Annotated List of Articles Published in the Journal of Dam Safety
Association of State Dam Safety Officials – www.damsafety.org

Hammer, Greg. *If it ain't broke.....or is it?* Journal of Dam Safety - Spring 2003 (V. 1 N. 1)

The 90-year old Clear Lake dam was modified for overtopping protection in 1996. The dam is a rockfill embankment, with a steel sheet-pile cut-off wall. Founded on land-slide talus, the dam increased the storage in a natural lake created by the slide. The original outlet was a 20" diameter riveted steel outlet, with a bifurcated section using two 16" diameter conduits placed within a timber crib tunnel. Closure gates were located under the crest of the dam. In conjunction with the armoring project, the outlet was renovated to provide control and guard gates in a new upstream wet-well gate tower. When the reservoir was refilled, sinkholes developed over the connection between the new and old outlet conduits. As plans were being developed to repair the outlet, investigations revealed that the outlet was collapsed, and the cause of the sinkholes was determined to be the result of moving the outlet gate upstream, and thus creating a differential pressure on a joint that would previously have been inundated under normal conditions. Moving the gate upstream allowed this section of the outlet to be dewatered when the gates were closed. With bad joint connection, the dam began to pipe into the outlet. This was a condition that became evident by increased turbidity of outlet releases when the gate was closed.

Geographic interest: Colorado

Subject terms: case studies, rehabilitation, design, sinkholes, conduits, failures, incidents, embankment dams, rockfill dams, gates, joints, piping

McClelland, Duane M. and Becker, Brian D. *Improving your dam safety emergency action plan: Insights from the U.S. Fish and Wildlife Service.* Journal of Dam Safety - Spring 2003 (V. 1 N. 1)

The utility of dam safety emergency action plans (EAPs) can often be greatly improved by giving practical consideration to the needs of operators during high-stress, rapidly developing emergency conditions. During the years 2000 through 2002, the U.S. Fish and Wildlife Service worked with GEI Consultants, Inc. to improve EAPs and EAP training for FWS personnel managing high or significant hazard potential dams. The authors identify common EAP deficiencies, critique the EAP format recommended in the current Federal Guidelines, and present an updated FWS EAP format.

Subject terms: emergency management, federal programs, EAPs, state programs, federal programs, guidelines

McCook, Danny K. *Tips for earthfill construction.* Journal of Dam Safety - Spring 2003 (V. 1 N. 1)

Article details the importance of checking the water content of soils in the borrow and checking the percent saturation of field quality control tests.

Subject terms: embankment dams, construction, design, quality control, geotechnical investigations

Binder, Denis. *Emergency Action Plans: A Legal and Practical Blueprint.* Journal of Dam Safety - Fall 2003 (V. 1 N. 2)

Viable emergency action plans (EAPs) must be in effect when a disaster occurs such that their prompt implementation will reduce the resulting injuries and damages. Indeed, implementation of an emergency action plan should be one of the first responses in an emergency. An emergency action plan is not designed to prevent an accident. Other measures must accomplish that goal, but these plans are designed to minimize or mitigate the impacts and vulnerability when the tragedy occurs, as well as to

facilitate recovery efforts. The number of ways an accident can occur, a facility fail, or system malfunction is probably infinite. Accidents happen. So too do disasters and tragedies. In spite of the best precautions, structures fail and systems malfunction. Natural phenomena include avalanches, blizzards, cold snaps, drought, earthquake, fire, floods, heat waves, hurricanes, landslides, lightning, tornadoes, volcanoes, tsunamis, and wildfires. Human acts can include basic negligence, pollution, computer hacking and viruses, deferred maintenance, disgruntled employees, sabotage, terrorism, vandalism, and biological and chemical attacks in subways, office buildings, and public arenas. Environmental emergencies include air pollution, oil spills, toxic spills, and workplace accidents. However, whether the cause of the emergency is of human or natural origin, or a combination of both, the impacts and results may be the same. While the threats may be infinite, the foreseeable damage, the resulting emergency, is finite. Prompt implementation of an emergency action plan may minimize the damages. Indeed, even with the total failure of a facility, emergency action plans can facilitate recovery efforts, not only at that site but throughout the system or area. Emergency action plans have not been the subject of much litigation or comment in the legal literature. However, despite the seeming judicial novelty of these plans, the legal principles applicable to them easily fit into the established law of negligence. Liability issues can arise in three contexts: 1) absence of an emergency action plan; 2) inadequacy of the plan; and 3) failure to follow the plan. All three should be subject to the general negligence standard of reasonable care under the circumstances.

Subject terms: emergency management, legal aspects, training programs, testing, warning systems

Petersen, Kathryn M. *Lost Creek Dam Rehabilitation - Five Years Later.* Journal of Dam Safety - Fall 2003 (V. 1 N. 2)

The underwater application of a geomembrane to Lost Creek Dam in Northern California was a unique engineering project completed in 1997. Because this project was the first of its kind anywhere in the world, it was the subject of a number of papers and articles. The geomembrane installation was chosen as the method to halt seepage through the porous concrete dam and thereby arrest deterioration that was occurring as a result of the freeze-thaw cycle. As with any new rehabilitation method, there is always the question, "Did it work?" Has seepage through the concrete and the damaging freeze-thaw cycle actually been eliminated? A visit to the dam on a dry February day a little more than five years after the installation helped answer that question.

Geographic interest: Georgia

Subject terms: seepage, geosynthetics, case studies, design, concrete dams, rehabilitation, freeze-thaw deterioration, monitoring

Woosley, Dallon Thomas. *Emergency Response at Pine Lake Dam.* Journal of Dam Safety - Fall 2003 (V. 1 N. 2)

Pine Lake Dam is an earthen dam located in the northern portion of Metro Atlanta, in Forsyth County, Georgia. The dam is 32 feet tall with a 12-inch diameter corrugated metal pipe as the principal spillway. A county road runs along the crest. The slopes at the dam are steep and there are two pipes that serve as the emergency spillway system running under the road. These two pipes are a 48-inch and a 42-inch corrugated metal pipe. The lake surface area is 21 acres at normal pool with a drainage area of approximately 600 acres. It is unclear exactly when this dam was built, but some of the county residents indicate that the dam was built around 1974. The Georgia Safe Dams Program (GSPD) received a couple of phone calls about this dam on March 5, 1998. On Monday, March 6, 1998, our staff went on-site to investigate the condition of the dam and to meet with county officials. It was sheer luck that this dam had not already failed. Nearly every conceivable problem with an earthen dam could be observed at this one location.

Geographic interest: Georgia

Subject terms: conduits, embankment dams, emergency management, erosion, legal aspects, ownership, hazard classification, state programs

Bendel, Russell and Basinger, Donald. *Sliplining at Lake Toxaway - problems and solutions.* Journal of Dam Safety - Winter 2004 (V. 2 N. 1)

Included in the aging infrastructure in America are the thousands of dams that are over thirty (30) years old. Many of these aging dams are earthfill embankment dams that were constructed with corrugated steel pipe (CSP) conduits passing through the embankment. When a CSP conduit has reached or exceeded its service life, deterioration of the conduit becomes a problem. The deterioration can consist of leaking joints, holes, and failure of the pipe. Traditional methods of open trench repair or replacement can be very costly, and in some cases space may be very limited. Imagine excavating down 40 feet or more through the entire earthfill embankment to expose and replace an old pipe, and with the associated risks of bad weather or even flooding. The sliplining technique can often be used in lieu of open cut excavation for rehabilitation of the existing outlet pipe. In some cases, sliplining can increase the hydraulic capacity of the outlet pipe. If designed and installed properly, the slipline technique can add an additional 50 years of service life to the existing outlet pipe, and in many instances, at a fraction of the cost of replacing the deteriorated outlet pipe using traditional methods. Sliplining does not come without its own set of problems to conquer. In lieu of available research that addresses these problems, engineers must rely on engineering fundamentals, thorough research of available information, and a conservative approach to overcoming some of the sliplining obstacles. The Lake Toxaway Dam drain conduit rehabilitation is an example of a successful sliplining project that had its share of obstacles to overcome. Through experience on previous projects, open dialogue with the contractor, and a conservative approach to each problem at hand, a 326-foot long CMP drain conduit was sliplined from the downstream end while a 47-foot deep, 527-acre lake remained at normal pool and in service for the lake's private community.

