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Septic Tank Effluent Pump Systems

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Abstract

Septic tank effluent pump (STEP) systems are beginning to be recognized as the preferred and most economical method of collecting and transporting partially treated wastewater to a treatment facility. A conventional septic tank provides pretreatment, removing most settleable and floatable solids from the wastewater. Specially designed pumps convey the septic tank effluent under pressure through a network of small diameter plastic piping to a treatment site. Shallow collection lines, following the contours of the terrain, eliminate the need for costly deep excavations. Changes in both vertical and horizontal alignments may be made in the field. The impetus for this rapidly developing technology has come mainly from the western United States. Oregon's Department of Environmental Quality, for example, requires engineers to consider STEP systems whenever a new wastewater collection project is contemplated. The success of a STEP system depends primarily on the skill of the engineer in designing and managing the project. Guidelines for designers are discussed and brief descriptions of several successful STEP systems are included.

Introduction

Septic tank effluent pump (STEP) systems, also known as effluent sewers, have a lot to offer. Shallow burial of small-diameter mains means installation costs and disruption of the community are minimized; infiltration and inflow are avoided; collected effluent is already pretreated in the septic tanks so final treatment is relatively simple and inexpensive; the septic tanks' reserve capacity means that problems are seldom emergencies; and, surprising to many, operation and maintenance, taking into account both power costs and routine maintenance and repair, cost less than does O&M for conventional gravity collection systems.

Why then aren't STEP systems cropping up all over? In fact, they are, at least in some regions of the United States. Michigan, for example, has more than 30 STEP systems in operation, most serving lakeshore communities. But the leader in applying STEP technology is the West. In just three states-California, Oregon, and Washington-more than 100 STEP systems have gone on line in the past two decades. Most live up to their billing as being reliable, low maintenance, and cost effective. A few have caused their owners a lot of grief and given pause to other communities considering STEP systems. What makes the difference between success and failure? The single most important factor in the success of a STEP system is the skill of the engineer in designing and managing the project. Close seconds are a competent installing contractor and a practical operator with a good attitude.

Case Study: Elkton, Oregon

Elkton, a small community in Southern Oregon, hugs the Umpqua River, renowned for its salmon, steelhead, and bass fishing. When residents realized that their failing septic systems were a threat to the

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river and to their own health, they were lucky to find an engineer who was willing to devise a way to solve their problem at a price they could afford. A traditional gravity sewer was way beyond their means. Considering all the alternatives, the engineer identified a STEP system as the most cost-effective choice.

At the time of its construction, the Elkton STEP system had 67 septic tanks with pump units (for services below the hydraulic grade line) and 34 with effluent filters (for gravity services above the hydraulic grade line). Residential tanks are 3800 L (1000 gal) capacity; schools, restaurants, and some commercial establishments have larger and/or multiple tanks. All tanks are concrete, single compartment, and every tank was designed, built, and tested for watertightness. All pumps are 0.4 kW (1/2 hp). Mains are mostly 5.1 cm (2 in) diameter, with just the final hundred meters or so being 7.6 cm (3 in) diameter.

Here’s the clincher: cost of the system in 1989, including engineering, construction, inspection, and startup fees was only $897,800-less than $7000 per home. And that included a recirculating sand filter and 11, 000 lineal feet of drainfield for treatment! Nearly ten years after construction, maintenance on Elkton’s STEP system averages less than an hour a month per 100 homes and as yet none of the residential tanks has needed to have the solids removed.

Is it just luck that Elkton’s STEP system has been such a success? Hardly. The individuals who created it and maintain it are the key. A design engineer who paid rigorous attention to detail and provided careful inspection, a conscientious installing contractor, and maintenance personnel who take pride in their work-all have contributed to a system that’s a model for other communities.

Designing for Success

There’s nothing mysterious about STEP systems. There just aren’t a lot of engineers who have experience with them, and for a good reason-they’re not part of the engineering curriculum at most colleges and universities. Designing a STEP system for the first time takes a certain degree of commitment. The engineer must educate himself: study existing systems and learn from others’ successes and failures, learn about specialized equipment and design techniques, and, probably most helpful of all, seek the advice of an experienced STEP designer. Beyond that, attitude is everything. Woe is the community, its STEP system about to go to bid, whose engineer was overheard to say that he doesn’t care which pumping equipment the contractor installs-so long as it survives the one-year warranty period.

A Little PR Goes a Long Way

Public relations may be outside some designers’ comfort zone, but a successful STEP system isn’t going to happen without a healthy dose of public education. Getting homeowners on board as stake holders at the beginning of a STEP project is vital. Typically a simple explanation of the economics-the low capital and treatment costs, low-cost O&M, and the resulting low utility charges-piques their interest immediately. Mention the environmental benefits-total biosolids to be handled are several times less than in a conventional system-and it begins to make sense to most everyone. And when someone protests “all those pumps,” a description of their advantages-reliability, longevity, safety and low cost to operate relative to large lift station pumps-is usually sufficient to alleviate concerns.

While design is in progress, the engineer should schedule visits to each home to pin down mutually-agreeable locations for the tank, control panel, and service line, to arrange for easements, to make sure roof and other freshwater drains are not plumbed into the sewer line, and to help homeowners feel they're part of the process.

Septic Tanks First

Tanks for STEP systems absolutely must be structurally sound and watertight. Unfortunately, tanks that meet those specifications are not universally available. Manufacturers may claim they make them-and, indeed, some do-but a designer shouldn't just take their word for it. Engineered design calculations should be checked and a demonstration of the tank's watertightness required. Both concrete tanks and fiberglass tanks, when well built, are satisfactory for the job.

