LINKING ON-SITE WASTEWATER DESIGN AND MAINTENANCE

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Abstract

Effective on-site wastewater designs must consider not only the objective of consistent reliable performance but also ease of construction and maintenance. There are several examples in the field where design professionals developed elegant designs that were difficult to construct and nearly impossible to maintain. These weaknesses resulted ultimately in the failure of systems employing the design, because when a system is difficult to maintain, it simply is not maintained. Advanced treatment and performance-based designs cannot withstand the abuse caused by an ignorant or inattentive owner/operator. For these systems in particular, careful attention to detail in the planning of how to easily, quickly and cheaply maintain a system is paramount.

Keywords

inlet tees, performance, maintenance, meander tanks, monitoring, union connectors

1 Introduction

The history of on-site wastewater is full of examples where little to no attention has been paid to the plight of the installer or the drainer. These individuals have the dubious distinction of having to construct and maintain systems conceived by a designer. The best designers usually have an interdisciplinary background and lots of real-world experience. The optimal designers are those who have 'worked through the ranks', perhaps having worked in the inspection, construction, repair or maintenance of on-site systems earlier in their careers. More often, the design professional has had broad training in environmental, geotechnical or consulting engineering with limited on-site wastewater related work.

As on-site systems move more towards performance-based designs, the complexity and need for routine operation and maintenance will increase. These systems will be less passive and less resilient to owner abuse, disregarded warning signs and postponed maintenance. Systems that are easy to construct, provide early warning of needed maintenance and allow straightforward maintenance are more likely to perform as desired.

2 Design and Planning

Design of on-site wastewater systems is best approached from a systematic planning perspective. All aspects of the system, including its maintenance, must be considered before the design is complete. Spending just a few moments considering how the system will be constructed and serviced is well worth the time investment.

In evaluating a design, the following concepts should be stressed. First, access to maintainable components and compartments must be of adequate size and conveniently positioned. Access ports (manholes) of 0.145 m^2 are large enough to allow visual inspection of tanks and use of conventional cleaning equipment. For septic tanks, access ports should be positioned on the inlet and outlet areas of the tank. Secondly, unit processes must be placed in treatment vessels sized so a reasonably low frequency of maintenance can be used. For instance, on a

residential system, replacement of treatment media more frequently than annually should be avoided.

Third, a minimum of special tools and equipment should be required to construct and maintain the system. The exception to this rule is that access risers to the ground surface should be fastened with tamper-resistant fasteners requiring a special tool to open. This requirement will discourage unauthorised entry and vandalism and encourage homeowners to use the services of maintenance professionals.

Finally, the system should be able to be constructed and maintained by individuals with a skill level normally available in the area. If special knowledge is required to properly construct and maintain a design, qualified individuals should receive training and certification by the manufacturer and/or the designer. They should receive and be trained from a published installation manual or maintenance manual as appropriate. Consequently, these specially trained providers should be compensated commensurate with the value and time required to gain these additional skills.

3 Historical Examples

3.1 Meander Tanks

Throughout the history of on-site sewage systems, there are examples of design choices that have had negative consequences for system maintenance. Meander tanks were popular in the United States in the first half of the 20th century (Minnis & Burks, 1998, Winneberger, 1984). These tanks have internal compartment walls parallel to the long axis of the tank. They were designed to create a circuitous path for optimal settling of solid materials in the sewage.

When these tanks were drained by hand, wastes were removed slowly enough for liquid levels in either side of the compartment wall to equilibrate. However, with the advent of rotary vane vacuum pumps, even large municipal sized tanks could be quickly drained. When meander tanks were first drained mechanically, the compartment walls could not withstand the hydraulic load created by the unequal liquid levels and many collapsed. This design is not popular to this day in the United States, although designers tout the improved flow path these systems create (Bounds, 1997).

Today, the problem of undue hydraulic stress on compartment walls is not so severe in standard compartmental tanks. In this case the wall spans the short axis of the tank and therefore the forces generated by an unequal liquid level require less reinforcement. If the compartment wall is loosely slid into a channel in the tank walls, the compartment will allow liquid to equilibrate during the draining process.

3.2 Inlet Tees

In Florida, septic tank contractors have historically had poor experience with inlet tees. They tend to hang up toilet paper. When a large amount of grease was discharged into the system, the vertical leg of the inlet tee would act like a miniaturised grease trap. Grease would cool and coagulate along the sides of the inlet pipe, eventually backing up sewage exiting the home. When a plumber was called to address the slow draining of house plumbing, they would 'solve' the problem by knocking the inlet tee off.

The Florida code addressed the issue by making the inlet tee an option. They are rarely used in a conventional gravity application. The Florida code requires a compartment wall and outlet filter. Florida's code was recently modified to include hydraulic and vacuum testing of tanks for structural strength and water-tightness. A cast-in-place compartment wall is sometimes essential for larger tanks to meet new strength specifications (Ellen Vause, 2001 personal communication)

4 Practical Pointers

Experienced designers have a number of practical ideas that improve the longevity of their systems. A few of these tips are detailed below.

4.1 Place Floats on a Separate Float Tree

Pump systems are controlled by a series of mercury switch or mechanical switch floats. These floats rise and fall with liquid level in a pump tank and are activated or turned off depending upon the liquid level. Examples of float arrays are high-water alarm, low-level cutout, and redundant pump-off.

The float array is often strapped to the pump discharge pipe. This is poor practice because to examine and troubleshoot the floats, one must lift the entire assembly including a very heavy pump! Also, pump vibration when the pump is activated can loosen the straps and allow the floats to slip from their intended settings.

A better solution is to construct a PVC pipe float 'tree', install it vertically in the pump tank, and arrange float switches on it. An inverted toilet flange makes an excellent base for such a tree. Service personnel report the number one problem they encounter with float trees is corrosion failure of connectors. When they examine the float tree, all the floats have fallen to the bottom of the pump tank. This situation can be avoided by specifying all plastic cable ties, ties with 300 grade stainless steel teeth, or cable weight and pipe clamp connectors.

4.2 Use True Union Connectors

A designer truly has not thought of how their system is to be maintained if they have not specified true union connectors around key maintainable portions of a system. Maintenance personnel have reported having to saw through PVC pipe to replace key components of a system! True union connectors on the horizontal leg of a pump discharge pipe allow the service person to loosen, remove and reinstall a pump in minutes.

5 Conclusions

If a system is difficult to maintain, it will not be maintained. Owners will ignore warning signs. Maintenance personnel will be unable to examine key components of a system for wear and tear, waiting for catastrophe to alert them to a part's failure.

The strength of conventional septic tank and drainfield systems was their passive and robust performance with minimal need for maintenance. As performance based standards are used in Australia and New Zealand, higher levels of system performance will be sought. It seems each step in performance improvement requires the addition of more maintenance-intensive processes. The experience of the author in reviewing, evaluating and trying to develop performance-based designs in Florida is that a maintainable design is paramount to long-term reliable performance.

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