Geographic interest: North Carolina

Subject terms: underwater investigations, conduits, embankment dams, rehabilitation, gates, drainage systems, construction, grouting

Hansen, Kenneth D. and Kahler, Charles M. *RCC tests, testing, and test sections - lessons learned.* Journal of Dam Safety - Winter 2004 (V. 2 N. 1)

The use of roller-compacted concrete (RCC) to rehabilitate existing dams and build new dams is now more than two decades old. Since its introduction, RCC has become a powerful tool to dam safety design engineers. The use of RCC to provide overtopping protection for existing embankment dams has now passed the 80 projects mark. Another dozen old concrete or masonry dams have been buttressed using RCC. In addition, about 25% of the 65 new RCC gravity dams built in the United States to date have replaced failed, poorly performing or structurally inadequate existing dams. Nearly all of the dams that required replacement were older embankment dams. In order to properly provide quality control to the RCC being produced and placed, tests were needed to assure that the specified mixture proportions were being produced, the RCC had the desired consistency and that the RCC had been compacted to a required minimum density. In addition, RCC test specimens needed to be prepared that produced properties similar to those achieved in the actual project. It soon became apparent that some test methods that had been used for conventional concrete or in some cases for soils could be adopted for RCC. However, some new test methods needed to be developed for RCC that were unique to the no-slump consistency of the material. In the development of new test methods for RCC construction, much has been learned. Some tests that were used early in this development have fallen out of favor while some continue to be used. However, some of the test standards that were accepted earlier need modification and some only have a certain range of applicability depending upon the consistency of the RCC mixture. This article is a condensed version of the paper published in the Proceedings of 2002 ASDSO Annual Conference, September 8-11, 2002 in Tampa, Florida.

Subject terms: roller-compacted concrete, quality control, concrete, design, construction, testing, gravity dams, embankment dams, rehabilitation

Lindon, Matthew. *The Little Deer Creek Dam Failure - A Forensic Review of a Fatality.* Journal of Dam Safety - Winter 2004 (V. 2 N. 1)

The combination of several deficiencies - including marginal design and exploratory testing, minimal site preparation, questionable construction quality, insufficient bedrock preparation, poor conditions during construction - likely caused the June 16, 1963 failure of Little Deer Creek Dam. On this date, a four-year-old boy became the first dam failure casualty in Utah history.

Geographic interest: Utah

Subject terms: failures, incidents, legal aspects, seepage, design, foundations, construction, site preparation, site selection, embankment dams

Bruce, Donald A. *Crisis management: dealing with massive underflows in karstic limestone.* Journal of Dam Safety - Spring 2004 (V. 2 N. 2)

Dams must often be founded on karstic limestone terrain, or on other soluble rock types. Whereas it is typical practice to install a grout curtain under a new dam, such an operation cannot be guaranteed to comprehensively treat a karstic rock mass to a degree that seepage under long term service conditions may not – eventually – result in channels being opened through features in the karst filled with residual clay or other erodible or weathered materials. This long term deterioration may be superimposed on any short term disturbance to the karstic terrain created by construction activities, such as blasting, excavation, and the local alteration of piezometric levels. Grout curtains in virgin karst have a finite effective life – the length of which depends on the rock mass characteristics, the intensity and quality of any grouting conducted, and the prevailing hydraulic gradients. Unfortunately, this life expectancy cannot be reliably or precisely predicted.

In recent years, major rehabilitations have been funded to a number of large and vital existing structures owned by the U.S. Army Corps of Engineers, including Beaver Dam, AR; Walter F. George Dam, GA; and Mississenewa Dam, IN. All have been protected by constructing “positive” concrete cut off walls – overlapping large diameter piles in the case of Beaver Dam, diaphragm walls in the latter instances. A notable exception to this pattern has been the repair of the foundations of Patoka Lake Dam, IN, where a relatively innovative grout curtain was selected on overwhelming cost reasons over a concrete wall. Similarly, the recent karst related seepage problem of a major TVA structure was also resolved by the use of contemporary grouting principles.

Subject terms: grouting, geology, seepage, instrumentation, monitoring, design, rehabilitation, concrete, foundations

Caldwell, Larry. *Rehabilitation of Aging Watershed Dams: The 21st Century Challenge for Watershed Project Sponsors.* Journal of Dam Safety - Spring 2004 (V. 2 N. 2)

Watershed project sponsors spent the second half of the 20th century constructing dams and applying conservation practices to protect people and reduce flooding and erosion. Today, they are challenged to assure these aging dams continue to function effectively while protecting public health and safety through the 21st century. Congress authorized the USDA Natural Resources Conservation Service (NRCS) to assist communities in rehabilitating their aging watershed dams when it enacted the Watershed Rehabilitation Amendments of 2000. Considerable progress has been made in implementing this new authority. This is a result of the initiative of watershed project sponsors and the excellent partnership between the sponsors, community leaders, NRCS, state conservation agencies, and state dam safety

agencies. As of March 2004, 118 watershed rehabilitation projects have been initiated in 20 states. Watershed rehabilitation efforts will not only ensure that watershed dams are safe and protect people in the community, but that they will continue to provide flood control, recreation, and wildlife habitat for another 50 to 100 years. This report provides background on watershed rehabilitation, summarizes progress on projects funded to date, estimates the number of requests for assistance in the future and shares lessons learned on completed projects.

Geographic interest: U.S.

Subject terms: federal programs, rehabilitation, age factors, embankment dams, legislation, benefits

Rizzo, Paul C., Bair, Jeffrey M., Osterle, John P. and Gault, Howard W. *Construction Dewatering At Saluda Dam.* Journal of Dam Safety - Spring 2004 (V. 2 N. 2)

Saluda Dam (Dam), owned and operated by South Carolina Electric & Gas Company (SCE&G), impounds Lake Murray, one of the largest man-made lakes in North America. The Dam is a semi-hydraulic fill structure constructed in 1930 following the typical "puddle dam" construction technology. This type of construction resulted in significant seepage through the Dam upon filling, which required placement of riprap benches and the installation of an extensive network of seepage collection drains on the downstream slope of the Dam to control seepage after initial construction.

The Dam is being remediated to meet changes in earthquake safety criteria as directed by the Federal Energy Regulatory Commission (FERC). The remediation consists of a 5,500-foot-long Rockfill Berm and a 2,200-foot-long Roller Compacted Concrete (RCC) Berm on the downstream slope of the existing Dam. Both the RCC Berm and the Rockfill Berm will serve as the primary water retention barrier in the event of an earthquake induced failure of the existing Dam. Both require a highly competent foundation with the RCC Berm founded on rock. Therefore, extensive foundation excavations into the residual soil or bedrock encountered at the toe of the existing Dam are required to facilitate construction of the Berms.

