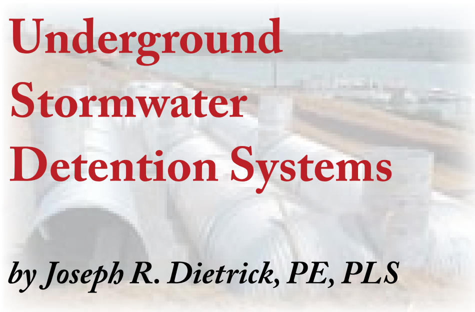
FEATURE ARTICLE



Underground Stormwater Detention Systems

by Joseph R. Dietrick, PE, PLS

We have all heard the old adage "buy land, it's the only thing they're not making more of." With the exception of accretion, I suppose this is true. I know that land is a good investment, and that over time it almost always returns a profit. Even in a recession, nobody is giving land away.

As surveyors, we are often called upon by our clients to help them make the best use of their land. We develop plans based on the local ordinance requirements and do our best to maximize the space available for development (meaning a good return on the investment for our clients). However, frequently, an open basin type stormwater detention system takes up more space than the client can afford for such a purpose. When the price of land becomes the driving force in a development, underground stormwater detention becomes a realistic solution to satisfying the stormwater management criteria.

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Underground stormwater detention systems come in many forms—anything from simple stone filled sumps to large reinforced concrete tanks. The advantage of an underground system is that it doesn't impact the space available for development of the site. Usually these underground systems are located under access drives, parking lots or other open areas of the site. The disadvantage is the cost.

If the cost of the land is ignored, an underground detention system will always be more expensive than an open basin. In order to successfully design an underground system, the designer needs to keep in mind some basic considerations. These considerations can be summarized by the PennDOT acronym TS&L—Type, Size and Location.

Type

The type of underground system varies with the requirements of the design. Small sites that do not need much storage capacity can be adequately served with stone sumps.

Stone sumps are an effective method of storing stormwater, but not necessarily that economical. It is commonly assumed that there is a 40 percent void ratio in a stone filled sump. This means that only 40 percent of the excavation is available for the storage of stormwater. A stone sump is an excellent type of system when infiltration is desired. Stone filled sumps should be wrapped with a geotextile material to prevent the migration of the surrounding soil into the stone voids. Maintenance of these type of sumps is difficult. If the sumps become clogged with debris or otherwise not function properly, the only repair is to remove and replace them.

When designing a stone sump, it is a good idea to require a debris catchment device to filter the stormwater before it enters the sump. When the inefficiencies of stone sumps outweigh the benefits, the next logical type of underground system is a pipe system. Pipes are a more efficient and commonly used method of underground storage. Corrugated metal pipes or double-walled plastic pipes are readily available and can be fabricated in various ways for use as underground storage.

The use of concrete pipes for underground storage is not a normal practice. A series of pipes connected by manifolds at each end form a practical system that is easily constructed, easily maintained and is reasonably priced. The design of a pipe system should include an adequate number of access points and inspection ports. It is good practice to include vents at the upper end of the pipe system to prevent a build up of gases. When using a pipe system it is important that the designer and the contractor follow the manufacturer's recommendations for bedding, backfill and cover. The use of open-bottom chambers has become a popular choice when infiltration is desired. This type of underground system combines the benefits of the stone sump with the greater volume capabilities of the pipe. Groundwater infiltration may be a key component of the overall stormwater management plan and will influence the

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type of underground system that is selected. Underground systems that allow for infiltration are becoming a popular means of meeting the National Pollutant Discharge Elimination System (NPSDES) requirements for volume control.

When a very large quantity of stormwater storage is required, there are several types of proprietary systems available. The manufacturers of these large systems will usually assist in the preparation of the design and detailed drawings.

Size

Designing an underground detention system is no different than designing an open basin type system. It is simply a matter of sizing the control orifices to regulate the discharge from the detention facility to the release rate dictated by the ordinances. The stormwater storage necessary to meet this release rate determines the size of the facility. Most computer software obtainable for the design and analysis of stormwater detention systems has options for underground storage facilities. As I mentioned above the size of a stone sump is constrained by the allowable void ratio. Studies have shown that the size of the rock used in a stone sump does not have a great impact on the available void ration. When sizing a pipe system, don't forget your high school math – πr2. A 4-foot diameter pipe will hold four times more stormwater than a 2-foot diameter pipe. My experience has shown that the larger diameter pipes, while costing more per foot, are the most economical solution. I have specified pipes systems ranging in size from a 2-foot diameter pipe to an 8-foot diameter pipe. Pipes larger than 8-feet in diameter become difficult to transport and assemble. The factors affecting the size of pipes to be used in an underground system are the manufacturer's cover requirements and the discharge point elevation.

Location

The location of the underground system is usually a by-product of the site layout. Obviously, you do not want to put a stormwater detention system under a building (not that this hasn't been done, but it would require some very special design considerations). The location of other underground utilities, such as electric conduits, water lines, gas lines and underground fuel storage tanks, usually affects where the underground stormwater system can be placed. It is best to construct the underground system in original material. If it is to be located in a constructed fill, the weight of the system full of water should be included in the fill design. Access and maintenance must be a priority when selecting a location for the underground detention system. Stone sumps, pipe systems and other underground facilities should be designed with overflow capabilities. Just as an open basin typically is designed with an emergency spillway, the underground system should have a means of allowing excess stormwater to leave the system without causing any damage to the system or other infrastructure. The overflow needs to be located so that when stormwater is being released it is directed to an acceptable discharge point.

It is imperative that the underground system be installed according to the manufacturer's specification. A company that markets an underground detention system will warrant it as long as it is constructed properly. This includes the bedding and backfill. It is always a good idea to have the manufacturer's representative on site when a system is being installed. There are those who cut corners when they know that what they are working on will be buried. A failure of an underground system usually involves the failure of what is above it as well (e.g., parking lot or access drive).

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Underground systems can be used in series or in conjunction with other detention systems. I recently worked on a project where the site parameters limited the size of an open basin. In order to attain the necessary detention requirements, I incorporated an underground pipe system into the design. This underground pipe system was designed to receive stormwater from a large roof area. The metered discharge from the pipe system was conveyed to an open basin where additional detention was achieved. Given the site constraints, the combination of the two types of detention proved to be the correct solution.

The bottom line is that underground stormwater detention systems are effective solutions when site restrictions limit the options for the designer.

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