AquaDam®

"Water Controlling Water"™

User's Guide

(Includes Material Specifications)

Low-Impact, Environmentally Friendly Water Filled Cofferdams for Stream Diversions, Flood Control, Haz-Mat Containment, and Dewatering Structures.

AquaDams® are flexible water filled barriers that can be used as barriers or cofferdams to isolate work areas such as stream diversions and dewatering boat ramps, boat docks, and pond liners for repairs.
They are more effective than sandbags and other water control devices.

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AquaDam Inc.
PO Box 144 / 121 Main St.
Scotia, CA 95565
(800) 682-9283
www.AquaDam.net
email: Inquiries@AquaDam.net

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Introduction

AquaDam Inc.® manufactures AquaDams®, a low-impact water filled option that is quickly supplanting temporary earthen filled cofferdams (barriers). The Clean Water Act demands the use of alternatives to fill discharges, where practical, to achieve Best Management Practices. Site isolation is mandatory. Water filled protective devices, such as AquaDams®, are the ideal tools for water management programs that protect the aquatic environment. The U.S. Army Corps of Engineers has and is presently approving the use of AquaDams® as a viable, environmentally acceptable method of diverting or containing water.

The following is an overview of AquaDam Inc®; the various applications of AquaDams®; site and size requirements; equipment and manpower requirements; installation techniques; safety, maintenance, and removal.

About The Company

AquaDam Inc.® was incorporated in 2009, after 20 years of using the idea of water controlling water to offer a new concept for managing water diversions, dewatering, flood control barriers, levee toppings, and water storage by using AquaDams. AquaDam Inc. offers observation services and free consulting services regarding the installation and implementation of a water filled cofferdam. The most important features of AquaDams are the ease and speed at which they can be installed (especially in emergency situations), and that they consist almost entirely of onsite water and have a good chance of being reused.

Patents

AquaDam Inc.® uses patents on the design and utilization of multiple chambered AquaDams® that use water and air as the inflation media, and the technique used in connecting multiple AquaDams® together to achieve any necessary length.

US Patent No. 5059065
US Patent No. 5125767
US Patent No. 6481928

Several other patents are currently pending.

Concept

AquaDams are portable dams meant for temporary use, which are filled with onsite water,and can be installed wherever needed to contain or divert the flow of water. AquaDams consist of two basic parts: an outer or “master” sleeve made of a heavy duty geotextile woven polypropylene with a vertical internal stability baffle, which holds the two polyethylene inner tubes (A & B) in contact when filled with water. The baffled outer sleeve and inner tubes combine to form an AquaDam as shown in *Figure 1*, a cut away section illustrating the relationship between the inner and outer tubes of a typical filled AquaDam.

Figure 1: A Typical Filled AquaDam®

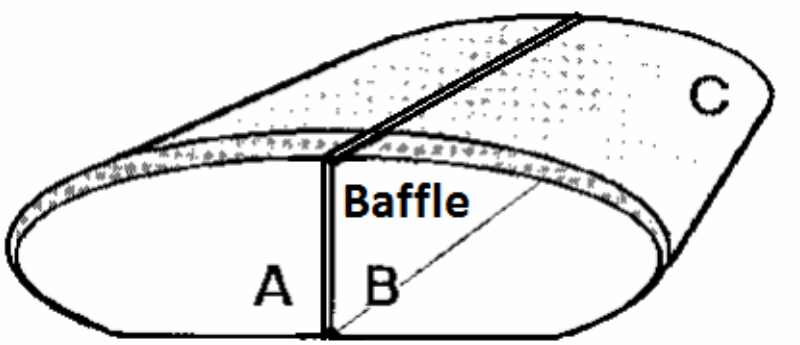

Figure 1. A cross section of a typical AquaDam, illustrating the relationship between the two inner tubes which contain the water and the “master” sleeve that keeps the inner tubes parallel and in contact with each other.

A and B illustrates the two inner tubes inflated with water.
C is the outer or “master” sleeve made of very tough polypropylene woven geotextile fabric which confines the water filled inner tubes, making the AquaDam a solid wall of water. These two confined columns of water provide the mass, weight, and pressure that gives the AquaDam its stability.

To install an AquaDam, onsite water is pumped into the two inner tubes during the installation process. The durable woven outer sleeve confines the water-inflated inner tubes. The counter friction / hydraulic pressure between the inner tube and the baffled outer sleeve, along with the mass and weight of the water, creates pressure and stabilizes the AquaDam when lateral water pressure is exerted against it. Due to the inherent flexibility of the materials used to confine the water, AquaDams will conform to most surfaces, providing an excellent seal and keeping water seepage to a minimum.

AquaDams come in a variety of sizes, ranging from to 16 feet in height when inflated. AquaDams come in standard lengths from 50 to 500 feet, in 50 feet increments, and are available for immediate shipment. Any length can be fabricated, usually within 3 to 4 days from the time of order. Shorter, longer, or irregular lengths are available with notice. Using coupling collars, two or more AquaDams can be joined together to form a continuous cofferdam of any length. AquaDams are joined together by patented coupling collar connection. Large and small AquaDams can be used in conjunction with each other. The possible configurations are almost endless. They can be used in a straight line, to form an arc, or to encircle an area.

AquaDams are usually assembled at the factory and shipped rolled and ready for use at the job site. However, it is not unusual to assemble larger AquaDams on site. A typical AquaDam® consists of the "master" sleeve and a pair of inner tubes rolled up on a wooden core, as shown in *Figure 2.* In many instances, the core also plays an important part in the installation, rerolling for future use, and transportantion of AquaDams.

