Dam Embankment Armoring Project

- Frequently Asked Questions-

Please read all the questions and answers below. This project is multi-layered, and some questions/answers overlap each other.

- **Question – Who owns Lake Barcroft Dam?**
  - *Answer – The Lake Barcroft Association (LBA) owns the Lake Barcroft Dam.*

- **Question – Who is responsible for managing the operation of the Lake Barcroft Dam and for ensuring its regulatory compliance?**
  - *Answer – In 1973, following Hurricane Agnes and after the establishment of the Lake Barcroft Watershed Improvement District (LBWID), the LBA (formerly known as Barcroft Beaches Incorporated (BBI)) assigned "LBWID the sole rights to make all determinations relative to the operation, maintenance, repair, inspection, and testing of the Dam".*

- Q**uestion – What is the primary objective of this major dam embankment armoring project?**
  - *Answer – To bring the Lake Barcroft Dam into all regulatory compliances with Virginia Dam Safety Regulations.*

- **Question – Which government authority is requiring this work to be done?**
  - *Answer – The Virginia Division of Dam Safety (a division of the Virginia Department of Conservation and Recreation) is the regulating authority on all privately owned dams, county-owned dams, and State-owned dams. Virginia's dam safety regulations are embodied in the Virginia Code and are enforceable by law.*
    - Virginia Division of Dam Safety (virginia.gov)
    - Virginia Dam Safety Regulations
    - Code of Virginia - Article 2. Dam Safety Act

- ***Question – Are existing dams "grandfathered" (exempt) from regulatory changes?***
  - *Answer – When considering the mitigation of risk to lives and properties downstream of a dam, an existing dam is not exempt from regulatory changes.*

- **Question – Is the Lake Barcroft Dam being singled out by the Virginia Division of Dam Safety?**
  - *Answer – The answer is NO. In recent years there have been numerous dams across the State that have had to make upgrades to comply with Virginia's dam safety regulations. Furthermore, States across the Country have strengthened their regulations in recent years and upgrades have been required on many of the dams that they regulate.*

- **Question – What has changed with the Dam that now requires these upgrades to be implemented?**
    - *Answer – There have been no changes to the Lake Barcroft Dam in the last 50 years that have caused the new requirements for this project. The changes have been the regulatory requirements, not the Dam. Dam failures globally and the higher frequency of major climate disasters have prioritized downstream impacts as the major consideration in regulating dam safety requirements.*

- ***Question – How has the LBWID validated the need and justification for these Dam improvements?***
    - *Answer – The LBWID has employed the services of two of the very best engineering firms in our region to thoroughly review the DCR Dam Safety Regulations and the existing structure and capabilities of the Dam. This analysis involved the review of the civil engineering, structural engineering, and hydraulic/hydrologic engineering details for the Dam. There have also been several meetings and discussions between the LBWID and DCR Dam Safety officials to better understand their assessment of the Lake Barcroft Dam and their application of the regulations. This process was not rushed and took almost 18 months to complete.*

- **Question – What is the primary objective of Virginia's Dam Safety Regulations?**
    - *Answer – To protect the lives and properties downstream of dams in Virginia.*

