UgB

Underground Detention

Description

Underground detention vaults and tanks are large underground structures that provide necessary storage volumes for attenuating peak flows and providing channel protection. Underground detention vaults are box-shaped underground stormwater storage facilities typically constructed with reinforced concrete. Detention tanks are typically made with large diameter pipe. Basic storage design and routing methods are the same as for dry detention basins except that a bypass for high flows is typically included. Both serve as an alternative to surface dry detention for stormwater quantity control, particularly for space-limited areas where there is not adequate space for a dry detention basin or multi-purpose detention area.

Underground detention vaults and tanks are not intended for water quality treatment and must be used in a treatment train approach with other structural controls that provide water quality treatment. This will prevent the underground vault or tank from getting clogged with trash or grit and significantly reduce the maintenance requirements for the underground detention system.

Prefabricated concrete vaults and packaged pipe detention systems are available from commercial vendors.

Selection Criteria

A permanent detention basin design must be stamped by a professional engineer licensed in the state of Tennessee. The professional engineer must be qualified by education and experience to perform the necessary hydrologic and hydraulic calculations. Underground detention structures are not appropriate in areas where groundwater impacts can cause the structures to be buoyant.

Location

Underground detention systems are to be located downstream of other structural stormwater controls providing treatment of the “first flush” volume. The maximum contributing drainage area served by a single underground detention vault or tank is 25 acres.

General Design

Underground detention systems are sized to provide extended detention of the channel protection volume and can be designed to attenuate the peak flows for the specified design storms. Due to the storage volume required, underground detention vaults and tanks are typically not used to control the 100-year storm volume except for small drainage areas (<1 acre).

Detention Vaults: Minimum 3,000 psi structural reinforced concrete may be used for underground detention vaults. All construction joints must be provided with water stops. Cast-in-place wall sections must be designed as retaining walls. The maximum depth from finished grade to the vault invert should be 20 feet.

Detention Tanks: The minimum pipe diameter for underground detention tanks is 36 inches.

Underground detention vaults and tanks must meet structural requirements for overburden support and traffic-loading if appropriate. Adequate maintenance access must be provided for all underground detention systems. Access must be provided over the inlet pipe and outflow structure. Access openings can consist of a standard frame, grate and solid cover, or a removable panel. Vaults with widths of 10 feet or less should have removable lids.

Inlet and Outlet Structures

A separate sediment sump or vault chamber sized to 0.1 inches per impervious acre of contributing drainage should be provided at the inlet for underground detention systems that are in a treatment train with off-line water quality treatment structural controls.

For peak flow control, a low flow orifice capable of releasing the channel protection volume over 24 hours must be provided. The channel protection orifice should have a minimum diameter of 3 inches and should be adequately protected from clogging by an acceptable external trash rack. The orifice diameter may be reduced to 1 inch if internal orifice protection is used (i.e., an overperforated vertical stand pipe with 0.5-inch orifices or slots that are protected by wirecloth and a stone filtering jacket). Adjustable gate valves can also be used to achieve this equivalent diameter.