Figure 2:

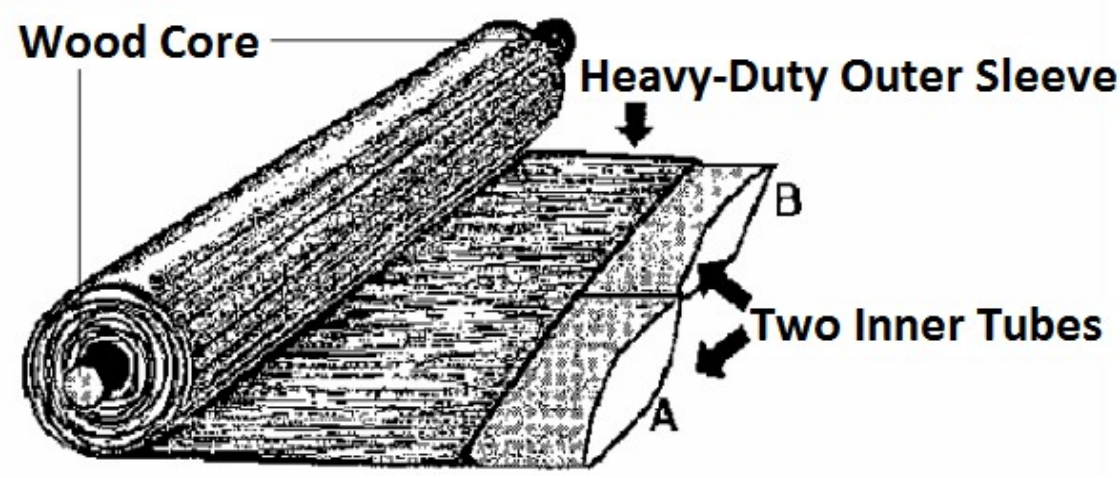

Figure 2. A typical factory assembled AquaDam prior to inflation, showing the inner tubes and outer sleeve rolled up around the core. The AquaDams' tubes (A & B) are left open for filling purposes. This open, starting end will be elevated up the stream bank (the starting point) which has to be higher than the elevation that the main body of the AquaDam will achieve when fully inflated. The other end is sealed and has an attached coupling collar used for allowing a second AquaDam® to be connected.

What Is A Cofferdam?

Applications

AquaDams can be used in a wide range of applications. Listed below are some of the more common applications of AquaDams :

Construction • Work area Isolation and Dewatering • Water diversion in rivers and wetlands • Water containment • Boat ramp dewatering • Pond liner repair dewatering • Bridge pier repair • Pipeline crossings • Erosion control through diversion or containment of flowing water • Water intake structures for municipalities • Water discharge structures	**Environmental** • Fish habitat improvement • Silt containment, sediment collection, or settling ponds • Hazardous material or chemical spills (containment) • Temporary foot causeway through environmentally sensitive areas • Wetlands management •
Flood Control • Residential • Municipal • Industrial • Commercial • Levees, levee toppings	**Water Storage** • Residential • Municipal • Industrial • Commercial

The old ways of earthen fill discharges and expensive sheet piling have been the traditional method of isolating submerged work areas. These methods are environmentally detrimental, time consuming, and expensive because of their reliance on heavy equipment.

Water filled cofferdams eliminate the fill-discharge risk of construction sites. Onsite water is pumped into an AquaDam, which unrolls due to the water pressure inside it and can be installed in hours in most applications, without causing damage to the aquatic environment with the AquaDam isolating the work area. Complete dewatering of the worksite can be achieved and your work can begin.

When used for perimeter flood control and augmenting levees, for example, AquaDams are much more effective than sandbags. They can be installed quickly, at a fraction of the cost, without all the foot traffic associated with labor-intensive sandbagging.

The amount of water that can be stored in a standard 4 foot AquaDam, with a width of 10 feet and a length of 100 feet (filled to capacity), is about 21,000 gallons. AquaDams are durable, long lasting, and with proper installation and removal can be stored and used again and again. Should a leak develop, patching tape is available. If necessary, replacement tubes are available for purchase.

AquaDams are relatively easy to install, requiring only a couple of portable pumps, an onsite water supply, and two or more laborers depending on the size of the AquaDam.

AquaDam® Height Selection and Size Criteria

Appropriate AquaDam height selection is determined by a number of factors, including work site conditions, the water depth to be contained or diverted, and to a lesser degree, stream bed slope and water velocity. Accurate estimation of maximum water depth over the life of the diversion project is very important . *Table 1* lists sizes of AquaDams and their maximum rated controllable mud / water depth. Customized dams of any length can be ordered.

Table 1: Standard AquaDam® Heights and Maximum Controllable Mud / Water Depth

Inflated Height (Feet)	Inflated Width (Feet)	Maximum Controllable Mud / Water Depth (Inches)
1' (0.3m)	2' (0.61m)	9” (23 cm)
1.5' (0.45m)	3' (0.9m)	14” (36 cm)
2' (0.61m)	4' (1.2m)	18” (45 cm)
2.5' (0.76m)	5' (1.5m)	24” (61 cm)
3' (0.9m)	7' (2.1m)	30” (77 cm)
4' (1.2m)	9' (2.7m)	38” (97 cm)
5' (1.5m)	11' (3.3m)	44” (112 cm)
6' (1.8m)	13' (4m)	54” (137 cm)
8' (2.4m)	17' (5.2m)	74” (188 cm)
10' (3m)	21' (6.4m)	88” (223 cm)
12' (3.7m)	25' (7.6m)	100” (254 cm)
16' (4.8m)	33' (10m)	126” (320 cm)

This chart represents the maximum controllable mud / water depth to be controlled on flat surfaces. The slope and topography of the stream bed needs to be accounted for as well as water depths.

Water Depth

The height to be controlled by the AquaDam is the most important factor when selecting the proper size. A good rule of thumb is to overestimate water levels over the lifetime of the project. The importance of determining the correct projected maximum water depths after installation and diversion of the stream cannot be stressed enough. Too small of an AquaDam will fail. The depth of water to be retained by an AquaDam is often underestimated by the buyer, resulting in an AquaDam that is too small for the projects requirements. This results in delays, increased costs and potentially unsafe work conditions.

Water Velocity

When an AquaDam is used to dam or divert flowing water, water velocity is a concern. During installation, the AquaDam is being filled with water, causing it to unroll across the stream channel. This causes water flow to back up and an increase in water depth. The water velocity around the end of the AquaDam is increased. Depending on the firmness of the river bed, some undercutting might occur around the end of the AquaDam as it is being installed. This results in an increase in the depth of water to be retained and should be factored into the analysis. Velocity of current is also a factor. The water head will build up on the upstream side and water on the downstream side flows away before the completion of the installation. Installation in moving water requires control of the rate of unrolling of the AquaDam, maintaining head above surrounding water level with ropes.

Installation Site

AquaDams can be installed on top of most types of soils or fluvial materials, including: flat lying bed rock, mud, sand, gravel, small rocks, and vegetation. Select a site that is flat, and devoid of: wire, rebar, sharp objects, garbage, glass or dead vegetation containing tree branches, rip-rap, or other obstructions. The slope of the river bed should also be relatively flat or inclined in the direction of the upstream or contained water. Make sure to check the installation course for holes, obstructions or washed out areas that may cause problems during installation.