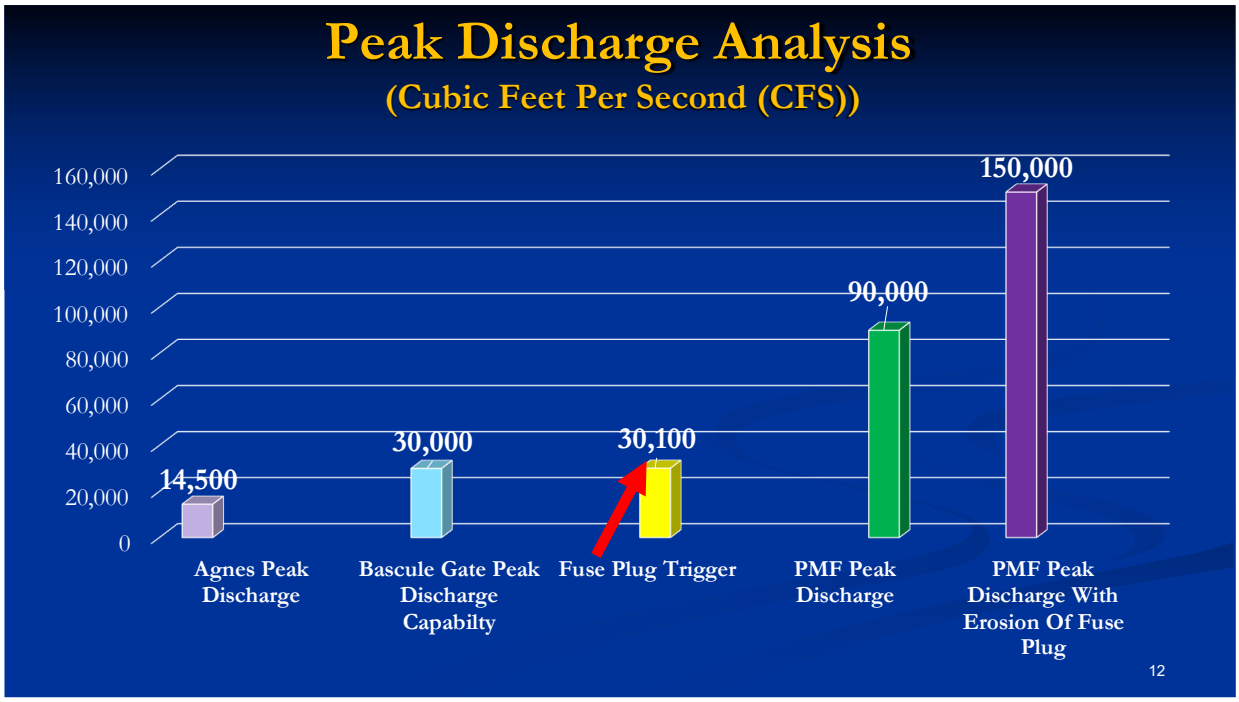
- **Question – What is the greatest risk that a dam poses to lives and properties that are downstream of it?**
    - *Answer – The greatest risk to lives and properties downstream of a dam is the amount of water that the dam impounds on a normal basis. If this water were suddenly to be released, it has the potential to result in man-made catastrophic flooding. Furthermore, if this water were to be released during an extreme rainfall event, it could substantially increase the level of flooding that would have naturally resulted from the rain event itself.*

- **Question – How many lives and properties reside downstream of the Dam?**
    - *Answer – Within the inundation zone of the Lake Barcroft Dam, there are thousands of lives and properties. There are residential communities, schools, businesses, government facilities, major highways, mass transit, medical facilities, and more.*

- **Question – How will the planned improvements to the Dam mitigate risk to lives and property downstream?**
    - *Answer – Currently the Dam requires the use of what is called an "Emergency Earthen Fuse Plug," which is designed to erode during high rainfall events, such as it did during Hurricane Agnes. Current DCR Dam Safety regulations require dams to pass the flow generated by the most scientifically conceivable extreme rainfall event determined as viable for their watershed. The Lake Barcroft Dam currently cannot discharge that much flow, which is much higher than the flow sustained during Hurricane Agnes. The issue at hand is that the use of the Emergency Earthen Fuse Plug will substantially increase the amount of flow discharged during that extreme rain event. The substantial increase in flow is caused by the Emergency Earthen Fuse Plug*

eroding and the water in the Lake being discharged downstream. By armoring the Dam and abandoning the use of the Emergency Earthen Fuse Plug, the Dam will be capable of passing the flow generated by the extreme rain event and would no longer increase the flooding levels downstream over than what would occur naturally from the rain fall event. during those extreme rain events.

- **Question – How much additional flooding would be caused by the current configuration of the dam?**
  - *Answer – The regulations require that the Dam be able to safely discharge the volume of water generated by a scientifically possible rainfall event – what is called Probable Maximum Precipitation. This is the amount of flow that can conceivably be generated in our watershed during the most scientifically possible extreme rain event. The Dam's bascule gate (the Dam's current configuration) is <u>not</u> capable of discharging that amount. To discharge excess water, the Dam currently relies on the Emergency Earthen Fuse Plug. By using the Emergency Earthen Fuse Plug, we would start draining the entire Lake and the peak discharge would increase to significantly more water downstream. The Dam's current configuration would increase the outflow during that most conceivable rain event by approximately 66%.*



Because any flow volume of more than <u>30,000 cfs</u> will create a water surface elevation in Lake Barcroft that would cause the complete over topping of the dam and erosion of the Emergency Earthen Fuse Plug, the earthen embankment/s must be armored to prevent erosion and a potential breach of the dam.