An engineer is well advised to start the search for tanks at the outset of the design process rather than to wait until bid time. Even if a local tank manufacturer agrees to produce tanks suitable for a STEP system, it often takes time to gear up. New forms may have to be ordered, reinforcing techniques learned, and crews trained. If tanks must be brought in from a distance, extra time must be allowed for transportation. By making tanks an early priority, a designer can avoid construction delays, or, worse, tanks that leak or collapse once the system is operational.

The Collection Lines

A novice STEP designer needs to develop a new mind set, putting aside much of what was learned in school and in practice about how sewers operate. A gravity sewer must be designed with slope adequate to maintain minimum velocity so that solids don't accumulate. In a STEP collection main, which handles essentially solids-free effluent under pressure, minimum velocity is irrelevant. Because the solids remain in the septic tank and there is no I&I, collection lines in a STEP system are much smaller in diameter than those in a gravity system. Manholes are superfluous in STEP system mains. On those systems where they have been installed anyway, they have proved to be a source of damaging infiltration, not to mention the cause of wasted expense.

A STEP collection line must have air-release valves to avoid the headloss that pockets of air can cause. Pressure-sustaining valves are essential to keep the lines full, thus preventing generation of odorous gases. For clearing mains of construction debris at startup and for subsequent routine maintenance, STEP collection lines must be fitted with pigging ports. STEP units above the hydraulic grade line must have antisiphon valves to prevent draining of the septic tanks' contents.

The Pumping Systems

In evaluating STEP pumping equipment, it's essential to differentiate between minimum standards and the quality necessary for reliability and long life. Effluent pumps, for example, have useful lives that range from 13 months to 20 years or more. Some are lightweight and easy to service; others require back-saving lifting devices. Stainless steel pumps are corrosion-resistant; cast-iron bodied pumps are short-lived in a septic tank environment. Some are built to withstand frequent cycling; others wear out quickly in such duty.

A minimum standard for pumps and other electrical components is ensured only if UL listing is required. Indeed, pumps should be UL listed specifically *for use in effluent*. Beyond UL certification, control panels should be designed to withstand the weather, and component parts should have long life expectancy. What good is a pump that lasts 20 years if the contactor that controls it wears out in two?

To ensure quality pumping systems will be installed, engineers must specify equipment with a track record for reliability. Contractors should be required to obtain prebid approval from the engineer for all equipment to be used. Substitutions after the bid is awarded should not be allowed. What happens when contractors shop around, mixing and matching components to save a few dollars? Pumps too heavy to remove or not removable because they're blocked by discharge piping; pump vaults locked in place because the access riser is too small or because valves are in the way; float switches that are incompatible with control panels: they've all happened and are just a few of the reasons integrated pumping packages should be mandatory.

The Installing Contractor

While the bid process usually prevents an engineer from simply selecting a contractor he has confidence in, STEP systems designers should be aware that there are contracting companies with experience and expertise in STEP construction. It makes sense to seek them out, ask for relevant job references, and request bids from the best.

Inspection

Throughout the installation, rigorous inspection is the engineer's best insurance that quality will be maintained, especially if the contractor is new to this kind of construction. For example, a compacted base on which to place the septic tank is essential; otherwise, settlement will lead to broken pipes and fittings. Inspection of the installed tank and attached riser for watertightness needs to be done with care. It must be filled with just enough water to test the tank-to-riser connection. Water too high in the riser can create pressures that can crack an otherwise good tank.

The supplier of the pumping systems should be required to be onsite for the first installations to ensure that the contractor, the engineer, and his inspector understand the equipment and how it goes together. A mistake at this point will be duplicated many times over and may result in multiple costly repairs later on.

Operation and Maintenance

Once a STEP system has been designed, built, and accepted by the owner, its fate rests in the hands of those hired to operate and maintain it. While a can-do attitude carries a lot of weight, operators ultimately need the guidance of a thorough O&M manual supplied by the design engineer in order to understand the level of maintenance to expect.

If the operator at one STEP system had been instructed to monitor sludge and scum depths in the septic tanks, for example, he might not have taken it upon himself to have the tanks pumped annually, an entirely unnecessary expense to the district. Occasionally operators have been known to exaggerate their work load to turn their part-time jobs into full-time ones. One fellow routinely answered alarms in the middle of the night, collecting overtime pay, even though the septic tanks' reserve space makes emergency service calls almost always unnecessary. But then there's Elkton, where two retirees cheerfully take turns monitoring and maintaining the STEP system plus its treatment facilities in just a few hours each week.

If attitude helps, training is essential. STEP system owners should insist on the O&M manual and the supplier of the pumping equipment must be available to the operator for troubleshooting assistance. Periodic workshops at which operators of STEP systems can network to solve problems can be useful and are popular on the West Coast.

The Payoff

A STEP system works for the small town of Elkton. And the same technology works for the district that includes the cities of Olympia, Lacey and Tumwater, and the county of Thurston in Washington. These STEP systems are being used to economically handle rapidly expanding residential development. It even works for Montesano, a town of 3,000 in Western Washington, where the gravity collection system leaked so badly that winter flows often were dumped barely treated or untreated into the Chehalis River. When the gravity system was replaced with a STEP system, infiltration and inflow plummeted and plans for a 40-acre wastewater lagoon could be scrapped in favor of a three-acre aerated facultative lagoon. Case studies of these and other STEP systems are available from the authors.

Not many years ago government agencies were eager to hand out grants and low-interest loans to anyone with a wastewater problem to solve. As long as the money flowed, engineers found plenty of work without having to justify their designs as cost-efficient. Today with less and less money for infrastructure coming out of state capitals and Washington D.C., wastewater projects, increasingly, have to stand on their own merits. STEP systems work and can be built and operated affordably. Engineers who acquire a working knowledge of STEP system design will have a leg up when budget-conscious communities come looking for someone to solve their wastewater collection problems.