Geographic interest: South Carolina

Subject terms: dewatering, case studies, slope stability, design, roller-compacted concrete, seismic analysis, seismic behavior, rehabilitation

Findlay, R. Craig and Rabasca, Steve. *Diversion dam: seismic stability and seepage assessment/rehabilitation.* Journal of Dam Safety - Summer 2004 (V. 2 N. 3)

Diversion Dam, located in Croghan New York is an embankment dam that is a component of the Soft Maple Hydroelectric development. The development is part of the Beaver River Project, owned and operated by Reliant Energy. At the time of this writing, Brascan is in the process of purchasing this and the other New York State hydro assets of Reliant Energy. The dam is under the regulatory jurisdiction of the Federal Energy Regulatory Commission (FERC). The dam is approximately 900 feet long at the crest and is about 70 feet high, and has a high hazard classification under FERC Guidelines. The dam was constructed between 1924 and 1925 using hydraulic fill techniques. The hydraulic fill method of embankment construction, commonly used in the early half of the 20th century, generally results in looser density fill than would otherwise be achieved by modern compacted lift-fill placement methods. Because of the loose character of the fill, saturated portions of hydraulic fill dams may be susceptible to liquefaction triggered by seismic shaking. This paper reviews the most recent seismic stability assessment of Diversion dam and discusses the seismic rehabilitation that was completed in late 2002.

Geographic interest: New York

Subject terms: seepage analysis, seepage control, seismic analysis, seismic behavior, drainage systems, rehabilitation, embankment dams

Jamieson, Stephen L., France, John W. and Perri, Peter P. *CM/GC construction of Guanella Dam.* Journal of Dam Safety - Summer 2004 (V. 2 N. 3)

Paper describes the fast-track design, permitting, and construction approach that was utilized to develop a new water supply reservoir for the City of Golden, Colorado. The fast-track approach resulted in the completion of the entire project in a little more than one year, which was two years ahead of schedule. Innovative approaches and the cooperation of the SEO, contractor, engineer, and owner were required because of the ongoing drought in Colorado, which essentially shut down Golden's water supply at its most severe period during the late summer of 2002. Guanella Dam is a high hazard potential, off-channel, zoned-embankment dam with a maximum vertical height of 34'.

Geographic interest: Colorado

Subject terms: design, construction, permits, geotechnical investigations, seepage control, case studies, embankment dams

Schultz, Mark. *Dam performance during the San Simeon earthquake.* Journal of Dam Safety - Summer 2004 (V. 2 N. 3)

On December 22, 2003, a M6.5 earthquake occurred near California's central coast, seven miles northeast of San Simeon. This was the largest earthquake in California since the 1999 M7.1 Hector Mine earthquake. Only four other earthquakes, since 1906, caused more expensive damage. Shaking was felt up and down the California coast, from the Bay Area to Los Angeles, with continuing moderate aftershocks as large as M4.9. Dams, roads, bridges, and other modern infrastructure generally performed very well in this seismic event. The majority of damage occurred in Paso Robles, where 40 buildings collapsed, or were severely damaged, and two fatalities tragically resulted. Federal, state, and local disasters were declared. Approximately 1,500 homes suffered minor damage, and approximately 500 homes and businesses were seriously damaged. About 60,000 homes lost power. Twelve state-regulated dams, one Army Corps of Engineers (ACOE) dam, and seven small military dams experienced strong shaking with an estimated peak ground acceleration greater than 0.10g. Paper summarizes dam performance and damages to various structures.

Geographic interest: California

Subject terms: earthquakes, seismic analysis, seismic behavior

Johnson, Brian S. *Performance-based design of an urban spillway.* Journal of Dam Safety - Fall 2004 (V. 2 N. 4)

The Standley Lake Dam Improvement Project began in 1999 to help ensure that the dam successfully transitions to address the changes that have occurred over its 96 years of operation. A significant embankment raise in 1965, suburban development, advances in dam engineering technology, and increased local, state, and federal regulations have all contributed to the challenges of maintaining the facility as a critical regional resource for another 50 to 100 years. This paper describes the project, which was completed in October 2004.

Geographic interest: Colorado

Subject terms: spillways, design, spillway capacity, hydrology, design flood, development

Schellhammer, Chris, Roberts, Thomas I. and McClellan, Phillip. *Preparing EAPs for the 21st Century: How Dam Owners are raising the bar for EAPs by instituting technological growth.* Journal of Dam Safety - Fall 2004 (V. 2 N. 4)

Engineering practices and regulatory enforcement in the dam safety arena have significantly evolved over the last 25 years. The methods, technologies, and capabilities for designing and monitoring dams are far ahead of where they were 25 years ago. With innovative technologies, dam owners can now utilize computers for real time monitoring of their dams. These technological systems can also be used as a resource for Emergency Action Plans (EAPs). However, it can be argued that these technological advances are underutilized. For example, in Virginia less than 10 percent of dams are equipped with monitoring electronics.

Geographic interest: Virginia, U.S.

Subject terms: EAPs, emergency management, monitoring, instrumentation

Tomlinson, Ed, Jarrett, Robert D. , Parzybok, Tye and Trieste, Doug. *Reanalysis of a Colorado Extreme Rainstorm Using GIS, Paleoflood, and Rainfall-Runoff Analyses.* Journal of Dam Safety - Fall 2004 (V. 2 N. 4)

Probable Maximum Precipitation (PMP) studies are based primarily on analyses of extreme rainstorms where the largest historic rainfall observations are used to determine PMP values for the surrounding regions. The October 4-6, 1911, rainstorm over the southwestern US produced large rainfall amounts and significant flooding in Colorado. The daily rainfall observation of 8.05 inches at Gladstone, Colorado, was significantly larger than other rainfall observations for the storm, especially considering Gladstone is at an elevation of 10,400 feet. Previous site-specific PMP studies for drainage basins in southwestern Colorado have considered this storm and consistently concluded that, although widespread moderate/heavy rains occurred in the region, the maximum daily precipitation value of 8.05 inches reported at Gladstone is most likely in error, although the magnitude of the error is not known (McKee and Doeskens, 1997). Because of its influence on several site-specific PMP studies currently being completed for drainage basins in western Colorado, a re-analysis of the Gladstone rainfall observation was performed using detailed storm rainfall analyses, paleoflood analysis, and rainfall-runoff modeling results. The main conclusion is that the 1911 Gladstone observation is an error and should not to be used in subsequent hydrometeorological studies. After extensive review, the Colorado State Engineer's Office has accepted this conclusion (Colorado SEO, written communication, September 23, 2004). The significance of including the 1911 Gladstone rainfall observation is that it causes the PMP values of southwestern Colorado basins to be overestimated by about 25 percent.

Geographic interest: Colorado

Subject terms: geographic information systems, PMP, PMF, hydrology

Bliss, Mark. *Jet Grouting for Seismic Remediation of Wickiup Dam, Oregon.* Journal of Dam Safety - Spring 2005 (V. 3 N. 1)

To prevent failure due to strong ground shaking during a seismic event, the U.S. Bureau of Reclamation undertook a three-year project to modify Wickiup Dam in west-central Oregon. Analyses showed that low-density materials, susceptible to liquefaction under strong ground shaking, were present in the foundation of the left abutment dike. A multi-disciplinary team composed of geotechnical engineers, geologists, construction engineers, and experts in value engineering completed a Corrective Action Alternatives scoping study in January 1999. This study indicated that jet grouting of the foundation materials could be the least-cost alternative to stabilize the soils and prevent failure of the dam under strong ground shaking. Because of a lack of historical information regarding the potential cost and effectiveness of jet grouting the types of weak materials in the foundation of the dam, a jet grouting test section was constructed. The test section proved the effectiveness of jet grouting in treating the required zones and answered Reclamation's questions about potential costs; thus, jet grouting was selected as the preferred alternative. Following preparation of final designs and a two-step negotiated contract process, a construction contract was awarded to Hayward-Baker Inc. in July 2001.

