to an item and flush it, so it can be hidden and retrieved later. When vacuum plumbing is used, communication through the plumbing fixtures or waste network is eliminated, as the system's valves are only open during a flush cycle. In comparison to valve metering alone, "The vac system is even better because everything must pass a valve, and once it does, it can't be retrieved at the fixture," Barchacky pointed out.

At SVSP, all water waste, including greywater from lavatories and mop sinks, is transported to a collection center where it is macerated before leaving the facility.

Outside the new mental health facility, in facilities that do not use AcornVac, they must use bar screens to catch debris that has been flushed and must employ prison inmates at the to clean the screens. This is a problem because those inmates will collect any flushed contraband and keep it for themselves. With the vacuum plumbing system, this problem is resolved. "With gravity plumbing, we've seen t-shirts, plastic bags, blankets, all come through the plumbing. With AcornVac, there's no debris going to the main sewer line," said Ochoa.

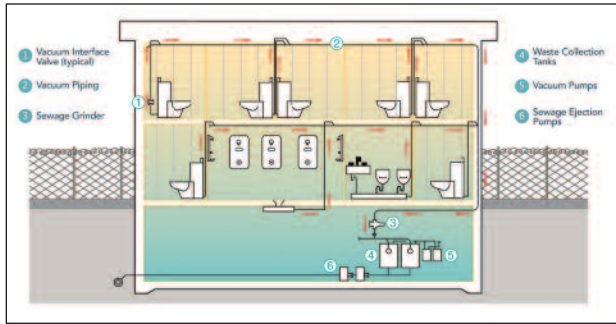
A long-term solution

Both Barchacky and Ochoa are optimistic about the

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This diagram depicts the combination vacuum plumbing system as designed for a prison.

longevity of the vacuum plumbing system and point to the fact that there are very few movable parts in the system that would need replacing. Ochoa has worked at the California Department of Corrections for 20 years and said, "I've been involved in implementing water-saving technology in the past, and some of it risks becoming antiquated. As long as the AcornVac system's parts and components keep working as well as they have, I think it will perform well for a long time." As for the CDCR's plans to save water in the future, Ochoa says, "As far as what I've observed so far at the Salinas Valley mental health facility, I would recommend AcornVac for any new construction built under the Governor's Executive Order." ■

Acorn's Benefits

- The 1/2-gallon flush efficiency and water savings. This was the primary reason for the selection of the vacuum system. There are great challenges for the institution both in delivering domestic water and dealing with wastewater discharges to the local treatment plant. The vacuum system helped achieve LEED goals as well as satisfying the site's infrastructure needs.

- The layout of the system isolates blockages to an individual toilet fixture rather than to a group of fixtures. This was not a primary consideration at the time of the design but was recognized as a potential benefit. As the system has been in operation the institution is seeing the benefit of not having blockages in mains or branches that can't be attributed to a particular room for corrective action.

- Safety and security. Unlike a conventional waste piping network, each toilet fixture is isolated from all others on the system by means of a closed valve. This prevents the cell-to-cell communication that is possible in an empty or even partially filled gravity waste-piping network.

- Cost benefits. Fewer roof penetrations, smaller diameter piping and water savings all contribute to lower installation and operational costs. Overall, the system resulted in an installation cost increase but given the sustainability benefits and operational cost benefits, the system is a success for the institution.