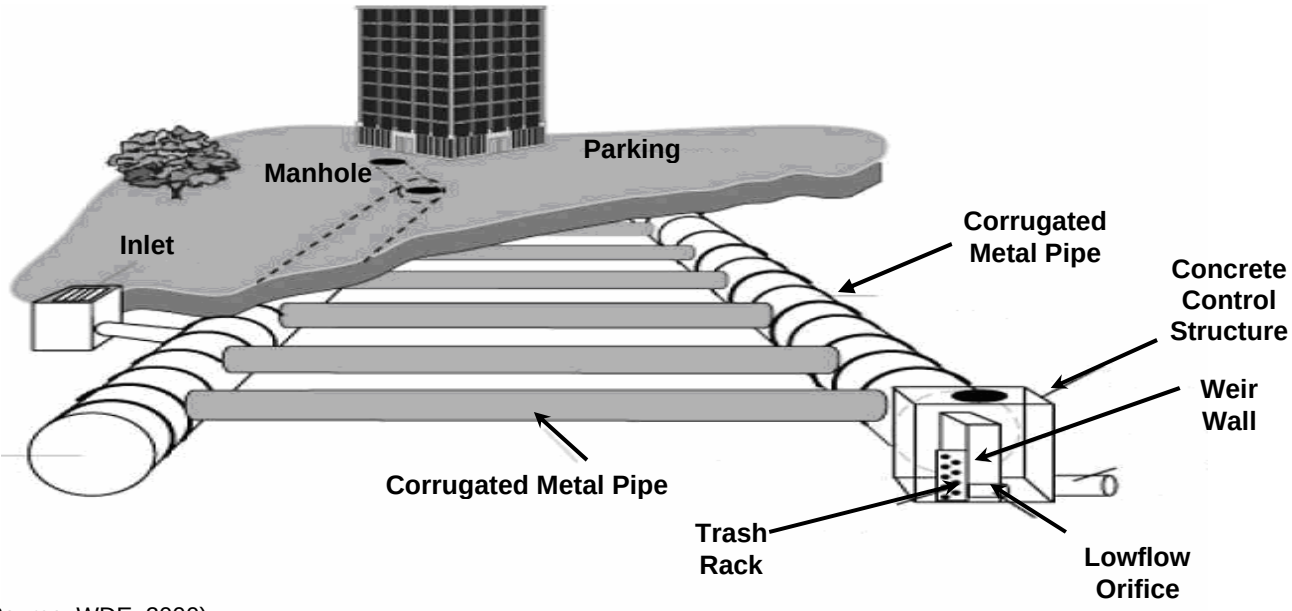
An additional outlet is sized for 5-year storm event volume control (based upon hydrologic routing calculations) and can consist of a weir, orifice, outlet pipe, combination outlet, or other acceptable control structure. A high flow bypass is to be included in the design of the underground detention system to safely allow for extreme flood flow.

Riprap, plunge pools or pads, or other energy dissipaters are placed at the end of the outlet to prevent scouring and erosion.

Maintenance

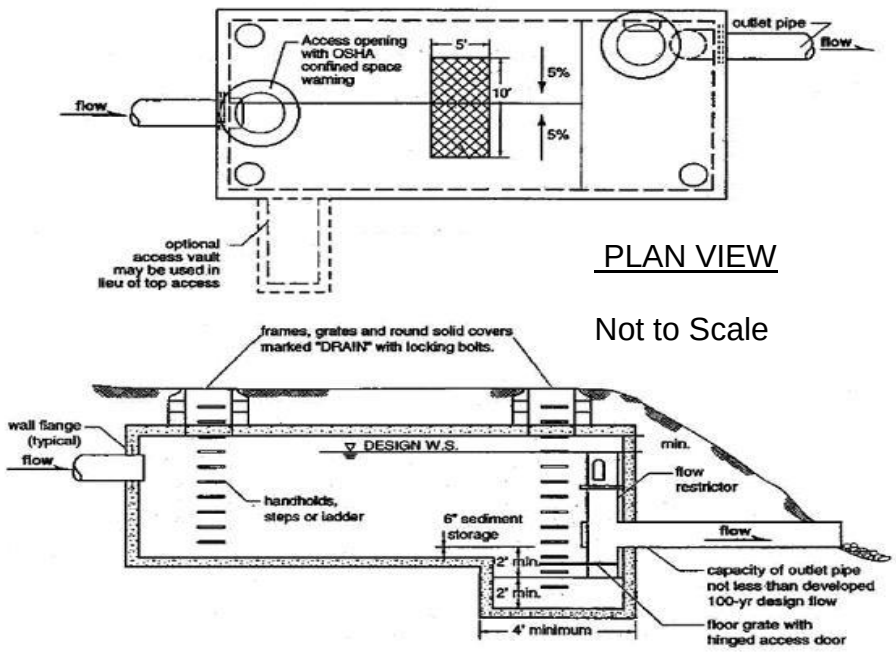
Removal of trash, debris and sediment build-up in the vault or tank and structural repairs to inlet and outlets should be conducted on a regular basis. Easy access should be provided to conduct routine inspection and maintenance requirements. Note that the cost of maintenance may limit the use of underground storage as a BMP for detention.