Geographic interest: Oregon

Subject terms: research, overtopping, embankment dams, erosion, vegetation, testing

Dewoolkar, Mandar M. , Huzjak, Robert J. and Castro, Gonzalo. *Application of finite element analysis in the geotechnical design aspects of a new earth dam.* Journal of Dam Safety - Spring 2005 (V. 3 N. 1)

Construction is underway for a new, zoned earthfill dam designed by GEI Consultants, Inc. The project is known as Rueter-Hess Dam and Reservoir, and is being developed by the Parker Water & Sanitation District (PWSD). The new dam will have a height above the streambed of 135 feet and a crest length of approximately 5,000 feet. The project will provide raw water storage to meet current and future municipal and industrial water needs in the PWSD service area. According to the Colorado State Engineer's Office (SEO 1988), the dam is classified as a Large, Class I (high hazard potential) dam based on its size and relative risk to population and infrastructure downstream. The dam and reservoir will be located east of Interstate Highway 25 in northeastern Douglas County, Colorado, approximately 3.4 miles southwest of downtown Parker on Newlin Gulch, which is a tributary of Cherry Creek.

Geographic interest: Colorado

Subject terms: federal programs, seismic analysis, seismic behavior, earthquakes, rehabilitation, case studies, geotechnical investigations, geology, grouting

Hanson, Greg, Morris, Mark, Vaskinn, Kjetil, Temple, Darrel, Hassan, Mohamed and Hunt, Sherry. *Research Activities on the Erosion Mechanics of Overtopped Embankment Dams.* Journal of Dam Safety - Spring 2005 (V. 3 N. 1)

The asset value of dams and flood defense structures in the US, EU, and around the world amounts to billions of dollars. Many dams are located close to centers of population and industry, and the consequences of failure of these structures include the risk of both loss of life and property. Erosion as a result of overtopping during flood events has been identified as one of the key causes of embankment dam failure. This report presents a discussion of small-scale and prototype research experiments that have recently been, or are being, conducted in the US, the United Kingdom (UK), and Norway on earthen embankment overtopping. The objective of this research is to advance the scientific knowledge and understanding of breaching by: (1) evaluating erosion processes; (2) determining breach erosion rates; and (3) collecting data for breach model development and verification.

Geographic interest: U.S., Norway, United Kingdom

Subject terms: research, overtopping, embankment dams, erosion, vegetation, testing, international programs

Kuperman, Selmo C., Moretti, M. Regina, Cifu, Sergio, Celestino, Tarcisio B., Re, Giacomo, Zoellner, Klaus, Pinfari, Julio, Rossetto, Serfio L.G., Carneiro, Edvaldo F. and Reigada, Ruitter P. *Criteria to establish limit values of instrumentation readings for old embankment and concrete dams.* Journal of Dam Safety - Summer 2005 (V. 3 N. 2)

Hydropower plants and facilities owned by CESP- (Companhia Energética de São Paulo, Brazil) are more than 30 years old. They are the Ilha Solteira, Jaguari, Eng . Souza Dias (Jupia) and Paraibuna power plants as well as the Paraitinga dam. The history of their behavior has been compiled and recorded by means of periodic inspections and readings of installed instrumentation. As is often the case with old dams, and even with new ones, most of the instruments did not have limit values established for evaluating their readings, with the exception of piezometers installed to check the uplift pressures at the

foundations of concrete structures. This paper presents a method developed to establish "limit values" for the readings of almost 2300 monitoring instruments installed at these five large concrete, earthfill and rockfill dams and how these instruments relate to the safety of the structures. The criteria, based on a blend of statistics and engineering judgment indicates that "attention" or "alert" conditions are reached when calculated reference values for readings are exceeded, or when measurements start to indicate a trend different from a pattern established throughout the years. Basic statistics principals were applied. Easy to use, the methodology was developed after a thorough reevaluation of the instrumentation and structural safety of these dams. Establishing limit values made the monitoring process more reliable and helped CESP to change the frequency of readings and to reduce costs.

Geographic interest: Brazil

Subject terms: instrumentation, monitoring, international programs, concrete dams, embankment dams, rockfill dams, stability analysis

Mayfield, Sarah M. *Public Efforts for the Public Good.* Journal of Dam Safety - Summer 2005 (V. 3 N. 2)

"The state of the states" -- a look at state dam safety programs, policies, and events in the past year.

Geographic interest: U.S.

Subject terms: state programs, emergency management, rehabilitation, financial aspects, failures, incidents, legislation, floods

Toms, Ed, Poulter, Don, Erthal, Norman B., Koopman, Henry and Laudeman, Steve. *Concrete arch dam post-tensioning - Tarryall Dam.* Journal of Dam Safety - Summer 2005 (V. 3 N. 2)

Tarryall Dam - located approximately eighteen miles southeast of Jefferson, Colorado - is a high-hazard, 70-foot high, concrete arch dam, with a right concrete gravity abutment. The dam was constructed in 1929 and is owned and operated by the Colorado Division of Wildlife. The reservoir covers approximately 160 acres at the normal water surface elevation of 8,860 feet. The dam has a 270-foot long crest at elevation of 8867.2 feet, two 42-inch steel outlet pipes, and a 25-foot wide uncontrolled rock-cut spillway located along the left abutment. The dam has experienced seepage at the right abutment for the last 40 years. Cracks along horizontal cold joints in the concrete and preliminary stability calculations indicated that the dam, from right of the dam maximum section to the right abutment, was not stable. This right section of the dam was also exhibiting downstream displacement at the lift joints. Boyle Engineering Corporation performed an initial dam and site evaluation, prepared an alternatives study, developed final design for remediation, and provided construction quality assurance services for the project. The following presents a summary of the stability, design, and construction issues for the remediation of the dam and how Boyle addressed these issues through collaboration and teamwork with the Colorado Division of Wildlife and the Colorado State Engineer’s Office.

Geographic interest: Colorado

Subject terms: concrete dams, arch dams, design, rehabilitation, financial aspects, cracking, stability analysis, joints, foundations, geology, testing, anchoring, seepage

Glenn, Mark, Boland, Thomas E. and Orner, Matthew R. *Waterproofing of a gravity masonry dam.* Journal of Dam Safety - Fall 2005 (V. 3 N. 3)

Located in central Pennsylvania, the Tipton Dam is a gravity masonry dam used for water supply and owned by the Altoona City Authority. Originally constructed in 1924 by the Pennsylvania Railroad, the dam is 515 feet long and 71 feet high with a storage capacity of 320 million gallons. Inspections revealed

spalling concrete (crest and spillway caps), exposed reinforcing steel, deteriorating joints, masonry joint leakage, inoperable sluice gates and clogged screens. An underwater inspection was performed on the intake structure; 24-inch diameter intake line; 36-inch diameter blow-off pipe; associated valves and sluice gates and upstream dam face/masonry joints. Videography showed that the sluice gates (two 24-inch diameter and one 36-inch diameter) and operators, although deteriorated, could be refurbished. Crest and spillway caps were repaired, reset and covered with a cementitious coating system. The deteriorated concrete was removed and new pressure mortar surfacing ("shotcrete") placed to maintain the original cap shape. Cap construction joints were cleaned and recaulked with new sealing compounds. Exposed concrete surfaces were coated with a cementitious waterproofing system. This work also improved the aesthetics and overall appearance of the dam. The upstream dam face was covered with a two-inch thick, fiber-reinforced, air-entrained, shotcrete to seal all joints and protect the stone masonry blocks. The surfacing was applied by equipment mounted on barges. By this sealing method, the seepage through the downstream mortar joints was effectively abated.
The gates were removed, shop cleaned, coated and reinstalled by divers. The operator stems, stem guides and trash racks were replaced with stainless steel material. Underwater cleaning of the gate bodies was performed in place by high pressure water and pneumatic cleaning tools. To maintain water storage levels, the work to correct these deficiencies was done by underwater and floating platform methods.

Geographic interest: Pennsylvania

Subject terms: gravity dams, seepage, rehabilitation, concrete dams, design, construction, case studies, gates, financial aspects

Horn, Richard. *Cut-earth cradle method for installing conduits through earth dams.* Journal of Dam Safety - Fall 2005 (V. 3 N. 3)

A method of installing pipe conduits in earth embankment dams, without use of concrete cradles or other devices, has been successfully used on three dams in West Virginia since 1994 (Anawalt Lake, South Sand Branch, and Chatham Lake dams). Compaction was achieved in the earth material surrounding the pipe prior to placing the pipe. Each pipe was installed on a yielding foundation that can move with the normal settlement of the dam embankment. The pipe materials used at the three dams include Ductile Iron (DIP), High Density Polyethylene (HDPE) and reinforced concrete pipe (RCP). A fourth dam is currently under construction using this technique. This method may be considered as an alternative installation method where conditions and construction methods are appropriate.

