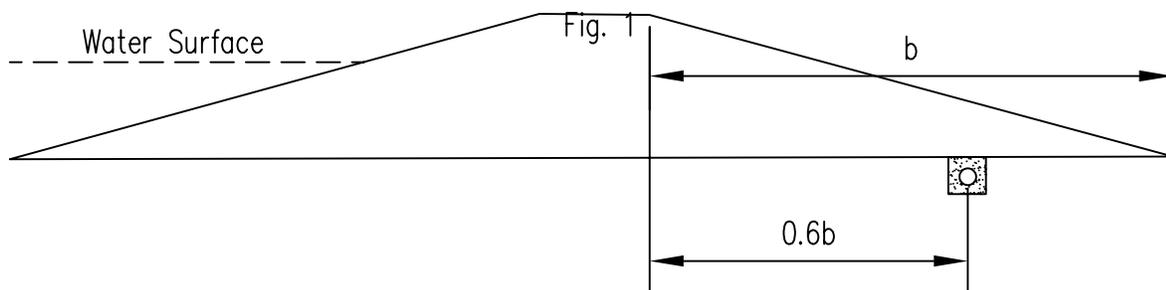


Embankment and Foundation Drain Criteria

The purpose of this criteria is to provide guidelines for planning and design of drains used in earth fills. Drains are used in dams to increase the stability of the dam, permit discharge of seepage, dry up downstream slopes, and to minimize the possibility of piping failures.

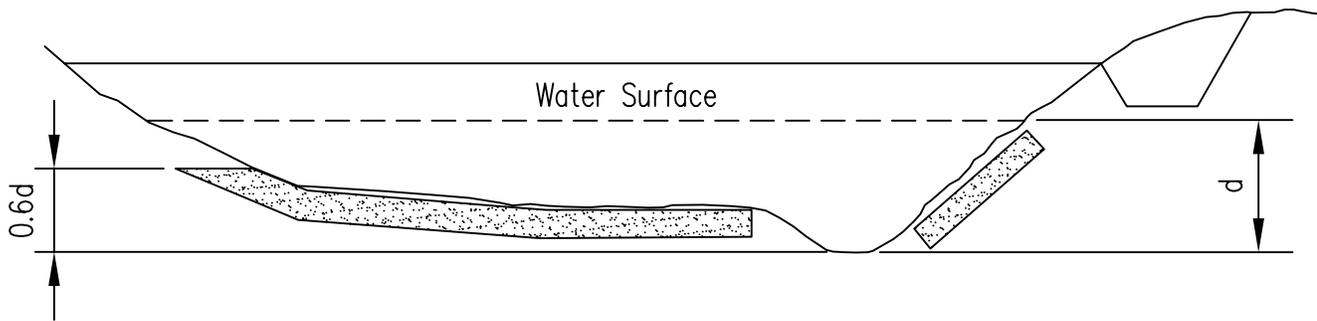
1. Foundation drains shall be installed in all dams when considered necessary by the designing engineer and in all dams over 25 feet high.
2. Location: The drains shall be located $0.6b$ from the downstream edge of the top of the dam where b is the horizontal distance of the backslope from the backside of the crown of the dam to the back toe. See Fig. 1.



The drain should extend up to $0.6d$ where "d" is the difference in elevation between the permanent water line and the lowest point on the back toe of the dam. See Fig. 2. The drains should be extended at abutment slopes of 1:1 or at the required elevation.

