4.4.12.5 Perforated Riser Pipe

Source: City of Franklin

Definition and Purpose
A perforated riser pipe is a dewatering device used in sediment basins (Section 4.4.7). It is a vertical perforated pipe that dewaters the basin at a rate governed by the head of water above the perforations and discharges water to the principal spillway. The perforation (i.e., orifice) with the lowest elevation sets the sediment storage elevation.

Appropriate Applications
Perforated riser pipes are applicable in any sediment basin. They are most ideal when dewatering solely from the top of the water column is not feasible (IDEM, 2021).

Limitations and Maintenance
In order to comply with specific sediment basin detention requirements (i.e., 48 to 72 hours), the diameter and number of orifices within the rise pipe must be computed. This computation is based on the head of water above the orifices which changes over time, thus computation time can be complex and lengthy, may require software, or rely on the interpretation of figures. Further, because a perforated riser pipe does not dewater from the solely from the top of the water surface elevation, sediment removal efficiencies of basins with this dewatering mechanism are lesser than those equipped with a floating skimmer

(Schussler, 2022; Zech et al., 2014). Lastly, orifices have a high potential to become clogged or blocked by trash and debris. Trash guards are highly recommended.

Planning and Design Considerations
Perforated riser pipes are typically made of PVC or metal and are typically connected to the principal spillway outlet. These structures must be stable, durable, and designed to resist flotation and external loading. The riser is anchored in concrete to maintain position and functionality. Multiple perforations, protective mesh, trash guards, or anti-vortex devices may be ideal to prevent clogging (IDEM, 2021).

Riser pipes often have multiple columns of orifices in which the vertical spacing is usually between six inches and one foot. As opposed to a single orifice, perforated risers have many openings, thereby reducing the likelihood of total blockage or failure, and dewatering does not solely occur from the sediment storage elevation. The number of columns, vertical spacing of orifices, and diameter of each orifice all impact the dewatering time and therefore must be selected carefully (Jarrett, 2016). Traditionally, dewatering time was an iterative process governed by the orifice equation:

$$Q = N \times C_d \times A \times (2 \times g \times H)^{1/2} \quad \text{(Eqn 29)}$$

where Q is the outflow rate (cubic feet per second), N is the number of orifices, C_d is the discharge coefficient (dimensionless, typically set at 0.6), A is the cross-sectional area of the orifice (square feet), g is acceleration due to gravity (32.2 feet per square second), and H is the static pressure head (feet, measured from the water surface elevation to the centerline of the orifice). The iterative process begins with assuming an area for the orifice. Iterations must be conducted at sufficiently small differences of H over the orifice centerline, as outflow will change with H. Obtain a corresponding outflow rate for each iteration of H until outflow is negligible. The time between each H iteration would need to be computed via level pool methodologies and summed. If the total time is not within the desired dewatering time, the process must be restarted with a different assumed orifice area.

As this methodology may be time-intensive and detail-oriented, dewatering time through in orifice is more efficiently computed via level pool methodologies in software such as HEC-HMS. Level pool routing in software will be particularly beneficial when riser pipes feature numerous orifices at various elevations. The most time-efficient and simplistic method would be using figures, if they exist for specific conditions. For example, the most common riser configuration is four columns of holes spaced at six-inch vertical intervals (Figure 4.4.12.2.1-A).

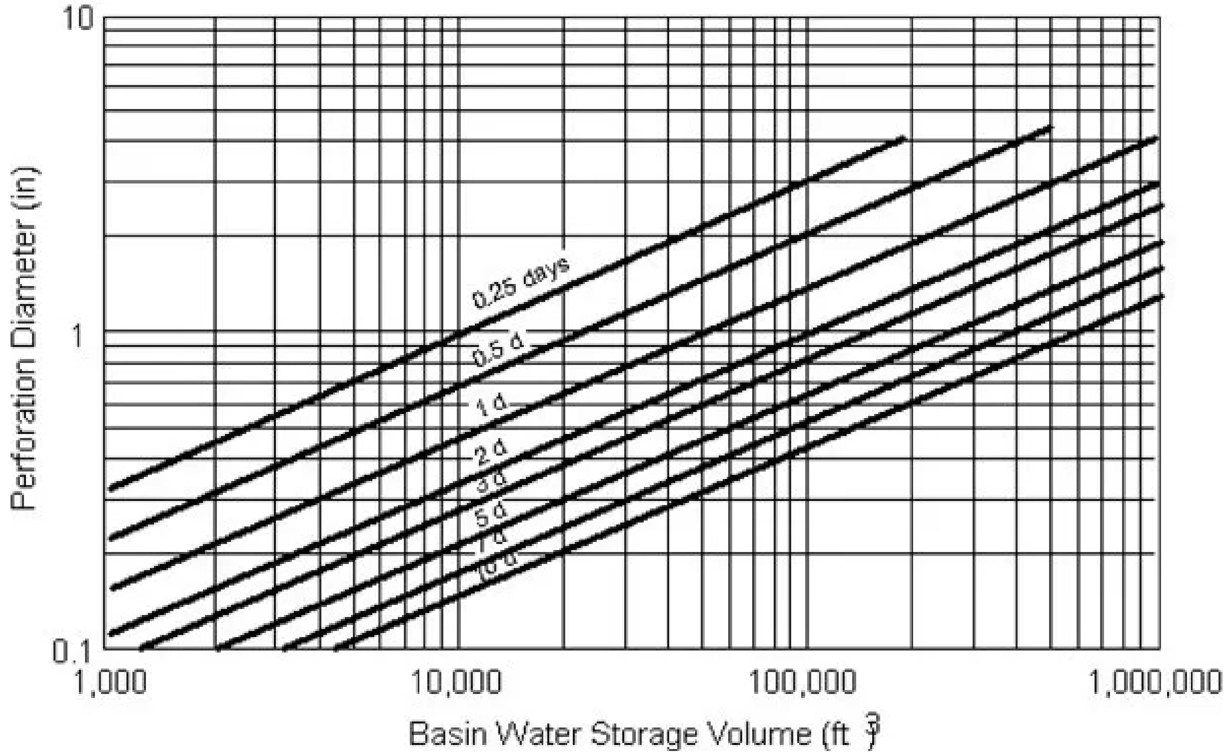

Figure 4.4.12.2.1-A: Design chart for a perforated riser with four columns of orifices spaced at six-inch vertical intervals. Source: Jarrett (2016).

Example Application

Example courtesy of Jarrett (2016)-

Given:

A sediment basin with a live storage zone of 40,000 cubic feet and a required dewatering time of 48 hours.

Determine:

The orifice diameters for a riser pipe.

Solution:

Using a four-column riser, Figure 4.4.12.2.1-A can be used to determine the required hole diameter of 0.67 inches. Therefore, the perforated riser for this basin would be a vertical pipe with four vertical columns of 0.67-inch diameter holes drilled, with the bottom row of holes located at the sediment storage elevation, with additional 0.67-inch diameter holes located on a six-inch interval upwards from the bottom holes.

References

IDEM. (2021). *Indiana Storm Water Quality Manual: Sediment Traps and Basins*.

Jarrett, A. (2016). *Controlling the Dewatering of Sedimentation Basins*. PennState Extension.

Schussler, J. C. (2022). *Improvements in Stormwater Detention Technologies through Large-Scale Testing Techniques*. Auburn University.

Zech, W. C., Logan, C. P., & Fang, X. (2014). State of the practice: Evaluation of sediment basin design, construction, maintenance, and inspection procedures. *Practice Periodical on Structural Design and Construction*, *19*(2), 04014006.