Geographic interest: West Virginia

Subject terms: conduits, embankment dams, design, construction, case studies

Newhouse, Scott G. *Can you build a dam on a permeable foundation?* Journal of Dam Safety - Fall 2005 (V. 3 N. 3)

This article presents the case of an earth dam in the southeast US built on a permeable foundation. The article presents interesting aspects of design, construction, first-filling, and the dam's performance in service. Early in first filling, before the lake was even half full, the dam showed significant seepage. Construction of dams on permeable soils is often necessary, and, therefore, relatively common. Avoiding seepage- related problems generally depends upon the engineer recognizing a permeable foundation and designing the dam accordingly. The dam's behavior-- good or bad- -depends on the measures taken to accommodate seepage. A dam's behavior depends on the permeability in the foundation, and measures such as a seepage cut-off and filter/-drain protection. Higher foundation permeability generally means higher potential for problems at the downstream toe. This article presents a case history supporting and illustrating this contention, and examines other dams where design did and did not accommodate permeable foundation conditions.

Subject terms: foundations, design, construction, seepage, case studies, failures, incidents, geotechnical investigations, piping

Larson, Eric, Wilkes, John and Dreese, Trent. *Geomembrane Installation at Salt Springs CFRD Dam.* Journal of Dam Safety - Winter 2006 (V. 4 N. 1)

Salt Springs Dam, owned by Pacific Gas & Electric Co. (PG&E) is the fifth oldest Concrete Faced Rockfill Dam (CFRD) in the world and the first CFRD to reach 328 ft. (100 m) in height. It is located in California, south and east of Sacramento, high in the Sierra Nevada Mountain Range. In the 1930s, construction of the dam was halted at about mid-height due to winter weather. When rock placement resumed in the spring, the lift height was reduced and sluicing techniques were improved to gain better consolidation. These changes created a zone of differential settlement in the dam where the concrete face has required continual repairs over its 70+ year history. In 2001, seepage in this zone increased significantly, exceeding the limit set by the California Department of Water Resources, Division of Safety of Dams. Immediately, and at considerable expense, PG&E hired divers to make temporary repairs as it began to investigate how to permanently fix the upstream face at Salt Springs Dam. The conclusion was to install a PVC geomembrane system over the upstream face with the goal of reducing seepage to 12 cfs (340 l/s). The work was done in two phases. In the spring of 2004, Phase I repairs began with the installation of the CARPI geomembrane system over the center of the face in the so called “transition zone” to mitigate the risk of significant seepage increases, as occurred in 2001.

Geographic interest: California

Subject terms: rockfill dams, concrete, design, construction, temperature, seepage, rehabilitation, underwater investigations, seepage analysis, geosynthetics

Swaisgood, James R., Montgomery, Dr. Jerry and Kofoed, Val O., P.E. *Mapping Seepage through the River Reservoir Dam No. 3.* Journal of Dam Safety - Winter 2006 (V. 4 N. 1)

The first step in addressing a problem with seepage is pinpointing its source. In the past, procedures for determining the exact location and nature of seepage flows have been both costly and time consuming. The approach to an emergency situation at River Reservoir No. 3, an arched earthen structure on the headwaters of the Little Colorado River, proves that a combination of sound engineering consulting and modern technologies can save time and money in response to emergencies.

Geographic interest: Arizona

Subject terms: seepage, embankment dams, geophysical investigations, emergency management, rehabilitation, financial aspects, design, construction

Toms, Ed, Poulter, Don, Samandi, Sam and Yonikas, Pat. *Overholser Dam-Ambursen Structure Rehabilitation.* Journal of Dam Safety - Winter 2006 (V. 4 N. 1)

Overholser Dam is a 125-foot-high (38.1m), 1,200-foot-long (366m) Ambursen structure constructed in 1916 used for flood control and water supply for Oklahoma City. Safety issues discovered during routine inspection of the spillway section included: 1) buttress wall continuous cracks, 2) foundation seepage, 3) upstream shell seepage, 4) excessive upstream shell sediment loading, and 5) concrete deterioration. Issues complicating project design and construction included: 1) methods for dewatering the face of the dam to minimize impacts to the City’s water supply, 2) increased water supply treatment costs due to diminished water quality directly related to the lower reservoir level, 3) construction scheduling to minimize water supply and potential flooding impacts, 4) construction methods to enable competitive bids from local contractors, 5) local, state, and federal environmental regulatory requirements to protect wetlands and aquatic habitats, and 6) preserving the historical aesthetics of the structure.

Geographic interest: Oklahoma

Subject terms: concrete dams, cracking, foundations, seepage, concrete, design, construction, dewatering, environment, historical interest, regulations

Bingham, William B., Kelly, Thomas A. and Sorrell, Susan A. *The ASDSO Peer Review Program.* Journal of Dam Safety - Spring 2006 (V. 4 N. 2)

In the mid-1980's, many administrators of state dam safety programs were looking for ways to improve the effectiveness of their programs, and raise awareness of these programs within the context of their larger state departments. At the time, state dam safety program budgets were facing severe competition for scarce state dollars. Many dam safety program administrators believed that a rigorous method of assessing and validating the effectiveness of their policies and practices, if performed by an outside entity, would help accomplish three objectives: (1) Improve their programs; (2) Raise the level of awareness and respect for the dam safety program among budget decision-makers, and (3) Help develop stronger legislative authority. Through the cooperative efforts of ASDSO and the Interagency Committee on Dam Safety, a committee of six individuals from state dam safety programs, electric utilities, and engineering firms developed a program to assist the state dam safety regulators in achieving these objectives. The resulting program (including a manual to document the process) was presented to ASDSO for adoption. The ASDSO Board of Directors adopted the proposed "Peer Review Program," and sought volunteer states to test it. In the summer of 1990, the states of New Mexico, Tennessee, and Wisconsin signed up for peer reviews. Based on the success of the reviews in these three states, ASDSO began offering peer reviews as a regular service to states in 1992. Since 1990, ASDSO has completed peer reviews in 25 states and Puerto Rico. Six of these states have undergone the review process twice, which further validated their progress and the value of the program.

Geographic interest: U.S.

Subject terms: state programs, federal programs, training programs, standards, permits, maintenance, construction, guidelines, public awareness, emergency management

McCann, Martin W. *National Performance of Dams Program: An Archive of Dam Information and Experience.* Journal of Dam Safety - Spring 2006 (V. 4 N. 2)

The NPDP, founded in 1994 and located at Stanford University, is devoted to the collection of current and historical information on the performance of dams for the purpose of supporting dam engineering and safety. The archive, coupled with an ongoing evaluation of dam performance data, provides a national capability to monitor the state of the nation's dams, contributes to the advancement of dam engineering, and supports effective dam safety policy.

Geographic interest: U.S.