Weather / Spring Run-off

Local wet seasons and thunderstorms affect water levels in rivers, lakes, and wetlands and are important to understand during your construction project. Projects that have flexible construction dates should be coordinated with favorable weather conditions that avoid high water levels. Water depth being controlled by the AquaDam should never exceed the rated maximum controllable mud / water depth during the life of the project, not just the day the AquaDam is installed.

Other Site Criteria

All of the previous factors are important considerations once the site has been selected. The following are additional factors that may influence the site selection:

Width of the River. A location on a wide, shallow river is easier to cofferdam than a narrow river channel. Wide rivers will allow a diversion with only minor increases in water depth. A narrow river will quickly increase in water depth as the AquaDam takes up available flow channel. The larger and wider the diversion channel, the less the water depth will increase.

Rough River Bed. An extremely rugged alpine river bed (such as the Eagle River) with large angular boulders within the stream bed is a difficult area, since a good tight seal can only be accomplished through the removal of said boulders by hand or heavy equipment. In the case of the Eagle River, the boulders were scraped into a line, and the AquaDam was installed directly upstream so that the boulders would help support it. Using four ropes to restrain the AquaDam from unrolling freely is also important in the installation.

Installation

Small AquaDams (1' – 4' high)

Equipment List:

- We recommend that you use at least two portable gasoline water 3” discharge pumps; any water supply will work. Anything from fire hydrants to garden hoses is acceptable; it all depends on the speed at which you want to install the AquaDam. *Attention: City mains water are chlorinated and pressurized, therefore, you may need a permit to use this water source. If this source is used, then an air bubble will form in the AquaDam and will need to be released.
- Two discharge and suction hoses, one each per pump; no fitting is required on the end of the discharge hoses.
- A roll of duct tape to secure and constrict the size of the fill tubes when coupling AquaDams together.
- For safety reasons, each laborer should carry a utility knife.
- 2” x 6” boards, 2 feet and 4 feet long
- Ropes

AquaDam Inc. recommends a 5.5HP Honda gas powered 3” discharge pumps which provide a maximum flow rate of 15,000 GPH. They are available from your local distributor for sale or rental. They can also be ordered from Great Plains Manufacturers and Distributors: 1-800-525-9716. Using two of these you can inflate: A 1' high by 100' long AquaDam in less than 15 minutes; a 2' high by 100' long AquaDam in 30 minutes; a 3' high by 100' long AquaDam in under an hour; and a 4' high by 100' long AquaDam in under an hour and a half.

Man Power. Two to four laborers are required to install the smaller AquaDams. Plan out the installation beforehand and discuss it with your work party. The number of AquaDams to be installed, time constraints, and access to the installation sites may dictate the need for additional help.

Rock Removal. Someone will have to remove rocks by hand from the path of the AquaDam to assure that a good seal is achieved. The laborers installing the AquaDam are already committed, and cannot be the rock picking crew. Rocks should be picked out from directly in front of the AquaDam as it is being installed. The rocks should be stacked on the work area side of the AquaDam to provide additional support.

Large AquaDams (6' – 16' high)

Equipment List:

- At least two discharge pumps are required; using larger or more numerous pumps will inflate the AquaDam faster; the fill tubes can be opened to accommodate any size discharge hose.
- One discharge and suction hose per pump; discharge hoses do not require fittings. No sharps on hoses entering AquaDam. Hoses must be long enough to reach from the pump to the start of the fill tubes.
- A roll of duct tape for securing the fill tubes.
- For safety reasons, each laborer should have a utility knife.
- In moving water, restraining ropes need to be used to assist the installation; at the very least, each 100 foot AquaDam that is installed requires 250 feet of ½ inch rope. A four rope set up is strongly recommended on the installation of AquaDams 6 feet high or larger in fast-moving rivers and streams.

Manpower (for installation in non-moving water). Three to five laborers are needed to install the larger AquaDams in non-moving water. Ropes are usually not needed to restrain the AquaDam from unrolling during the installation process, but can be used to pull the AquaDam around using people or equipment on shore, if water depths are too great for a laborer to stand. Non-moving water conditions require the fewest number of laborers.

Manpower (for installation in moving water). Five to seven laborers are needed to install the larger AquaDams; the exact number of laborers is related to the size and number of AquaDams to be installed, terrain above and below water, water velocity, water depths, and time constraints. *Table 2* better describes the manpower needed during a typical installation of AquaDams 6 feet or more in height in moving water.

Table 2: Recommended Manpower Requirements During Installation in Moving Water

AquaDam Size	Rope Assisted Installation	Number of Laborers in Water	Number of Laborers on Pumps
1 – 3 feet	No	2 - 4	1
4 feet	Yes - 2	2 - 4	1
6 feet	Yes - 3	2 - 4	1
8 feet	Yes- 4	2 - 4	1

Table 2. The need for ropes depends on moving water rather than the height of the AquaDam. The use of ropes is to prevent the AquaDam from prematurely unrolling during installation.

Strong water velocities or currents require more manpower to ensure proper installation, and to secure the safety of those installing the AquaDam. The above list does not address personnel that might be operating heavy equipment, such as an excavator. An AquaDam Inc. representative who will observe the customers crew and equipment during the installation and make suggestions is also recommended.

Table 2 (continued). In most installations, very little site preparation work is required, but to obtain a good seal, rock picking is a must. The are should also be policed for objects that might puncture the AquaDam during installation. See "Rock Removal" on page 9.

This guide assumes that all Federal, State, County, and City permits have been obtained from the appropriate government authority. AquaDam Inc. also recommends that the buyer (Prime Contractor, Company Supervisor, etc) have an understanding of the necessary permits and what can or cannot be done within the river bed (lake) should the use of heavy equipment be necessary.

AquaDam Installation Procedures

Installation can be broken down into three categories: moving water (rivers and streams), non-moving water (lakes, ponds, non-pumped irrigation ditches), and dry land installation.

Step 1 – Transport

Transport the AquaDam to the installation starting point. Smaller AquaDams can be easily moved into position by hand.

Carrying ropes or straps are provided on larger AquaDams. Just hook or tie the ropes or straps to a piece of heavy equipment for transportation. Unpack the AquaDam by carefully removing the protective wrap from the outside after cutting the packing ropes and carrying straps with a knife.