Figure 1
Conceptual Schematic of Typical Underground Detention Vault



(Source: WDE, 2000)

Figure 2
Typical Underground Detention Vault



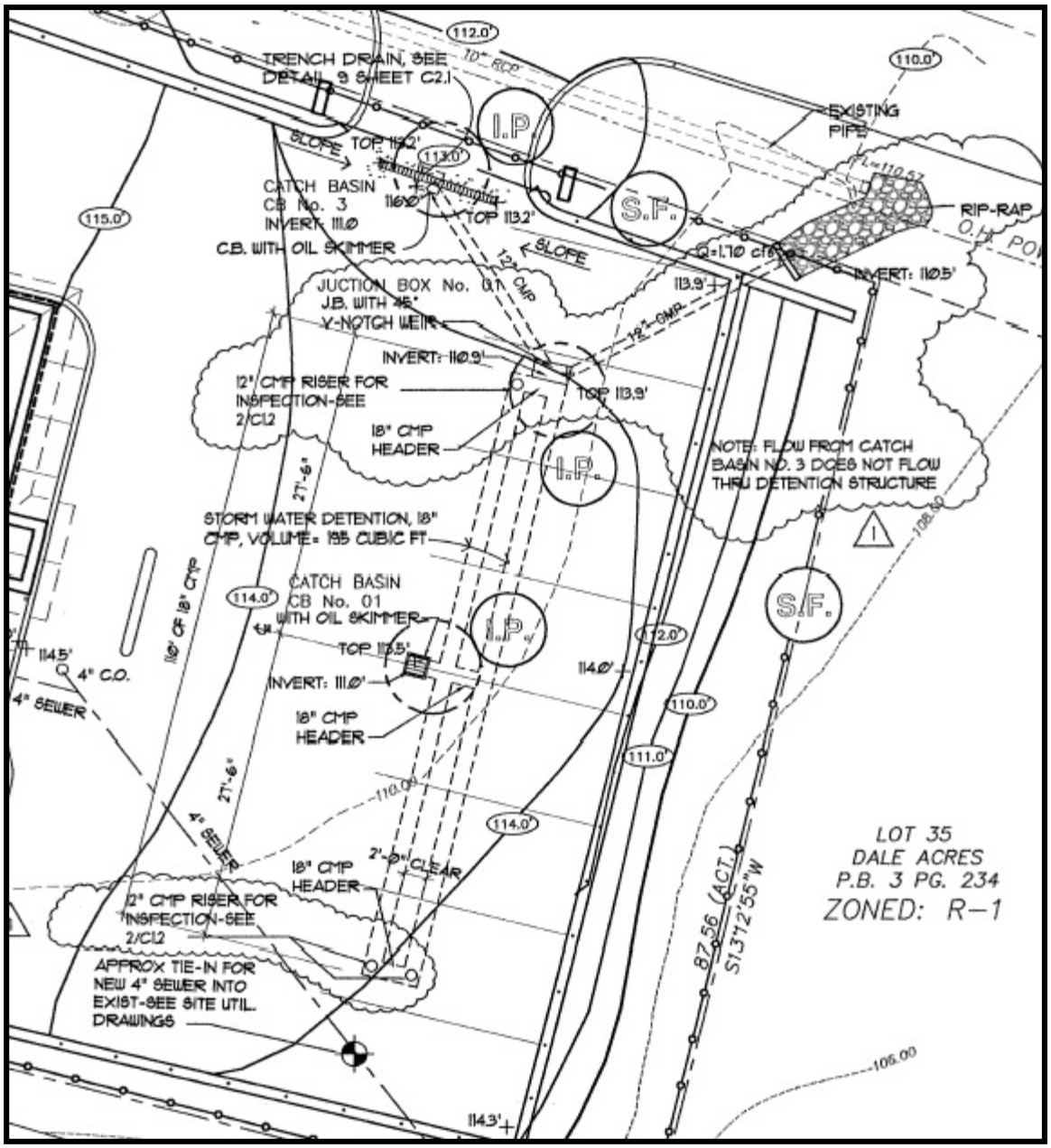
PLAN VIEW

Not to Scale

PROFILE VIEW

Not to Scale

Figure 3
Typical Underground Detention Structure



References:

Knoxville (City of). October 2007. Knoxville Stormwater Engineering Division. City of Knoxville BMP Manual. http://www.ci.knoxville.tn.us/engineering/bmp_manual/