Subject terms: research, failure analysis, failures, incidents, inspection, historical interest, gates, case studies, federal programs

Noble, Richard M., Dixon, Eric R. and Gerhart, Phil C. *Piute Dam rehabilitation project.* Journal of Dam Safety - Spring 2006 (V. 4 N. 2)

Piute Dam rehabilitation is the largest dam modification project completed to date under jurisdiction of the State of Utah Dam Safety program regulations. The project was the ASDSO 2005 National Rehabilitation Project of the Year. The dam located near Marysvale, Utah is owned and operated by the Piute Reservoir & Irrigation Company (PR&IC), of Richfield, Utah. Construction of the dam was initiated in 1908 as a combination rolled earth and hydraulic fill structure. Extensive analysis by various organizations over the past 25-plus years determined that Piute Dam did not meet current dam safety standards. The following

problems had been previously identified:
--The toe drain system-consisting of a rock drain and wood stave pipes designed to intercept water seeping through the dam embankment and foundation-did not appear to meet critical filter criteria. Additionally, there was no chimney drain in the embankment.
--The spillway could pass only 32 percent of the inflow design flood of 106,000 cu ft/s (3,000 m3/s) without overtopping the dam.
--The existing outlet guard gate system was inoperable; the gates were stuck in the open position and the trash rack had been severely damaged by a rockslide. Also, the control gate structure was determined to be unstable under seismic events.
--The steep embankment upstream slope also raised concerns regarding rapid drawdown and potential liquefaction of soil materials during a seismic event.
In 1992 PR&IC contracted with Franson Noble Engineering, of American Fork, Utah, to bring the dam into compliance with current dam safety standards. Gerhart Consultants, Inc., of Springville, Utah, was Franson Noble's chief geotechnical subconsultant throughout the design and construction of the project. The construction portion was completed in two phases from 2002 through 2005 at a total project cost of $8.3 million. The unique and innovative engineering designs adopted for this project are estimated to have saved as much as $6 million compared to more conventional designs and construction methods.

Geographic interest: Utah

Subject terms: rehabilitation, design, construction, case studies, spillway capacity, spillways, drainage systems, gates, drawdown, seismic analysis, slope stability

Bellisle, J. Matthew. *Emergency Response at the Whittenton Mill Dam.* Journal of Dam Safety - Summer 2006 (V. 4 N. 3)

Between October 16 and October 23, 2005, Pare Engineering Corporation in cooperation with the Massachusetts Department of Conservation and Recreation Office of Dam Safety, local emergency response personnel, and federal agencies, worked with the owners of a 173-year old timber dam to address significant concerns that had developed as a result of an unusual weather pattern that produced up to 16 inches of rain within the Massachusetts area. This storm system produced 7 days of precipitation that culminated with more than 8-inches of rain falling within a 30-hour period of time. The responders worked with the dam owner to initiate emergency measures necessary to prevent a potential breach of the dam.

Geographic interest: Massachusetts

Subject terms: failures, incidents, public safety, emergency management, temporary structures, design, construction, hydrology, timbercrib dams

Kannik, Mia. *Emergency Response at Salt Fork Lake Dam.* Journal of Dam Safety - Summer 2006 (V. 4 N. 3)

On February 15, 2005, a large seepage boil was discovered at the downstream toe of the 61-foot-high state-owned Salt Fork Lake Dam, in Salt Fork State Park. The boil was 4 feet in diameter and 18 to 24 inches deep. It was located 8 feet downstream of the toe of the dam and about 75 feet to the right of the original stream channel. The location was very close to the location of Boring B-5 installed during the USACOE Phase II investigation performed by BBC&M Engineering in 1980. The flow measured about 50 gallons per minute. During emergency operations, a second boil - about 6 inches in diameter and 18 inches deep - was discovered. The flow measured about 3 gallons per minute. Ohio Dam Safety Program staff instructed the Park staff that the situation was very serious and that regular monitoring of the dam and boil must be performed through the night. By the next afternoon, the flow had increased to about 130 gallons per minute. Twenty-four hour surveillance was initiated. One of the most potentially serious dam safety emergencies in DSEP history was underway.

Geographic interest: Ohio

Subject terms: emergency management, geology, design, embankment dams, monitoring, dambreak analysis, computer programs, flood analysis, mapping, filters, construction, outlet works, training programs, inspection, seepage

Spencer, William D. *Relief drain hole cleaning and dam safety.* Journal of Dam Safety - Summer 2006 (V. 4 N. 3)

Although often neglected, drain hole cleaning is a necessary maintenance item for the prevention of excessive hydrostatic uplift pressure build-up under a concrete gravity dam. Uplift in the form of hydrostatic forces, acting within a dam and its foundation, is a potential source of dam failure. In many concrete gravity dams, uplift pressure reduction is accomplished by a line of cored, vertical holes that extend into the bedrock along the drainage gallery of the dam. However, where dams are founded on carbonate bedrock, the carbonates tend to precipitate sediment that can fill the drain hole, or crystallize and completely bridge the drain hole even within generally high flow zones. If not addressed, the resulting reduction in the effectiveness of the drain holes can permit an increase in the hydrostatic uplift pressures beneath the dam, thereby reducing the factor of safety of the concrete structure. The high costs associated with the cleaning process, and the lack of a quantitative method for evaluating the effectiveness of the cleaning processes, have caused many dam owners to put off the process year after year, until the effectiveness of the drains may be highly impaired. Since the year 2000, several methods have been quantitatively evaluated by the author in an effort to identify a viable drain hole cleaning system. The effectiveness of the cleaning processes has been determined through programs of pre- and post-testing that have been customized for each dam and its unique drainage system. Through the evaluation process, improved techniques for drain hole cleaning have been developed.

Subject terms: drainage systems, maintenance, concrete dams, financial aspects, ownership

Shewbridge, Scott, Costa, Ray Jr., Sills, George and Hess, John R. *The evolving approach to levees in California.* Journal of Dam Safety - Fall 2006 (V. 4 N. 4)

Some of the most expensive and populated land in California's Central Valley is protected by agricultural levees that are over 100 years old. Over the last 20 years, the US Army Corps of Engineers has undertaken numerous projects to mitigate this threat, but post-construction performance in some areas indicated that only part of the seepage and stability problems were mitigated. A Blue-Ribbon Task Force was convened and determined that new analytical and design approaches were necessary. This article describes the evolution of levee investigations, evaluations, design, construction, and performance in California, including mitigation for through seepage and underseepage. The article then reviews a number of converging influences affecting technical and policy changes, including Hurricane Katrina, lawsuits, legislation, shifting societal expectations, and FEMA's updated policies instituted for the Flood Insurance Rating Map Modernization project. Flood control for the California Central Valley is a critical infrastructure concern for the State and Nation. It is provided by an interconnected system of dams, weirs, bypasses, and most importantly, earthen levees, some of which are over 100 years old. Many of these levees were built either by farmers with light equipment using local, uncompacted, clean river sands and little to no foundation preparation or clamshell dredges that excavated river/slough materials by the bucket load. At the time, occasional failures were expected, but what were once areas of croplands are now growing cities, industrial areas, and suburbs. Today, a major flood and levee failure in the Sacramento area alone would put at risk over 400,000 people, 170,000 structures, 117 schools, and potential for damage estimated at 7 to 15 billion dollars. The flood control facilities, including the levees, are cooperatively managed by a number of agencies, including the California Department of Water Resources, the California State Reclamation Board, local levee and flood control districts, and the Sacramento District of the USACE. This article describes the problems encountered by these agencies and the experiences and lessons learned in upgrading agricultural levees to provide protection for intensively developed urban, industrial, and suburban areas. It then looks at the convergence of a number of different factors

forcing evolution of our society's approach to levees.