Step 2 – Starting Point

The open, starting end of the AquaDam will have long fill-tubes protruding from the open end of the outer sleeve of the AquaDam (usually 2 to 6 feet long). These are for connecting one AquaDam to another using a connection collar. The fll-tubes are not the start of the AquaDam. The AquaDam starts at the woven outside (usually black) sleeve that confines the two inner water tight tubes (see *Figure 1*). Position the end of the outer sleeve up the bank at least as high as the main body of the AquaDam will be when fully inflated (i.e., a 3 foot high AquaDam would have at least 4 feet in elevation up the bank. The bank slope will have to be calculated in, and the end will have to be higher than the water level inside the AquaDam after inflation. The AquaDam will only achieve its rated height at the lowest point along its path.).

If the bank is not tall enough to achieve its necessary starting height, a small amount of fill material can be placed at the waters edge to create a false bank or berm. This is the least expensive way to way a good starting point.

Step 3 – Preparing the AquaDam for Filling

Insert a fill hose into each fill tube. Excess fill tube length can be cut off if not desire for future use. Wrap duct tape or tie rope tightly around the fill tubes to keep the fill hose from bucking out. The corners at the end of the AquaDam The corners at the end of the AquaDam can be tied to an anchor, such as, a tree or rock to prevent it from slipping down the bank slope. For smaller dams (3 feet and under), laborers are needed to stand in front of the AquaDam roll at the foot of the slope along the waters edge. Filling begins by pumping into both the inside tubes at the same rate. The rolled portion of the AquaDam will begin to unroll, and will push against the laborers legs. The laborers will wait for the water level inside the AquaDam to rise above water level. When the height of the AquaDam is great enough (several inches), the laborers should take a step back. Then they must wait until the height builds up again before taking another step back. All laborers must step backwards in unison and cooperate so that a foot does not get caught under the AquaDam. Water levels inside the AquaDam must be kept at a level higher than the upstream water side of the AquaDam. This water depth will increase as the unrolling AquaDam begins to constrict (cut off) the available flow channel.

Step 4 – Moving Rocks and Debris

When installing an AquaDam, you must not only remove rocks from its path to maximize formation of a good seal, you must remove all debris. Sharp, angular objects are often submerged along the path of the AquaDam, and usually the only way to find them is to walk around in the water until you step on them. Not only will these obstructions cause a greater amount of seepage into the work area, there is always the possibility that they may cause damage to the AquaDam. **Never take it for granted that your work area is free from debris! Always check first!**

This shopping cart was completely invisible during high tide.

Step 5 – Restraining Ropes

Large AquaDams
AquaDams that are four or more feet in height commonly require control ropes to restrain the rolled AquaDam during the installation process in live streams. Without these ropes the pressure of the water in the inner tubes will cause the AquaDam to unroll before the proper inside head pressure is achieved. Maintaining control and preventing the pressure from prematurely unrolling the AquaDam is very important. The pressure of the water mass inside the AquaDam has to withstand the pressure generated by the difference between the upstream and downstream water levels. In standing water, the pressure will be the same on both sides of the AquaDam (until dewatering begins by pumping).

The number of ropes required by a particular sized AquaDam is discussed in *Table 2* and *Figure 3*. If ropes are to be used in the installation process, they should be placed under the AquaDam before water is added. The ropes are attached to the base of the metal posts or trees, then run under the AquaDam, over the top, and back to the starting point. They should be held in a manner that will allow the rope to be let out as the AquaDam unrolls across the stream. The rope should be twice as long as the AquaDam when inflated, plus an extra 50 feet. Bending the rope around a heavy, round smooth anchor, such as, a telephone pole or excavator, adds leverage.

Standing Water Applications

Installation into standing water is much simplier than installation in live streams. The AquaDam will unroll itself with a minimum number of laborers to assist in the installation. Ropes can be used to turn the AquaDam in places where it is too deep for laborers to stand. Water level from one side of the AquaDam to the other should remain equal, making it unnecessary to maintain dam height during installation. Laborers just need to guide it in the right direction.

Step 6 – Determine Height and Elevation

The rolled AquaDam should start at the top of the riverbank or berm. The open, starting end of the AquaDam must be raised higher up the starting point than the height of the fully inflated AquaDam. Gravity keeps the water used to fill the AquaDam from flowing back out the elevated end.

Figure 3: Large AquaDam Installation Across a Flowing Stream

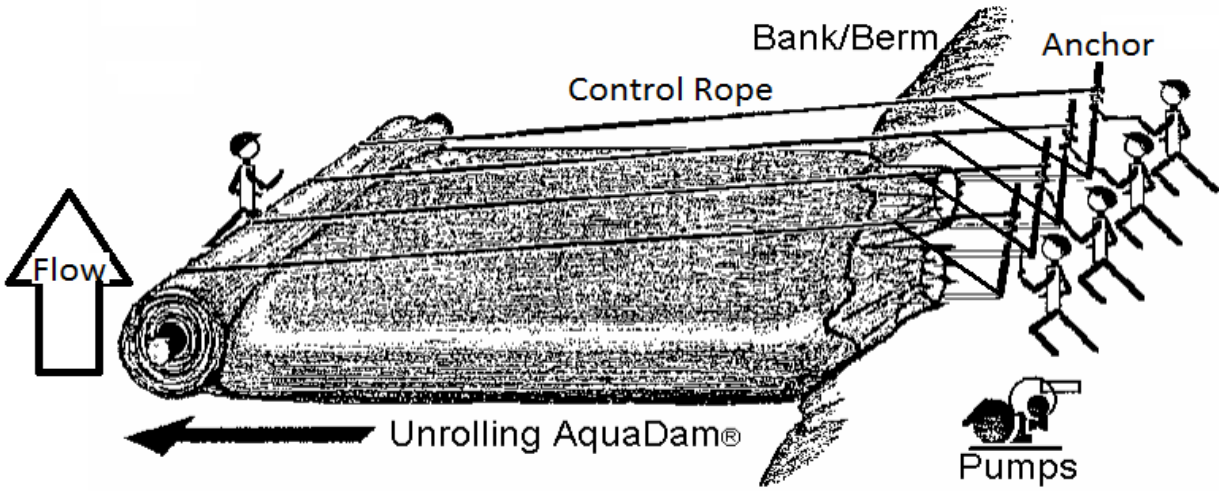

Figure 3 shows the location of the ropes, posts, laborers and the inflating AquaDam.