- **Question – Please help me understand these extreme rain and flooding events that have been referenced?**

- *Answer – As for the extreme rain events, when developing dam safety regulations, the Federal Government and the States rely on the studies that NOAA (the National Oceanic and Atmospheric Administration) has done to determine what is scientifically possible when it comes to the most extreme rainfall that our atmosphere can produce. NOAA has developed regional charts for the maximum amount of rain that is scientifically possible. NOAA refers to these as Probable Maximum Precipitation charts. Dam owners across the Country are required to use these charts when developing hydraulic modeling that is specific to their dam.*
- *As for the extreme flood or flow events that have been referenced, dam owners are required to develop very sophisticated and detailed modeling of their contributing watershed to determine what is the most extreme peak flow that is possible for their dam to experience. That model is then used to simulate the Probable Maximum Precipitation so that the Probable Maximum Flood/Flow (PMF) can be determined. Please note that the way that the models are developed is highly regulated as well. Once the maximum flood/flow is determined, the dam must be able to safely pass that amount of water without the risk of dam failure or contributing to additional flow.*

- **Question – Would downstream flooding still occur during extreme rain events after the improvements to the Dam were completed?**
  - *Answer – The answer is YES, flooding downstream of the Dam would still occur during extreme rain events after the completion of the Dam improvements. However, the level of flooding that would occur would only be caused by the rain event itself, it would not be increased by releasing the water that is normally in Lake Barcroft. The flooding that would occur would be only a result of Mother Nature. The Dam would simply be passing the amount of water that it is receiving (Note – this is a legal requirement for the Lake Barcroft Dam – the Dam must pass through the amount of water it receives on a continuous basis, regardless of weather conditions).*

- **Question – In simple terms, what improvements will be made to the Dam?**
  - *Answer – The earthen embankments on the eastern and western ends of the Dam will be armored so that during the most scientifically conceivable extreme rainfall events, water can flow over the entire width of the dam, not just through the bascule gate that generally regulates normal flow. This will prevent the major erosion of the western earthen embankment (the Emergency Earthen Fuse Plug) that happened during Hurricane Agnes.*

- **Question – How soon does this project have to be completed?**
  - *Answer – This project will take several years to complete. Over the course of the next 18 to 24 months, the LBWID will be working on the following phases: design concept, detailed design/contract development, and permitting approval. Following that, we will then move into the advertising and bidding phase. It should also be noted that the actual construction may be completed in multiple phases. <u>It is conceivable that it may take 4 to 6 years to complete this project.</u>*

- **Question – When will we know how much the improvements to the Dam will cost?**

- *Answer – Currently the LBWID's engineers are working on developing alteration/upgrade concepts and evaluating them for compliance, difficulty, operational impacts, and cost. Upon completion of this phase, the LBWID will receive a recommendations report from the engineers. The LBWID will then evaluate the report and work with the engineers and the Virginia Dam Safety officials to determine the most appropriate concept, or combination of concepts, with which to move forward. As of right now, the LBWID is expecting to receive the Phase 2 recommendations report by early 2024. Upon evaluation of the recommendations report, we should have a better estimate of what the total cost of the project may be. It is likely to be a significant cost, in the millions of dollars.*

- **Question – How will this project be paid for and will the LBWID have to increase its tax rate?**
  - *Answer – The LBWID will look at a combination of using existing reserves, accessing Federal and State grants and loans, and use of its bonding ability as a government entity to cover the cost. While any bonds and/or loans would be paid back through the WID taxing authority, this cost would be amortized over many years (20 to 30), as was done to reestablish and upgrade the Dam following Hurricane Agnes. This will likely result in a modest increase in the current LBWID tax rate but will avoid any short-term assessments in the thousands of dollars to any resident of the community.*

- **Question – What steps are the LBWID undertaking to identify options?**
  - *Answer – Fortunately, the community is in a better situation than it found itself following Hurricane Agnes—the LBWID is established and it has legal status that opens more funding avenues that were not available back then. By being a governmental entity (a "Political Subdivision of the Commonwealth"), the LBWID has access to State and Federal grants. Furthermore, in recent years there have been Federal and State grants established to address the funding of dam-related projects such as ours. We are evaluating the potential of each of these grant opportunities.*
  - *We are also reaching out to our elected political leaders to brief them on the project. We will be seeking their support for government grant/funding mechanisms.*
  - *Lastly, we are evaluating the possibility of issuing long-term bonds, or obtaining low interest loans, to supplement any shortage of grant revenue that will be required to fully fund the project.*