Geographic interest: California

Subject terms: levees, legislation, public awareness, public safety, insurance, federal programs, floods, development, floodplain management, legal aspects, social aspects, policy, partnerships, Risk assessment

Talbot, James R. and Pabst, Mark. *Filters for earth dams.* Journal of Dam Safety - Fall 2006 (V. 4 N. 4)

Between 1980 and 1985, the Soil Conservation Service, now known as the Natural Resources Conservation Service, performed an extensive study to determine appropriate gradation criteria for sand filters to be used for filter/drainage zones in embankment dams. The study was performed at the NRCS Soil Mechanics Laboratory in Lincoln, Nebraska with the assistance of the late James L. Sherard, eminent earth dam consultant. The study included a large number of tests simulating cracks or other anomalies in dams with the potential for developing concentrated leaks under high water pressure. Filters with varying gradations were placed downstream of a simulated core material containing simulated cracks to determine the gradation necessary to prevent movement of base materials through the filter and to provide a self-healing condition. A large variety of materials were used to simulate the base soil of the dam upstream of the filter/drainage zone. Specific testing was performed to verify the properties of the filter that determine its ability to prevent the base or protected soil from passing through it for use in designing filter gradations. These properties included the ratio of particle size at 15 percent passing of the filter to the particle size at 85 percent passing of the base soil, uniformity of the filter gradation, and other factors influencing segregation, permeability, and grading of the filter. Since the NRCS study, the US Army Corps of Engineers and the Bureau of Reclamation have revised their guidance for filter design. Their guidance generally conforms to the findings of the NRCS study. With further experience, both the USACE and Reclamation have modified their guidance and added important useful information about placement and construction techniques.

Geographic interest: U.S.

Subject terms: filters, embankment dams, drainage systems, research, guidelines, federal programs, design, standards, geotechnical investigations

Ward, Craig F. and Levergood, Grace. *Downhole seismic method for estimating structure depth.* Journal of Dam Safety - Fall 2006 (V. 4 N. 4)

One of the challenges facing dam engineers in conducting safety evaluations and design of remedial improvements for existing dams with soil foundations is estimating the bearing depths of concrete or stone masonry structures with soil foundations. Often, no design or as-built drawings are available showing the depths of existing structures within a dam. For these cases, the elevations of the bottoms of existing cutoff walls, spillway structures, and retaining walls must be estimated for use in stability and seepage analyses. The determination of structure depth using conventional explorations, such as drilling through a structure or excavating test pits, is often not practical. Core drilling through a concrete structure is expensive and time consuming, and can weaken the structure. Excavation of test pits to determine structure depth can only be performed for small dams with relatively shallow structures. Also, it is usually necessary to drain the impoundment prior to test pit excavation. The authors used a less intrusive means for estimating structure depth with a down-hole seismic method. Vibrations induced by striking the concrete structure are measured using a geophone at various depth intervals in a cased borehole drilled adjacent to the structure. This method was adapted from one used more commonly for determining the depth of steel sheet piling in soil; however, because the contrast in compression wave velocity between concrete and soil is not as pronounced as it is between steel and soil, interpretation of the data to determine the depth of a concrete structure requires the development of a wave front model.

Geographic interest: New Hampshire

Subject terms: seismic analysis, foundations, geotechnical investigations, testing, case studies, embankment dams, design, rehabilitation, construction

Holderbaum, Rodney E., Warren, Gordon W. and Roarabaugh, Donald P. *Designing and Constructing Spillway and Stability Improvements for Loch Raven Dam.* Journal of Dam Safety - Winter 2007 (V. 5 N. 1)

Loch Raven Dam, located just north of Baltimore, Maryland, is a 100-foot high, 650-foot long concrete gravity dam with an ungated 288-foot wide spillway. The 93-year-old structure impounds Loch Raven Reservoir, a primary water supply source owned and operated by the City of Baltimore. The dam has undergone several modifications during its life; however, the structural height and configuration remained unchanged from 1922 until 2002 when the current modifications were initiated. Inadequacies regarding safety of the dam were first noted in the Phase I inspection report prepared in 1978. During the 1980s and 1990s, additional inspections and investigations were performed to evaluate the extent of the safety deficiencies, which consisted primarily of inadequate spillway capacity and structural stability. The studies ultimately led to preparation of final design documents and construction of a $30 million rehabilitation project. Construction began in 2002 and was completed in mid-2005.

A key requirement faced during design and construction was the need to maintain a full pool throughout the project. This constraint combined with the runoff from a 300 square mile drainage area significantly impacted design and construction of the dam rehabilitation. Two key features of the selected rehabilitation measures were installation of high-capacity post-tensioned anchors and placement of approximately 60,000 cubic yards of roller-compacted concrete. The anchors served primarily to stabilize the structure during excavation, while the RCC was used to raise the non-overflow sections and provide a permanent buttress to improve stability. Other key aspects of the project included sequencing construction to maintain flow on half of the spillway at all times, performing large-scale construction activities including supplying two concrete plants with very limited staging and working areas, and maintaining public relations during the 3-year construction duration with the project embedded in a suburban location.

Geographic interest: Maryland

Subject terms: concrete dams, gravity dams, rehabilitation, roller-compacted concrete, anchoring, design, construction, financial aspects, spillway capacity, stability analysis, social aspects, public awareness, concrete

McCook, Danny K. *A Discussion of Uplift Computations for Embankments and Levees.* Journal of Dam Safety - Winter 2007 (V. 5 N. 1)

This paper discusses the two idealized foundation conditions most commonly analyzed for stability against excessive seepage and uplift pressures using simplified models. It discusses acceptable safety factors as defined by the total stress and effective stress method of computing safety factors. Readers are cautioned that simplified models seldom accurately model the complexity of natural horizons. These simplified models are most useful for determining the relative value of alternative designs and for screening type examinations. This article is a condensed version of a paper presented at the Western Regional ASDSO meeting in Kansas City in 2006.

Subject terms: foundations, seepage, stability analysis, models, geotechnical investigations

Norris, Barry F. and Falk, John A. *Summary Report and Lessons Learned Catastrophic Lagoon Failure Near Hermiston, Oregon.* Journal of Dam Safety - Winter 2007 (V. 5 N. 1)

On Tuesday afternoon, April 26, 2005 an off-channel wastewater reservoir located 5 miles (8 km) southwest of Hermiston, Oregon failed catastrophically resulting in the sudden and uncontrolled release of approximately 95 million gallons of water (360,000 M3). Impacts to downstream property included the breach of an existing flowing canal resulting in the loss of irrigation water, closure of a state highway due to undercutting of pavement, water/mud damage to farm houses and outbuildings, and destruction of planted crops and agricultural lands. Fortunately, no injuries or loss of life occurred as a result of the failure. The results from laboratory analysis of the discharge waters indicated that additional evacuation or other special health precautions were not required.

Geographic interest: Oregon

Subject terms: failures, incidents, floods, failure analysis, failure modes, embankment dams, geotechnical investigations, geosynthetics

Charlton, John E. and Adkins, H. Grady. *RCC foundation preparation: how much is enough?* Journal of Dam Safety - Spring 2007 (V. 5 N. 2)

The condition of a rock foundation that is acceptable for roller compacted concrete (RCC) placement is influenced by a number of factors that vary from one site to another. Geologic conditions and dam site limitations are significant factors in RCC foundation preparation. In this paper, the influence of, and the methods for dealing with these factors are discussed.

Subject terms: roller-compacted concrete, concrete, design, construction, geology, site preparation, foundations

Cooper, Chuck R. *Conduits through embankment dams.* Journal of Dam Safety - Spring 2007 (V. 5 N. 2)

A technical manual titled Conduits through Embankment Dams -- Best Practices for Design, Construction, Problem Identification and Evaluation, Inspection, Maintenance, Renovation, and Repair (FEMA 484) was recently published by the Federal Emergency Management Agency with support from the National Dam Safety Program. The manual was developed by representatives from the Association of State Dam Safety Officials, U.S. Department of the Interior's Bureau of Reclamation, Federal Energy Regulatory Commission, Natural Resources Conservation Service, and the U.S. Army Corps of Engineers. The manual condenses and summarizes the vast body of existing information, provides a clear and concise synopsis of this information, and presents a recommended course of action. The manual is intended for use by personnel familiar with embankment dams and conduits, such as designers, inspectors, construction oversight personnel, and dam safety engineers. The free manual is available in print copy (FEMA 484), CD-ROM (FEMA 484CD), and DVD (FEMA 484DVD) and contains more than 280 illustrative figures, 34 cases histories, and an in-depth glossary. The CD-ROM and DVD have built-in Adobe Acrobat Reader software, hyperlink, and search capabilities. The CD-ROM and DVD also contain PDF copies of all references cited within the manual that were available in the public domain or where reprint permission was obtained. In addition, the DVD has a collection of more than 150 "additional reading" references in PDF format. These references are included to assist the user in furthering their understanding of conduits and embankments dams. Copies of the manual may be obtained by calling FEMA's Publication Distribution Center at 1-800-480-2520. The author served as chairman of the multi-agency national committee responsible for developing this technical manual. Highlights from the technical manual are presented in this paper.

Geographic Interest: U.S.

Subject terms: roller-compacted concrete, concrete, design, construction, geology, site preparation, foundations

Halpin, Eric C. and Ferguson, Keith A. *US Army Corps of Engineers dam safety: Program status and lessons in transitioning to risk informed approaches.* Journal of Dam Safety - Spring 2007 (V. 5 N. 2)

USACE is working to incorporate risk concepts into dam safety management, routine activities, and programming decisions. A number of initiatives are ongoing to achieve this objective. These include developing new policy based on risk concepts, a new more detailed methodology, and a plan to communicate these strategies. The total program of incorporating risk into the USACE Dam Safety Program is being accomplished in three phases: (I) Screening for Portfolio Risk Analysis (SPRA); (II) Portfolio Risk Assessment methodology (PRA); and (III) Site Specific Risk Assessments.

Geographic interest: U.S.

Subject terms: federal programs, risk assessment, decision-making, public safety

Britton, Jeremy P. , Talbot, James R. and Walberg, Francke C. *The Seepage Problem and Remediation at Fern Ridge Dam.* Journal of Dam Safety - Summer 2007 (V. 5 N. 3)

Fern Ridge Dam, near Eugene, Oregon, was constructed in 1940, the first of thirteen earth dams in the Portland District of the U.S. Army Corps of Engineers. The embankment dam is over 60 years old and was built without the benefit of modern filter criteria. There were indications that the existing filter was too coarse and that the corrugated metal drainpipe may have been deteriorating. From 2002 to 2004, a series of observations and investigations of seepage conditions indicated that internal erosion (piping) into the dam's drainage system was occurring. In addition to turbid flows during rain events, silts and sands were observed in seepage flow during sustained pool levels with no rain. The worst-case scenario was that erosion of the foundation could lead to either a piping failure or clogging of the drain. With the dam in an active state of piping failure, a pool restriction with monitoring was implemented. In February 2005, the Corps decided to start an expedited repair of the dam's drainage system in order to return the project to full operation by the following fall. Preparation of plans and specifications began immediately and the dam was repaired and fully operational by November 2005. This paper describes the observations and investigations leading to the repair, the decision to repair the dam, the repair itself, the evidence of erosion found during the repair, and the post-repair performance to date. The case history may be useful to engineers and dam owners facing difficult repair decisions.

Geographic interest: Oregon

Subject terms: case studies, seepage, rehabilitation, drainage systems, piping, monitoring, federal programs, embankment dams, decision-making, filters

Nance, David. *Dams on the Arch: Paleokarst, An Often Under Evaluated Geohazard Associated With the Cincinnati Arch.* Journal of Dam Safety - Summer 2007 (V. 5 N. 3)

Many existing reservoirs are located in areas where karst or karstic conditions are known to exist. Some are located in areas where karstic conditions may exist but have not yet been identified or found to be problematic to the dam and outlet works. In the past, karstic conditions in the bedrock were often not identified as a potential issue during the design or during construction. This is especially true when the karstic conditions have been altered and buried by glacial action, as is the case for the region associated with the Cincinnati Arch. As we undertake the process of reevaluating reservoirs, dams, and outlet works for extended use we will need to reconsider the foundation conditions. At many sites, it will be important to note that the most problematic paleokarst conditions may exist in the bedrock associated with the walls of the valley rather than the valley floor. In addition, seepage prevention will be very problematic, and "seepage management" will become the best option. In many cases, extended use will require modification to outlet works, embankments, and in some situations sediment removal. If the potential for karstic conditions in the foundation is recognized during the reevaluation, modifications can be designed to not only avoid causing a problem to develop, but possibly identify and manage karstic seepage, or

decrease the risk associated with potentially karstic foundations for the structure and reservoir.

Geographic interest: Indiana

Subject terms: geology, foundations, seepage, design, construction, grouting

Stoessel, John and Wilkes, John. *Sabrina Lake Dam Geomembrane System Replaces 100 Year Old Redwood Membrane.* Journal of Dam Safety - Summer 2007 (V. 5 N. 3)

Remediation of Sabrina Lake Dam, a 70-foot (21.4 m) high, 900-foot long timber-faced rockfill dam.

Geographic interest: Oregon

Subject terms: case studies, seepage, rehabilitation, timbercrib dams, rockfill dams, financial aspects, design, construction, geosynthetics

Abdo, Fares Y. and Adaska, Wayne S. *Performance Review of RCC Spillways and Overtopping Protection.* Journal of Dam Safety - Fall 2007 (V. 5 N. 4)

Roller-compacted concrete (RCC) has become a popular method for providing spillway and overtopping protection for earthen dams. Over the past 27 years, RCC has been used for spillway or overtopping protection on more than 130 dams. In addition to providing protection from erosive forces of flowing water, several of these projects are located in areas exposed to numerous freeze-thaw cycles. For less than the 500-year flood event, RCC spillways and overtopping protection projects can serve as principal spillways; however, most RCC overtopping protection structures are emergency spillways designed to operate at a frequency not exceeding the 100-year storm. RCC is popular with designers and owners for its simplicity, speed of construction, strength and durability, and economic advantages over alternative methods. Because RCC emergency spillway and overtopping protection projects are designed to operate infrequently during major flood events, limited information is available on the actual performance of these types of structures. However, RCC projects that have been put to the test performed satisfactorily, with no evidence of excessive wear or structural distress. Several research projects have confirmed the excellent abrasion resistance and durability of RCC. Comparative tests on soil-cement, RCC and conventional concrete showed RCC to have a greater abrasion resistance than conventional concrete of higher strength. This was primarily due to the presence of a larger percentage of aggregate and less paste in the RCC mixture. In underwater abrasion tests using ASTM C1138, it was determined that abrasion resistance was a function of both the aggregate hardness and the strength of the paste. Despite the research findings, there is still the need to evaluate the reliability and performance of RCC under actual field conditions when subjected to debris-laden flows and hydraulic forces. The article includes examples of projects that have experienced multiple flows during their service lives.

Subject terms: research, roller-compacted concrete, design, RCC, concrete, overtopping, spillways, erosion, embankment dams, case studies

Capone, Edward J. *The National Weather Service Forecast Responsibility on the Nation's Rivers.* Journal of Dam Safety - Fall 2007 (V. 5 N. 4)

Throughout the history of the U.S., certain events have provided a catalyst for the development of today's Hydrologic Services Program (HSP). The HSP has expanded into 13 separate River Forecast Centers offices within the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS). The mission of these river forecast centers is to save lives and decrease property damage by the issuance of flood warnings and river stage forecasts, to provide basic hydrologic forecast information for the Nation's economic well being and to provide extended forecast information for water resources management. This article summarizes the history and work of the HSP.

Geographic interest: U.S.

Subject terms: federal programs, hydrology, historical interest, flood forecasting, floods, warning systems, operation

Levergood, Grace and Bjarngard, Anders. *New Hampshire's Innovative Approach to Dam Removals.* Journal of Dam Safety - Fall 2007 (V. 5 N. 4)

The Champlin Pond Dam and Champlin Farm Pond Dam were constructed in Rochester, New Hampshire by a private owner for recreational purposes in 1955 and 1967, respectively. The New Hampshire Department of Environmental Services (DES) Dam Bureau had classified both structures as low hazard dams. A breach of either dam would cause damage to downstream roads. