Dam or Filter - What's the Difference When it Comes to Sediment Control?

The concept of filtering and damming sediment control products has been a popular topic the past few years and seems to be gaining more interest. The theory behind both types of products and how their properties affect what is typically seen in the field will be discussed.

At the end of the day, we are looking for the right product in the right application so we do not see contaminated runoff flowing into our inlets or sediment clogging culverts. A few of the concerns that contaminated runoff and sediment cause are environmental, economical, safety, recreational, and health related. Thus, it is imperative we do our best to keep sediment out of our waterways.

Not all Best Management Practices (BMPs) perform equally. For example, the trend across the country has been to disallow straw bales in areas of concentrated flow. Bale checks are not designed to filter water. Bales are dense by nature, thus they may not be the best option out there for filtering applications, but they may work well in a different application. We are not going to talk about "bad" or "good" BMPs in this article. We are going to talk about differences amongst BMPs and how those differences effect where they work the best. Almost all BMPs work well when installed properly in the correct application. Please keep an open mind when thinking about this topic. It's not about bashing products. It's about learning from our mistakes and using the right product for the right application. Understanding the limitations of BMPs is a powerful tool because unfortunately there is no "silver bullet" BMP out there that can conquer all our challenges.

The unprotected slopes eroded and moved down gradient clogging the ditch and culvert on this site. Proper erosion control would have helped keep the soil on the slope.

Proper erosion control can greatly reduce the need for sediment control. It's a lot easier to keep the soil in place then you do not have to deal with it as sediment in runoff. Sediment is when "the horse is out of the barn" so to say and you need to address it. Let's try to "keep the horse in the barn" by incorporating effective erosion control plans on all our projects.

When erosion control practices are absent sites are unprotected and susceptible to erosion caused by both wind and water. As the soil erodes it moves to the low points on the site commonly clogging drainage channels, culverts, or other structures. Nutrients and other contaminates are commonly attached to the eroded soil particles that eventually end up in our waterways. In addition, regrading has to take place to fix the rills on the slope and clean out the ditch, which likely was not figured into the budget. All these negative impacts usually can be greatly minimized by simply installing an erosion control BMP, such as an erosion control blanket, on the slope.

Not all projects are perfect so what can be done if the "horse is out of the barn" and sediment control is needed? There are a lot of excellent technologies available for today's variety of situations we are faced with. When it comes to sediment control in concentrated flow areas, the density of the product determines how it is designed to function when runoff reaches it. Porous products are designed to allow water to flow through their matrices. For the purpose of today's discussion they will be referred to as filtering products. Filtering products have a flow rate of at least 35 GPM/ft^2. Dense products are designed to pool water in concentrated flow areas. Based on this, they will be referred to as damming products. Other industry terms that both filtering and damming products may be referred to as are "ditch checks" or "sediment retention devices (SRDs)."

The soil could not withstand the increased hydrostatic pressure caused by the damming product so scour under the dense structures resulted.

Mother Nature is a very intelligent individual and we can learn a lot from her. Mother Nature handles natural stream erosion through a series of pools and riffles. Erosion commonly occurs in the faster moving water of the riffles, but particles can settle out in the deeper, slower pools that follow riffles. Damming products are used to attempt to mimic this concept. In theory, the damming process of creating pools and riffles makes sense because water overtopping the up gradient device would dump into the pool created by the down gradient device. However, it is difficult to successfully recreate these pools and riffles in the field.

Donald et al. (2014) have completed some fantastic research at Auburn University on ditch checks commonly used on construction sites. They discovered that the inclusion of an underlay reduced the potential for scour underneath a practice, thereby maintaining the interface between the practice and channel. Their laboratory data confirms dense products can be successful in controlled, large-scale testing conditions by creating longer subcritical flow areas.

Commonly in field applications, water scours under or around damming products before over topping occurs. Concentrated water flow hits dense objects then the water and its energy are deflected in various directions. If overtopping is reached, scour holes on the down gradient side of the damming device are common.

Damming products cause the hydrostatic pressure to increase as the depth of water increases. This increase of energy can be a cause of scour under or around dense devices before ponding and overtopping occurs. So in theory, if all other things were equal except ponding depth, there would be more downward force in front of a device that had deeper water in front of it. Think of when you are really cold and you put several blankets on. The weight you feel increases with each blanket. Imagine the blankets are the depth of water increasing and you are the channel bottom.

Increased hydrostatic pressure caused by ponded water in front of damming products can cause erosion to commence. As the water depth and hydrostatic pressure increase, the downward force can causes scour directly under the dense object. As we see on a daily basis, moving water tends to take the path of least resistance. Thus, as downward force is continually increasing with water depth, the weakest point in the channel becomes the path of least resistance. We commonly see this weakest point in the channel being under damming devices.

A direct conduit for contaminated runoff is created as soon as water scours under dense devices. When scour under a damming product occurs, it makes them almost obsolete in terms of environmental protection benefits because of the direct flow path under them. The photo above shows an example of what happened when the hydrostatic pressure built up in front of a damming device. The reason for the failure was that the concentrated flow encountered the dense bales. The hydrostatic pressure built up then it found the path of least resistance, which was to scour under the bales. The photo should not surprise anyone at all because this is simply basic physics at work. Please keep in mind this same exact installation could have performed near perfectly in the right application.

A second means of scour related to damming sediment control products is scour around the dense device. As water hits the dense object, the depth increases. If the installation was not completed wide enough in the channel, the flowing water can scour around the side of the dense device. Scour around sediment control devices can typically be prevented by installing the devices at least three feet above normal pool on both sides of the device. It is not uncommon to see a device working well until it was scoured around because the installation width was not wide enough to accommodate the design flow conditions.

If overtopping is reached, a scour hole on the down gradient side of damming products commonly forms, if proper armoring is not present. Think about the plunge pool at the bottom of a waterfall. This is basically the same phenomena that is created when damming products overtop. As the water depth increases, the gravitational potential energy of the water also increases as the water depth, or its vertical position, increases relative to the channel bottom. A scour hole forms when the stability of the channel cannot withstand the increased energy of the water that is created by the ponding and overtopping. Vegetation typically does not establish in the scour holes, which introduces a weak spot in the system. Similarly, vegetation can be drowned by ponded water in front of damming products.

Donald et al. (2014) confirmed the inclusion of underlayment fabric to help reduce scour when using sediment control devices that pond water. The use of underlayment fabric is acceptable in temporary sediment control applications when vegetation establishment is not a goal of the project. However, because vegetation does not grow where the fabric is placed in most cases, the use of underlayment materials cause unvegetated or bare soil spots around the dense damming products. These unvegetated areas also introduce unprotected areas in the channel where erosion can commence. Vegetation is a tool in Mother Nature's BMP toolbox that undoubtedly works extremely well in a broad range of erosion and sediment control applications. Benefits of vegetated channels such as cooler water temperatures, filtration capabilities, safety as compared to hard armor, etc. are well documented in the literature.

Another process that can occur with damming products is a complete blow out. Occasionally blowouts could have been prevented by better installation, but we still are expecting the damming structure to hold all the energy contained by the water ponded behind it. Straw bale checks were tested at ErosionLab® in Rice Lake, WI in channelized flow conditions as part of an U.S. EPA grant. The bale structures were installed according to Wisconsin Department of Transportation specifications. Three bales were placed on the up gradient side and two bales were placed on the down gradient side to offset the seams of the first row. The structures were installed in a six-inch deep trench. Stakes extended into the subgrade six inches below the bottom of the trench. A series of structures were evaluated by the grant work. Three structures were installed 20 ft. apart in the 80 ft. long test channels. The bales were installed with the elevation of the bottom of the upstream structure equal to the elevation of the top of the downstream structure. Three tests were replicated in sand, loam, and clay channels. Installation was inspected by an agency employee before testing commenced. The comment was made that "this is not completely correct." We asked the inspector what they meant and they said "we never see installation this perfect in the field." Thus, the bale checks were installed "perfectly" according to the inspector.

Bales were dislodged or displaced in seven of nine tests. The photo above shows a bale structure that dislodged after approximately two minutes of flow around 3 CFS. This EPA grant work confirmed what we had been seeing in the field and it was very convincing that there was no reason to fight Mother Nature and intentionally cause hydrostatic pressure to increase until overtopping because of all the potentially negative effects that can occur. Porous filtering devices work with Mother Nature and allow flow through them, which may be a more suitable option for areas of concentrated flows. Filtering devices dissipate runoff velocity as their flow rate is exceeded, which provides "the best of both worlds" so to say because you get velocity reduction and filtering in one.

Water scoured around this dense rock check. The blue lines denote the approximate route of the original channel. Thus, the rock check dam worked as it was supposed to by damming up the water. However, the ponded water scoured around the side of the device before overtopping could occur.

Damming products may be suitable in temporary channels where vegetation is not desired, but the basic concept of ponding water should not be used in channels that incorporate vegetation as a component of the solution. Dense, damming products have been shown to work well in the field in sheet flow applications, when properly installed.

Filtering BMPs are designed differently than dense, damming BMPs that have been discussed thus far. Filtering BMPs are designed to allow concentrated runoff flows through their porous matrix. As water flows through the device, velocity is dissipated when the flow rate is exceeded and sediment begins to accumulate on the up gradient side of the filtering device. Sediment and other contaminants also are retained within the matrix as "filtered" water is released from the device.

Some devices, such as porous Great Lakes aspen excelsior filtering devices, can

This cut away of a Great Lakes aspen excelsior filtering device shows fine clay sediments that were retained within the matrix of the product after runoff was allowed to flow through it.

These gabions ponded water then overtopped exactly as the designer wanted them to do. However, the energy of the overtopping water created a scour hole on the down gradient side of the gabions, which eventually eroded a large section of the channel bottom in this concentrated flow application.

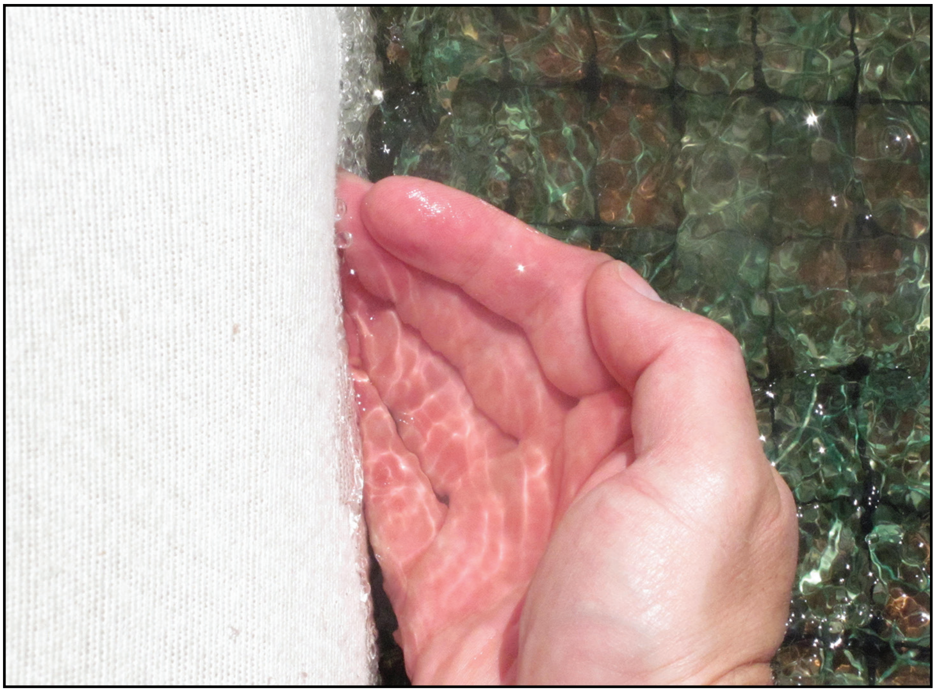
Complete blow outs can occur when using dense, damming products in concentrated flow applications like this bale structure that dislodged after approximately two minutes of flow at three cubic feet per second.

be installed over bare soil with or without a trench. Fibers of some devices expand when wet and contract when dried. This process works to create intimate, Velcro-like contact with the subgrade. If the fibers were packed densely in the device they would not be able to expand and contract and adhere to the subgrade. Filtering products with flow rates of at least 35 GPM/ft^2 have resulted in good laboratory and field results.

Filter products are designed to be porous and allow runoff to flow through them, thus typically there are not bare soil areas up gradient or down gradient of them. This is in contrast to the bare soil areas that commonly result upstream of damming devices that pond water and also downstream of the damming devices because of scour caused by overtopping.

Research by Boving and Zhang (2004) has quantified the capability of Great Lakes aspen excelsior fiber's capability to remove polynuclear aromatic hydrocarbons (PAHs) from contaminated runoff. PAHs are typical components of asphalts, fuels, oils, and greases, which are common to roadside runoff that ends up in concentrated flow channels. With this in mind, it is very important to allow flow through Great Lakes aspen products so contaminated runoff can contact the matrix and filtered water can be released. Dense designs do not allow water to contact the fibers so filtering does not have a legitimate chance. Materials made of the exact same matrix can perform drastically different at different densities. For example, our laboratory and field research has shown that more porous products work better because dense versions of the same exact matrix tend to cause scour in channelized flow applications.

It is also extremely important to verify what is inside a sediment control device before using them. The matrix of a sediment control device greatly effects performance. Today we see basically anything being used as a filler for sediment control products in some areas even to the extent of fillers being a convenient way to dispose of a waste stream. Engineered, curled and barbed aspen excelsior fibers that contain 80% a minimum of 6 in long that are 0.031 in ± 0.008 in wide x 0.027 in ± 0.006 in thick have been proven to be ideal for sediment control filtering matrices. Larger wood fibers, chunks, or chips tend to float during hydraulic events. Smaller wood fibers such as mulch-like materials or saw dust tend to compact too much resulting in a dense,



This photo of a Great Lakes aspen excelsior filtering device is what it's all about! Most of us ultimately are working toward improving water quality in some shape or form. This filtering device "clearly" is doing its job.

damming matrix. The type of wood fiber is also extremely important. Aspen excelsior fibers are free of toxins and have been successfully used in revegetation efforts since the 1960s. Other wood types, such as pine, contain toxic resins and should not be used for erosion control, sediment control, or revegetation applications. Pines are high in terpenes, which are a class of hydrocarbons similar to many found in gasoline or paint thinner (i.e. turpentine).

In addition, the matrix of a sediment control device can have negative environmental impacts, if not produced from a known, controlled raw material. If allowed, non-engineered matrices should provide certified testing on each shipment to verify nutrients, heavy metals, noxious weed seeds, invasive species, or other detrimental contaminates will not be released from them during hydraulic events. For example, Gulliver (2011) and the Minnesota Pollution Control Agency published a report stating that compost releases phosphorus into water when it is in contact with it. It is imperative to know what is going into our environment so please open up your sediment control products and make sure they meet the specifications you asked for. A wise man once said, "You don't get what you expect"… "You get what you inspect."

Porous filtering devices are very versatile in their applications because of the unique properties outlined. Filtering sediment control devices encourage vegetation establishment so they are suitable for both temporary and permanent channel applications. Filtering devices also work well in sheet flow applications such as perimeter control or slope interruption.

Every BMP has its place when installed properly in the right application. Large-scale testing has shown dense damming devices to work well in temporary sediment control applications in conjunction with underlayment fabric. These are applications where vegetation is not desired. Damming products have a good history in sheet flow applications such as perimeter control and slope interruption.

Please think twice about what you really want to accomplish on your next project and what type of sediment control product is best for the application. There is a huge difference between filtering and damming products.

Filtering and Damming devices do not function or perform equally in areas of concentrated flows. Hydraulic challenges can be created when damming devices are used without underlayment material in permanent channelized flow areas where vegetation is desired. Filtering devices are designed to dissipate velocity, filter contaminated runoff, and encourage vegetation establishment. Please think twice about what you really want to accomplish on your next project and what type of sediment control product is best for the application. There is a huge difference between filtering and damming products. **L&W**

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