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Fig. 2



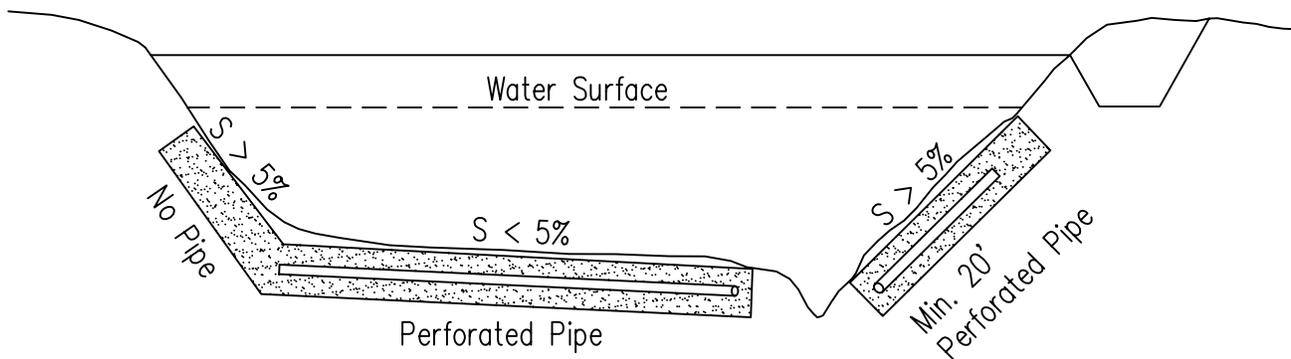
The top of the drain should be at approximately the same elevation as the downstream toe of the dam. See Fig. 3.

Fig. 3



3. Pipes: Perforated pipes shall be installed in drains where the slope is $< 5\%$ with a minimum of 20 feet of perforated pipe where drain slope is $> 5\%$. See Fig. 4.

Fig. 4



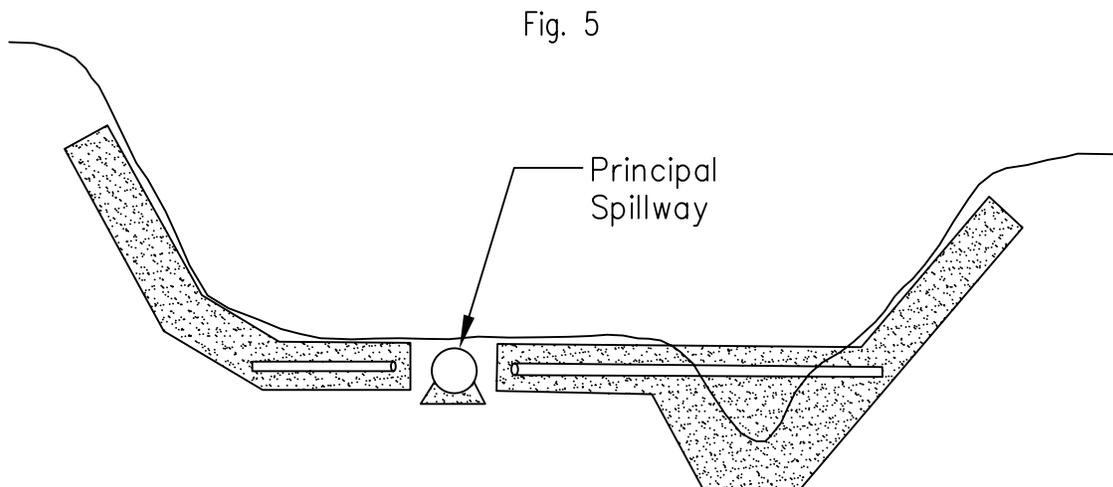
Pipe may be corrugated metal, asbestos-cement, or other suitable pipe with a minimum diameter of 6" and strength adequate for the load.

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The Pipe shall be located in the center of the filter material.

4. Filter material: If the material in the foundation and embankment is CL or ML soils, the filter material shall be a reasonably well-graded sand-gravel mixture with 50 to 85% passing a No. 4 sieve, not more than 5% passing a No. 200 sieve and maximum size 3". Other embankment materials will require gradation to fit that material. Pit run sand and gravel or a well graded clean mixture of fine and coarse concrete aggregates usually are adequate for this purpose. Crushed limestone should not be used.

The filter bed shall not be less than 3 feet by 3 feet and should be deepened to original ground when crossing channels. See Fig. 5.



If sand layer underlays ML or CL material, then drain system should extend into sand layer to relieve uplift pressure.