- **Question – Why don't those downstream of the Dam pay for the upgrades if they are the ones at risk?**
  - *Answer –Virginia's dam safety regulations are structured such that the dam owner is the party responsible for mitigating the risk to downstream lives and property. Because the risk that is being regulated is the amount of water that is being impounded, the party that is impounding it is responsible. If impoundment did not exist, neither would the risk.*

- **Question – How do we know that our design approach will be accepted by the Virginia Division of Dam Safety?**
    - *Answer – Because the Virginia Division of Dam Safety performs the regulatory oversight for dam construction and repairs/upgrades, the LBWID will be working very closely with them throughout the design process so that we can have confidence that any selected plan will fulfill our regulatory obligations.*

Additional Questions that have been submitted to the LBWID.

- **Question – Would the amount of downstream flooding in a catastrophic storm change if the Dam was not there?**
    - *Answer – If the Dam does not breach or fail during a catastrophic storm, the flooding that would occur downstream would be the same as if there was no Dam. If the fuse plug erodes during a catastrophic storm event, the level of flooding downstream of the Dam would significantly increase because of the added water from Lake Barcroft.*

- **Question – Would it help if we were able to lower the water level behind the Dam in anticipation of a storm?**
    - *Answer – Lowering the Lake in advance of a PMP level storm would not provide enough storage capacity to absorb the peak inflow, the Dam would still eventually overtop, and the fuse plug would erode.*

- ***Question – Would downstream flooding be worse if there was a Dam breach?***
    - *Answer – If the Dam were to breach or fail during an extreme storm event, the flooding downstream would be significantly worse compared to if it did not fail or breach. If the fuse plug erodes during an extreme storm event, the level of flooding downstream of the Dam would also be significantly worse.*

- **Question – It was said at the last informational session that the LBWID has to plan in light of existing County development regulations, assuming full development. What if the County changes its regulations to allow more development that would add to the watershed drainage into the Lake? Does that mean we might have to pay for even more dam improvements?"**
    - *Answer – Dam owners are responsible for ensuring that their dam is capable of safely passing the peak flow that could be generated from the contributing watershed. If development within the watershed theoretically increases the peak flow, the dam owner is required to increase the discharge capacity of the dam to safely pass the increased peak flow. However, because the required modeling techniques already account for the watershed being developed to the fullest extent that County ordinances will permit, there would have to be a significant number of changes to zoning ordinance to impact the peak flow. In addition, when modeling almost 25*

inches of rain in 6 hours, the entire watershed becomes impervious rather quickly. The absorption rate of the soil in the watershed is very limited during extreme rain events.

- **Question – How much of the flow volume and intensity is due to hard scape developments upstream of Lake Barcroft? If this amount is significant, what actions are under consideration to assure that a fair share of the cost is borne by the developers of the hard scape areas or the Fairfax County because permits were issued for developments with inadequate stormwater retention or attenuation?**
    - *Answer – By dam safety regulations, the maximum flow requirement is not calculated by actual watershed development data. Rather, it is by the maximum extent the watershed is permitted to be developed by existing county zoning ordinances. This ensures that a dam is capable of safely passing the maximum flow that can be expected if the contributing watershed becomes fully developed.*

- **Question – On page 13 of the "Virginia Dam Safety Regulation" weblink, it says a high-hazard dam can be allowed to pass flooding from 0.6 PMP instead of 0.9 PMP if certain criteria are met. I wonder whether the current 90,000 CFS value is the result of 0.6 or 0.9 PMP. If the value is based on 0.9PMP, I wonder if alternative plans for meeting the criteria for 0.6 PMP have been considered and if such plans would be more cost-effective?**

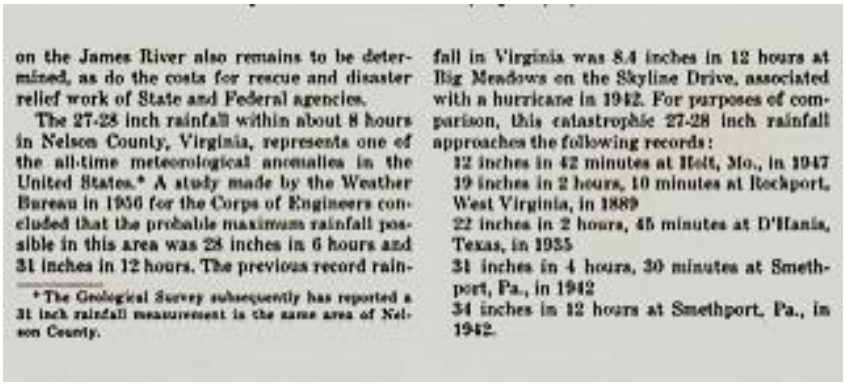
    Answer – High-hazard dams are permitted to have a reduced spillway capacity (0.6 PMP instead of 0.9 PMP). However, a differential damage analysis is required to determine the differential damage between the 0.6 PMP and the 0.9 PMP to homes, properties, and businesses that are downstream of the dam. The dam owner then needs to purchase an insurance policy on each of the properties that could be damaged because of the dam's reduced spillway capacity. As you can probably imagine, the annual cost of the insurance premiums would get very expensive. Regarding the Lake Barcroft Dam, its existing spillway capacity is still well below the minimum that would be allowed by the Virginia Dam Safety Regulation. Lake Barcroft can currently only safely pass approximately 0.3 PMF/PMP without the erosion of the existing Earthen Fuse Plug. Because ANY flow volume greater than 30,000 cfs will create a water surface elevation in Lake Barcroft that would cause the complete over topping of the Dam, and erosion of the fuse plug, the earthen embankment/s must be armored to prevent erosion and a potential breach of the dam.

- **Question – I'm wondering if the detailed valuations, measurements, documentation, and reports that give rise to the 90,000 CFS estimate could also be posted here. Ideally, the documentation is such that one could replicate the whole estimation process and reach a CFS number using the measurements reported in the document and publicly available resources/guidelines.**
    - *Answer – The required modeling for determining peak maximum flow is regulated by DCR Dam Safety. The specific modeling techniques and required data sets to be used in the model generate a specific maximum peak flow volume. A model of the dam's specific contributing watershed must be developed to determine the peak maximum flow. For high-hazard dams,*

these models cost upwards of $100,000, or more, to develop and run the required scenarios. This is not an exercise that a layman can replicate.

- **Question – How much more would armoring the embankments cost for a 40,000 cfs, or a 60,000 cfs event, versus the 90,000 cfs the VA DCR regs force us to meet?**
    - *Answer* – Currently*, we do not have an answer to that question. Because the Virginia Dam Safety Regulations currently require the Lake Barcroft Dam be able to safely pass the 0.9 PMP/PMP, the LBWID will be pursuing a remedial plan that will achieve full compliance of that regulation.*
      Because ANY flow volume greater than 30,000 cfs will create a water surface elevation in Lake Barcroft that would cause the complete over topping of the Dam, and erosion of the fuse plug, the earthen embankment/s must be armored to prevent erosion and a potential breach of the dam.

- **Question – You mentioned yesterday (during LBWID Information Session #3, on Dec. 6th, 2023) that in 1969, Camille dropped over Nelson County, VA, a record 25" of rain in 5 hours. What are those numbers based on? Attached is an authoritative report a month after the storm, on the record precipitation that states 27" in 8 hours in one small area of Nelson County, or less than 17" in 5 hours, implying that you, and perhaps DCR Virginia are using an estimate 60% higher than the best reported amount.**
    - *Answer – To be precise, we stated the following on slide 25 of the presentation: "PMP RAIN EVENTS HAVE HAPPENED IN VIRGINA. IN 1969 HURRICANE CAMILLE DUMPED AN EXCESS OF 25 INCHES OF RAIN IN NELSON COUNTY, LARGELY WITHIN A 5 HOUR PERIOD ". We underline the word "largely" because the exact rate is not authoritatively recorded. However, DCR Dam Safety officials have referenced that storm event as being a PMP event. As for the authoritative report that we are referencing (full report can be found here: https://www.weather.gov/media/publications/assessments/Virginia%20Floods%20August%201969.pdf), it also provided information on page 12 (page 12 of the pdf) about significantly higher rainfall rates during other storms in the United States, some of which were in Virginia's neighboring States (see info below). Tracking and recording weather is not a perfect science, nor is forecasting the weather. However, one of the world's leading-most authorities on weather and climatology (NOAA) has developed the PMP values that Dam Safety officials (and many States) utilize for developing dam safety regulations. Until the Virginia Dam Safety uses another organization's data, the LBWID will continue to use NOAA's PMP values because the LBWID must comply with the Virginia Dam Safety regulations.*



on the James River also remains to be determined, as do the costs for rescue and disaster relief work of State and Federal agencies.