Step 7 – Filling the AquaDam

Figure 3 represents the most difficult installation scenario, such as a flowing stream where ropes must be used. The onsite conditions can change quickly in live streams because water depths will change from one side of the AquaDam to the other. This difference in pressure will make the AquaDam move downstream unless head pressure is maintained inside the AquaDam during all phases of the installation. An AquaDam that is unrolled too quickly and is not allowed to fill above the level of the surrounding water, will move downstream with the water flow. The workers on the bank slowly let the ropes out to allow the AquaDam to unroll when inside water pressure and mass are achieved. Allow the AquaDam to unroll 2 to 3 feet at a time, then wait for head pressure to build again, repeating this process until the AquaDam is fully unrolled. Timing is everything. **Do not get in a hurry! Let your pumps work!** A requirement of using ropes is that the AquaDam must be installed in a straight line. Turns can be made depending on site conditions and use of a deadman. Head pressure must be maintained inside the AquaDam to prevent it from moving. Ropes tend to move to the outside of the unrolling AquaDam. The worker at the end of the unrolling AquaDam adjusts the ropes and keeps them in the center by slackening and moving one rope at a time while the other ropes maintain the necessary inside pressure to keep the AquaDam from moving downstream. On site rock that needs to be moved to assure a good seal should always be moved to the downstream side and used for support.

Figure 4:

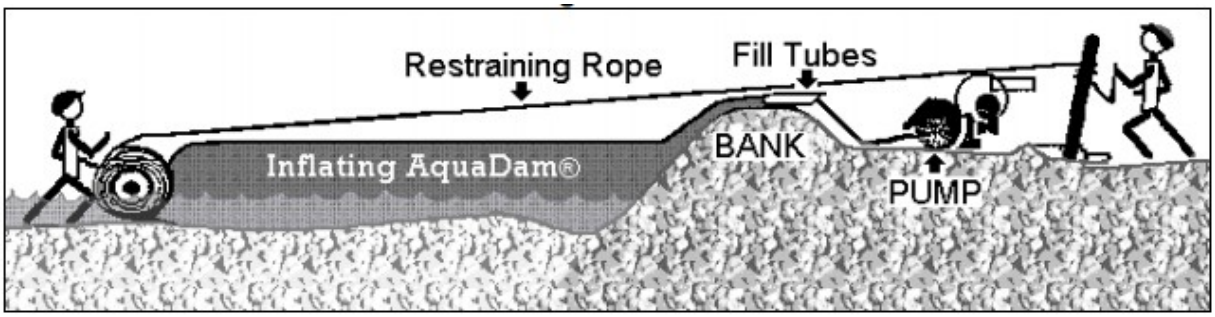

Figure 4. A cross section of a large AquaDam being installed in flowing water, illustrating the location of

the berm, pumps, ropes, laborers and the inside water head pressure, compared to the outside water levels.

Manning the Ropes

Once the ropes are manned, the pumps are primed, and the AquaDam is aimed in the proper direction (at a perpendicular angle to the slope of the staring bank), the pumps can be turned on and the inflation process can begin. *Figure 5* shows a picture of restraining ropes used during installation of a large AquaDam in a fast moving river. In some instances, a project demands that a larger AquaDam should be used despite the low water level, because of the anticipated increase in water depth. The AquaDam should be allowed to unroll at a rate of about 1 to 3 feet every time the ropes are slackened and maintain a 12 to 24 inch (or greater) head of water pressure inside the AquaDam, compared to the upstream water depth, which will be increasing. Each foot of installed AquaDam requires 2 feet of additional rope. The AquaDam has to overcome imbalances of water head displacements happening in the river during the installation process. **Only experienced installation personnel should attempt to install large AquaDams in moving water.** Smaller AquaDams can be installed more easily and require less expertise.

Figure 5: Using Ropes to Install an AquaDam in Flowing Water

Lateral Movement

An AquaDam being installed in flowing water is vulnerable to moving downstream during the installation process. Maintaining internal head pressure is very important. A technique used to install large AquaDams in flowing water is to install a shorter, sometimes smaller dam in a straight line using ropes (this is sometimes referred to as a “deaman”), and then place the bigger AquaDam directly upstream, allowing it to rest against the smaller AquaDam. In this fashion, t he head pressure in the larger upstream AquaDam can be lowered to allow it to turn around the end of the smaller AquaDam, without it having to be kept in a straight line with ropes. Another technique can be used with fill material that is inside of a 1 meter sandbag to create the same effect.

How Lateral Movement Occurs

Lateral movement of an AquaDan during installatioon occurs when there is insufficient head height inside the AquaDam to overcome the force generated from the difference in water height between the upstream side of the AquaDam and the downstream side. The difference in water depth must be compensated for by maintaining appropriate head height inside the AquaDam during and after installation. Upstream water levels will rise rapidly as the flow channel is reduced during installation and should be monitored continuously by the crew in the water.

Sometimes lateral movement is hard to detect, but usually the following are indications:

- Visual lateral movement of the AquaDam.
- The top seam of the AquaDam is straight for some distance but appears bent in the middle.
- The AquaDam is no longer pointed in the direction originally taken.

If lateral movement begins to take place or evidence of rolling can be detected, the steps should be taken to correct it. A minor change in water level could wash out the AquaDam if the proper amount of head pressure is not maintained during installation. One step that can be taken to prevent lateral movement is to increase the internal water volume which creates the internal pressure. All rocks moved for seepage control should be used to brace the AquaDam during installation. Often, fill material has to be excavated from the channel. This should be placed behind the AquaDam for controlled than what our Users Guide suggests.

AquaDams should always be filled with the maximum amount of water possible. Always fill your AquaDam to their recommended height, measured at the lowest point along the path of the AquaDam.
Other solutions to moving or sliding are to install a smaller AquaDam directly behind the main AquaDam on the dewatering side. In standing water, if the work are has already been dewatered, stop dewatering and allow the bodies of water on either side of the AquaDam to equalize.

Figure 6: Shoring-Up Cross Section

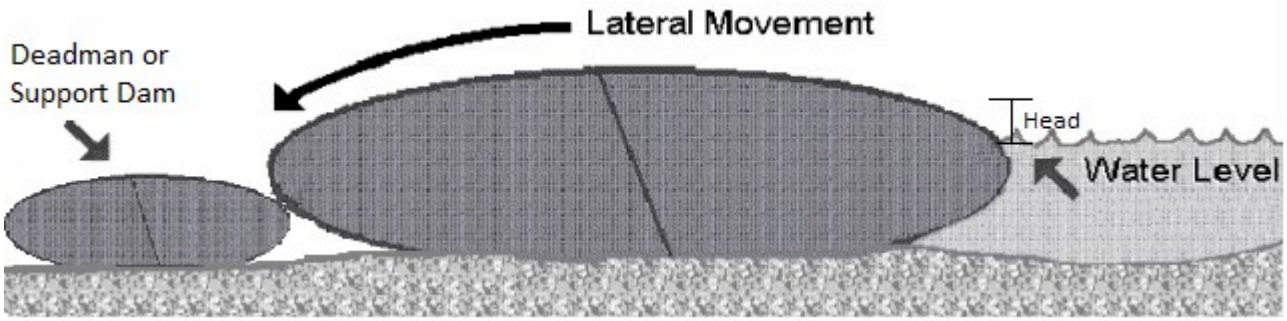

Figure 6. A cross section showing the placement of a support dam to shore up an AquaDam that shows signs of lateral movement.

Connecting AquaDam Sections Using Connection Collars

Step 1: Certain applications require two or more AquaDams to be coupled together to form a longer, continuous water-filled cofferdam. The following illustrates how this is accomplished (the procedure assumes that the AquaDams are being joined in a straight line end to end). All standard single closed-ended AquaDams come with a connection collar on the closed end. The other end is open and has the fill tubes, and has been designed to fit snugly into the connection collar. Before a second AquaDam can be attached, step one is to install an AquaDam fitted with a connection collar. Fill this first dam to about 2/3 capacity before making a connection.

Step 2: Position the second AquaDam directly in front and in line with the first partially filled AquaDam and unroll about 10 feet of the new section, exposing the length of the fill tubes. (See *Figure 7 A*)

Step 3: Insert the fill tubes through the holes on the connection collar, the left fill tube through the left hole and the right fill tube through the right hole. This is done by working your way inside the connection collar, pushing the inner tube toward the hole and having a second person reach through the hole from the outside, grab the tube, and pull it through the hole (about four feet of fill tube should be pulled on top for a four foot high AquaDam). Pull the outer tube of the AquaDam being connected inside the connection and around the inner tubes as well as possible. The new section should be totally enclosed by the connection collar, and the outer sleeve of the connecting AquaDam being installed should be pulled up so as to be in contact with the end of the first, partially filled AquaDam. Pull all excess material up on top through the holes. (See *Figure 7 C*)

Step 4: The 4'x8'x1/2" sheet of plywood described in the equipment list is for the pumps to sit on, should they need to be places on an AquaDam. When two AquaDams are attached together, pumps are generally set on the previously filled AquaDam, about 15 to 20 feet away from the connection point between the two AquaDams. The plywood will prevent damage to the AquaDam, but it is not necessary. (*See Figure 7 D*)

Step 5: At this point the new section is ready to be filled in the same manner as the first section. Follow all of the instructions previously presented to install the first AquaDam. *Figure 8* is a drawing of two AquaDams, one filled and the other ready to be filled.

Figure 7: Connecting AquaDams Using Connection Collars

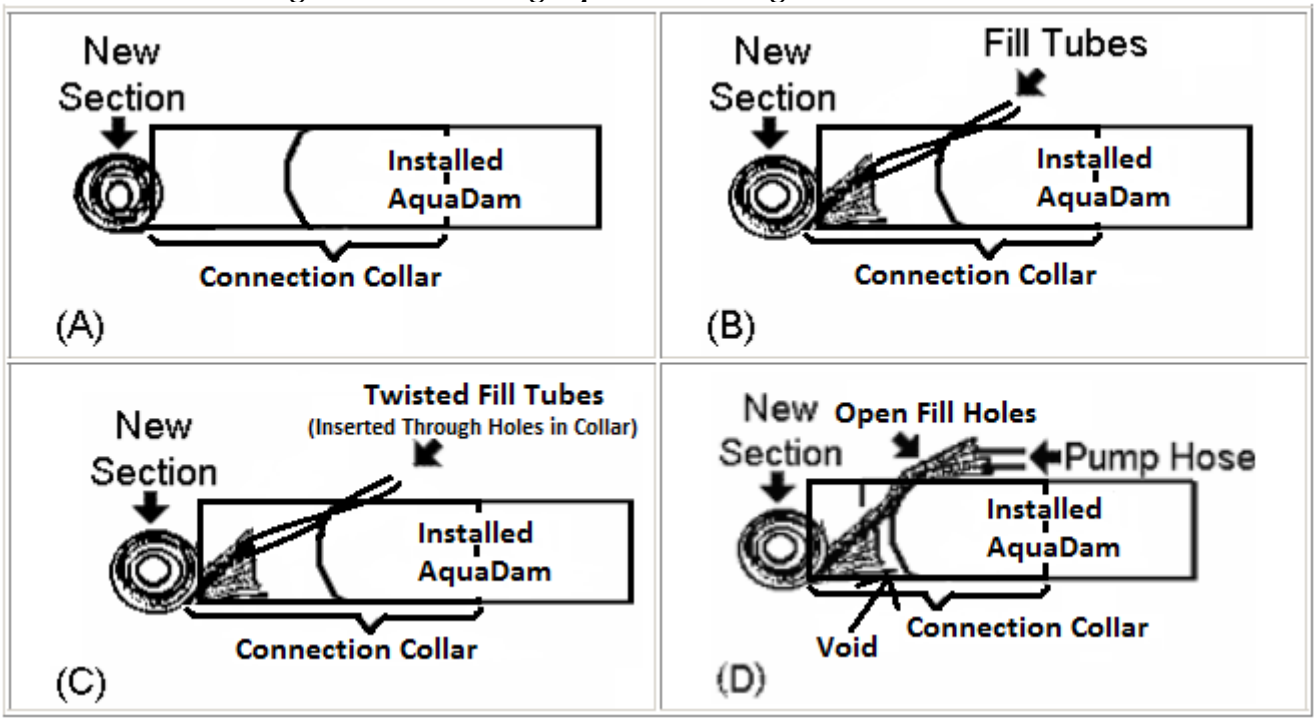

Figure 7, illustrates A, B, C , and D show the different steps taken in the process of joining two AquaDams together using a collar.

Figure 8: Two AquaDams Connected Together

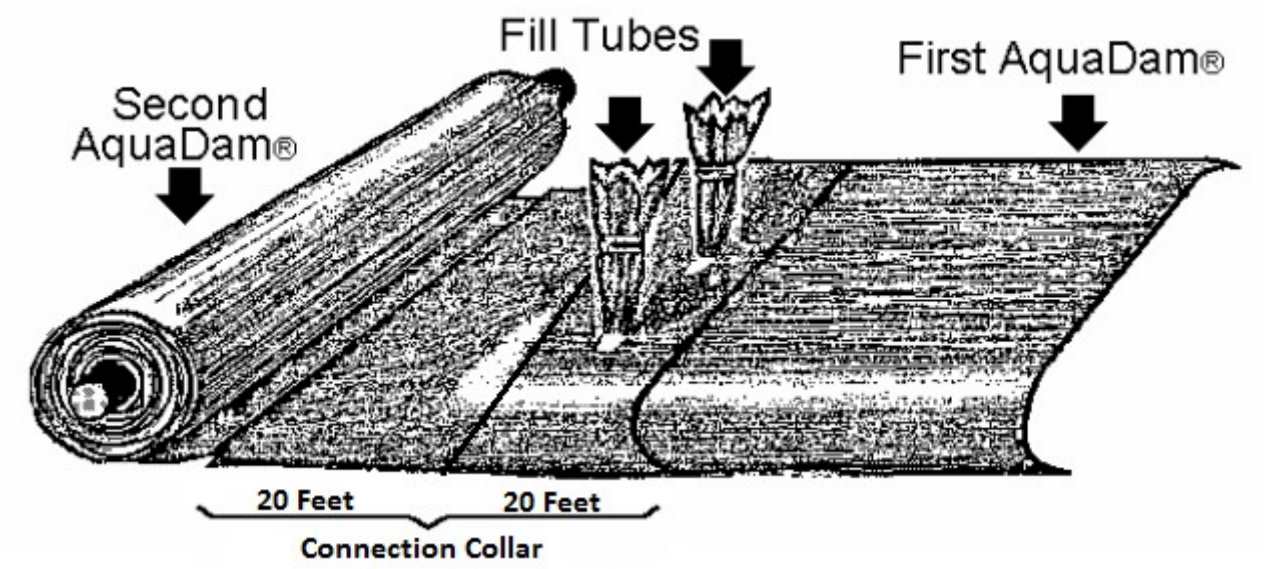

Figure 8: Two AquaDams are joined together by a connection collar and ready to be inflated. The two inner tubes stick out and up from the middle portion of the connection collar. These are the extra fill tubes located at the open end of each AquaDam.

Step 6: After the second AquaDam is filled, the fill hoses can be removed from the inner tubes. The fill tubes are rewrapped in such a manner that the tubes will stand up by themselves. If possible, use duct tape to attach the two upright inner tubes to each other, making them even more stable and preventing water from leaking out. Gravity will keep the water from rising above the height of the fill tubes. The fill tubes must be elevated higher than the main body of the AquaDam.

Maintenance Procedures

Installed AquaDams are durable and will last a long time. Each installed section should be monitored regularly for leaks. The easiest way to deal with a leak without removing the AquaDam is to pump more water into it. Small leaks can be patched with special repair tape. Patched damage will require periodic maintenance pumping.

There are four important observations that should be made on a regular basis.

- Leaks in the AquaDam
- Seepage under the AquaDam
- Inner fill tubes that have fallen over and are draining water
- Lateral movement of the AquaDam

Most leaks are of such a nature that they can be resolved simply by pumping additional water into the AquaDams on a periodic basis. Identify which of the tubes is leaking, untie and unwrap the inner tube and insert the discharge hose from the water pump and fill it. Sometimes, a leak is large enough to require a patch. To repair such a leak, first identify and isolate the area around it. Then, using a sharp knife, cut a 'cross' or X through the master tube and pull the material apart to expose the leak, being careful not to further damage the inner tube. Then, using tape provided by AquaDam Inc , apply the patch to the inner tube. Once the leak is repaired, cover the 'cross' cut in the master tube with the same repair tape. In most cases it is best to just add water on a regular basis, until the AquaDam can be taken out of service and patched properly from the inside or the inner tubes can be replaced.

AquaDam Removal Using Rerolling Brackets

Rerolling a small AquaDam after use in a small stream. When two or more AquaDams are connected together the downstream AquaDam is removed first by pumping out the inside water, or allowing the fill tubes to drain the AquaDam down to a level where the connection can be disassembled, allowing the water to pass out freely once rewinding begins at the other end. This forces the water to the open end and out.

Note: in some cases, it may be a better idea to hook the closed end to an excavator or other piece of equipment, lift it up, and simply let gravity drain the water out (see below).

Large AquaDam Removal

For larger AquaDams that are too big to reroll in place, equipment such as an excavator or backhoe can be used to pull the AquaDam from the lake (in standing water). Pump out or drain as much of the water as you can, and put a strap around the closed end of the AquaDam. Place the strap as close to the end as possible or water will remain trapped inside. Do not pull on the collar. Very slowly lift up on the strap. The water should drain out the open end. Make sure that the fill tubes are draining, they might need to be pulled further off the bank. Go slowly so that you do not lift the water any higher than is necessary for it to drain. Pull the deflated AquaDam out of the water. It can now be blown up with air for inspection and rerolling. After the AquaDam has been inspected and any holes have been patched, make sure that the coupling collar is still in place. It is now time to reroll the AquaDam for storage and reuse. AquaDams can be reused over and over again, depending on the application. They can also be used on a one-time basis and be destroyed when they are removed, or if they become contaminated with a hazardous material. It is difficult to remove large AquaDams used to block off flowing streams and rivers. Sometimes, there is no way to remove the AquaDam and maintain the internal water pressure necessary to hold it in place at the same time.

As the AquaDam is being emptied, it will be forced out of the way by the difference in water depth from the upstream side of the AquaDam® to the downstream side.

There are many applications where an AquaDam can be saved and rerolled for use at a later date. All smaller AquaDams can be rerolled. Rerolling requires brackets to fit over the ends of the wooden beams that the AquaDams come assembled on. A 3/4" drive ratchet can then be attached to the bracket. A 5' long section of pipe is slid over the handle of the ratchet (a cheater bar) to achieve maximum torque. Water can be pushed to the open end and out.

Safety

Emergency Removal

Laborers should stay out of harm's way and be aware that standing at the end of the unrolling AquaDam is dangerous, and they should stand clear whenever possible. The number of personnel in this position should be kept to a minimum. Should the laborers holding the ropes let go of them, the AquaDam will rapidly unroll, and a laborer could be pinned underneath. That is why all laborers should carry safety knives, so that the AquaDam can be slit open on the upstream side to relieve inside water pressure so that the AquaDam will immediately drain, allowing it to move off of the trapped worker. The best way to do this is with a single long, lateral slice down the side of the AquaDam. You must be standing on the upstream side. The downstream side is the direction that the AquaDam and all of the water behind it will move in. It is very important that everyone works together!

Obstacles and Debris

The beds of rivers and streams are rough and can have holes and other obstacles that should be avoided in them. The easiest way to avoid them is to just go around. Removing something large that is silted into the riverbed will leave a large hole. This leaves you worse off than you were before. Going over this type of area will have more seepage, and it will also affect the height of the AquaDam.

Cold Weather

In cold water, neoprene chest waders are highly recommended. All OSHA rules and guidelines should be followed closely. Personal Flotation Devices (PFDs) should be also used.

Walking on the AquaDam

The woven geo-textile fabric that the master tube is made of is puncture and UVI resistant. Heavy foot traffic on top of the AquaDam is okay. The only time you might curtail foot traffic is during cold weather, when ice occurs within the inner tubes, but they can still be walked on. The ice may cut the polyethylene when it cracks or breaks from foot traffic.

AquaDam Specifications

Inflated Dimensions	Controllable Mud/Water Depth*	Specifications of Inner and Outer Tubes	Capacity** per linear ft	Dry Weight per linear ft
1' H x 2' W (0.3m tall)	**9"** (23 cm)	**Inner Tubing:** 1 ply, 12 mil, Polyethylene **Outer Sleeve:** 1 ply, 300 lb/in² burst strength PP	12 gal/LF 45 liters/LF	0.75 lbs/LF 0.34 kg/LF
1.5' H x 3' W (0.45m tall)	**14"** (36 cm)	**Inner Tubing:** 1 ply, 12 mil, Polyethylene **Outer Sleeve:** 1 ply, 300 lb/in² burst strength PP	25 gal/LF 95 liters/LF	0.95 lbs/LF 0.43 kg/LF
2' H x 4' W (0.61m high)	**18"** (45cm)	**Inner Tubing:** 1 ply, 12 mil, Polyethylene **Outer Sleeve:** 1 ply, 300 lb/in² burst strength PP	50 gal/LF 189 liters/LF	1.5lbs/LF 0.68kg/LF
2.5' H x 5' W (0.76m tall)	**24"** (61 cm)	**Inner Tubing:** 1 ply, 12 mil, Polyethylene **Outer Sleeve:** 1 ply, 300 lb/in² burst strength PP	88 gal/LF 333 liters/LF	1.85 lbs/LF 0.84 kg/LF
3' H x 7' W (0.9m tall)	**30"** (77 cm)	**Inner Tubing:** 1 ply, 12 mil, Polyethylene **Outer Sleeve:** 1 ply, 300 lb/in² burst strength PP	120 gal/LF 454 liters/LF	2.5 lbs/LF 1.1 kg/LF
4' H x 9' W (1.2m tall)	**38"** (97 cm)	**Inner Tubing:** 1 ply, 12 mil, Polyethylene **Outer Sleeve:** 1 ply, 300 lb/in² burst strength PP	210 gal/LF 795 liters/LF	4.3 lbs/LF 1.9 kg/LF
5' H x 11' W (1.5m tall)	**44"** (112 cm)	**Inner Tubing:** 1 ply, 12 mil, Polyethylene **Outer Sleeve:** 2 plys of 300 lb/in² burst strength PP	320 gal/LF 1,211 liters/LF	6.4 lbs/LF 2.9 kg/LF
6' H x 13' W (1.8m tall)	**54"** (137 cm)	**Inner Tubing:** 1 ply, 12 mil, Polyethylene **Outer Sleeve:** 2 plys of 300 lb/in² burst strength PP	450 gal/LF 1,703 liters/LF	8.5 lbs/LF 3.9 kg/LF
8' H x 17' W (2.4m tall)	**74"** (188 cm)	**Inner Tubing:** 1 ply, 12 mil, Polyethylene **Outer Sleeve:** 2 plys of 300 lb/in² burst strength PP	700 gal/LF 2,650 liters/LF	12 lbs/LF 5.4 kg/LF
10' H x 21' W (3m tall)	**88"** (223 cm)	**Inner Tubing:** 2 plys, 8 mil, Polyethylene **Shroud:** 1 PP woven shroud around both inner tubes **Outer Sleeve:** 4 plys of 300 lb/in² burst strength PP	1,000 gal/LF 3,785 liters/LF	25 lbs/LF 11.3 kg/LF
12' H x 25' W (3.7m tall)	**100"** (254 cm)	**Inner Tubing:** 2 plys, 8 mil, Polyethylene **Shroud:** 1 PP woven shroud around each inner tube. **Outer Sleeve:** 5 plys of 300 lb/in² burst strength PP	1,700 gal/LF 6,435 liters/LF	35 lbs/LF 15.9 kg/LF
16' H x 33' W (4.8m tall)	**126"** (320 cm)	**Inner Tubing:** 3 plys, 5 mil, Polyethylene **Shroud:** 2 PP woven shrouds between inside tubes **Outer Sleeve:** 7-plys of 300 lb/in² burst strength PP	3,000 gal/LF 11,356 liters/LF	51 lbs/LF 23 kg/LF

*This number is based on the friction of a rocky bottom. Slick mud, poly pond liners, and other slick surfaces may require the use of a taller primary AquaDam and/or a support dam installed behind the primary AquaDam.

** Capacity is based on installation on flat ground. Slopes will reduce internal volume of AquaDam.

Aqua Dam Inc
"Water Controlling Water"
www.aquadam.net
1.800.682.9283
+1.707.764.1999
matthew@aquadam.net
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