

Flowing Water Effects

1 The problem

Many plays have outdoor scenes that call for some sort of water in the environment — a stream, pool, or waterfall. Sometimes these can be simulated using lighting or sound effects to give the impression that water is nearby. For maximum realism, or if the actors need to interact with the water, it is necessary to construct have actual water on the stage. This tech note examines the problem of having a stream on stage that flows down a waterfall and into a pool, and presents some notes for solving the problem, based on a design by Michael Powers [1].

2 Building a pool

A pool is simply a reservoir that holds water. This is not complicated to make, but introduces a few new concerns not usually present in most theatrical problems.

The first step is to construct a base for the pool. This is a three-dimensional scenery problem, since generally we are interested in natural-looking pools, which have that rather inconvenient property of not being in regular, easy-to-build geometric shapes. (Of course, sometimes a simple cubic basin is what is called for — this makes things that much easier.) This calls for building a frame for the pool, which may be irregularly shaped.

¹This is Tech Note \aleph_0 (read: “tech note aleph-null”), in keeping with the policy of using non-numeric tech note numbers I started in Tech Note $\sqrt{2}$. In the field of transfinite set theory, \aleph_0 is the smallest possible infinite size (“the first transfinite cardinal”). So it seems like an appropriate choice for this, my final tech note.

An important and easy-to-neglect issue in building the frame is the weight of the water it will need to support. One cubic foot of water contains about 7¹/₂ gallons and weighs approximately 63 pounds [2]. For a pool of any reasonable size, this quickly adds up; for large volumes of water, careful structural analysis will be important to ensure that the frame will be able to hold the weight, especially if the pool is being recessed into a platform. One simple way to minimize the amount of water used and thus the amount of weight that must be supported is to make the pool less deep; this is often a very reasonable option since the actual depth of the pool will always not be obvious to the audience.

The frame should then be covered with plywood (given the loads it will be supporting, something substantial like 3/4" plywood should be used. It then needs to be covered with a pond liner so that it can be filled with water. These are readily available from garden stores as waterproof plastic sheets, which can be cut to size and fit into the pool.

The pool can then be filled with water. Once filled, it should be emptied or changed regularly — the last thing anyone needs on the stage is a place for bacteria and other unpleasant things to grow, and a stagnant pool of water fits that bill all too well. A pool treatment can also be useful here, though ones containing chlorine are not ideal due to their distinctive smell.

3 Building the waterfall

Many of the same techniques from building a pool of water apply to building a waterfall. Again, we will need to use a waterproof pond liner around a frame and support structure. The difference, of course, is that the waterfall will be a stream (albeit one that sometimes flows horizontally and sometimes flows vertically), so it will not have as much depth. This allows the support structure to be more lightweight. A common means for building streams is to construct a set of curved ribs, then lay a thin layer of plywood or lauan over it that conforms to the curve of the ribs. This should then be covered with the pond liner.

The water should flow through the stream and down the waterfall into the pool, which serves as a reservoir. It then needs to be returned to the top of the waterfall; for this, a pump is required. A household sump pump, available from the Home Depot or similar hardware store in the \$100 range, is probably the easiest option.

For especially large installations, a common pump may not suffice. One option is to obtain a larger pump; McMaster-Carr carries sump pumps up to $\frac{3}{4}$ hp and effluent pumps up to 2 hp, though the latter may be a bit expensive for this purpose at over \$700 [3]. A simple alternative is to use multiple smaller pumps. Submersible pumps are best for this application: other types of pumps may allow the pump to be placed further away from the pool, reducing noise, but adding a drain to the pool requires creating and sealing a hole in the liner, which only adds complexity. Sump pumps may pump into a standard garden hose, which is certainly easy to find and easy to work with. However, the pump will be able to operate more efficiently if PVC pipe (usually $1\frac{1}{4}$ " or $1\frac{1}{2}$ ", though it depends on the pump) is used.

The pressure created by a pump, especially a large one, may be rather high. This could lead to the unusual effect of the water spewing forcefully upward or in a powerful stream — which, while useful for a fountain, isn't very realistic in a stream effect. The solution here is to increase the diameter of the pipe by using couplers with successively larger diameters. This causes the same amount of water to flow through a larger area, and thus with less force.

Waterfalls and streams are generally rather noisy. The sound of water flowing down the stream and into the pool can be a rather pleasant one, and can be a helpful part of the sound design for creating the outdoor atmosphere. If, however, that doesn't fit with the sound designer's vision, it becomes the technical designer's problem to fix. Reducing the velocity of the flowing water is an obvious solution with an obvious drawback. Adding rocks and similar objects to the stream will help reduce the volume of water that needs to flow, reducing the noise created (and also allowing a smaller, quieter pump to be used). It is also quieter to not have water fall directly from the waterfall into the pool; instead, it should flow onto a surface that slopes into the pool.

References

- [1] M. Powers, "Pools, waterfalls, etc." available at <http://www.hstech.org/howto/water/pools.htm>.
- [2] P. Carter, *Backstage Handbook*, 3rd ed. Louisville, Kentucky: Broadway Press, 1994.

[3] McMaster-Carr, Inc. <http://www.mcmaster.com/>.