The 27-28 inch rainfall within about 8 hours in Nelson County, Virginia, represents one of the all-time meteorological anomalies in the United States.* A study made by the Weather Bureau in 1956 for the Corps of Engineers concluded that the probable maximum rainfall possible in this area was 28 inches in 6 hours and 31 inches in 12 hours. The previous record rainfall in Virginia was 8.4 inches in 12 hours at Big Meadows on the Skyline Drive, associated with a hurricane in 1942. For purposes of comparison, this catastrophic 27-28 inch rainfall approaches the following records:

12 inches in 42 minutes at Holt, Mo., in 1947
19 inches in 2 hours, 10 minutes at Rockport, West Virginia, in 1889
22 inches in 2 hours, 45 minutes at D'Hanis, Texas, in 1935
31 inches in 4 hours, 30 minutes at Smethport, Pa., in 1942
34 inches in 12 hours at Smethport, Pa., in 1942.

*The Geological Survey subsequently has reported a 31 inch rainfall measurement in the same area of Nelson County.

- **Question – Since the area of this freak highest recorded storm was very small, to borrow an analogy from lightning strikes, the chances of such a freak storm happening over our lake watershed seems to be 1 in 3000 (ratio of our watershed area to the area of Virginia). Thus, if we assume such a freak storm can occur over VA once in a 100 years, should not the chances of it occurring over our LB watershed seems to be 1 in 300,000 years. Granted that this is an oversimplification, but if close to being true, why does the freak extreme rainfall in 1969 over Nelson, or "an act of God," have such a big impact on DCR and WID thinking? (The Virginia Climate Center has a good estimate of the impact of Climate on precipitation in the next 100 years---which I think is to increase precipitation by 20% from existing levels.).**
    - *Answer – It must be understood that PMP events are not evaluated for frequency of occurrence, or even likelihood of occurrence. The National Weather Service (part of NOAA), Army Corp of Engineers, and U.S. Bureau of Reclamation have been the primary agencies leading the effort to evaluate and determine PMPs. Their primary objective was determining what was "physically possible". A very detailed explanation of this and the studies that have gone into determining PMPs are provided in a study/report commissioned by the Virginia General assembly in 2014, Probable Maximum Precipitation Study for Virginia (https://www.dcr.virginia.gov/dam-safety-and-floodplains/document/pmp-final-report.pdf). Below is a quote from that report that references the aspect of "physically possible".*

      > *"It is important to remember that the methods used to derive PMP and the hydrological procedures that use the PMP values need to adhere to the requirement of being physically possible. In other words, various levels of conservatism and/or extreme aspects of storms that could not physically occur in a PMP storm environment should not be used to produce combinations of storm characteristics that are not physically consistent in determining PMP values or for the hydrologic applications of those values.".*

      With that said, the use of PMP's is not just an impact on the thinking of LBWID or Virginia's DCR Dam Safety. Regulatory authorities/agencies across the Country rely on PMP studies/values when formulating policies, especially in the dam safety sector. Please keep in mind that the LBWID is not a regulatory authority when it comes to studying the weather or dam safety regulation. The LBWID is a government agency with the task of safely operating and maintaining a dam that is classified as having "High Hazard Potential." As such, the LBWID is required to adhere to all State and Federal laws and regulations, especially those that pertain to dams. The LBWID is not making assertions

regarding the accuracy of the studies of weather or engineering that have led to the current formulation of Virginia's Dam Safety regulations. However, the LBWID does acknowledge that we have a responsibility to adhere to the law and to maintain public safety.

Furthermore, the most common reason for dam failures across the world is due to inadequate spillway capacity. This means that a storm that occurred in that watershed produced too much rain/stormwater to safely pass through the impacted dam. When asking a fair and important question of "how is the best way to prevent the most common cause of dam failures?", it appears to us that the answer is to make sure that dams can safely pass the rain/stormwater generated by the most extreme storm "physically possible". Anything less puts dams and public safety in jeopardy. Because ANY flow volume over 30,000 cfs will create a water surface elevation in Lake Barcroft that would cause the complete over topping of the Lake Barcroft Dam, and erosion of the fuse plug, the earthen embankment/s must be armored to prevent erosion and a potential breach of the dam.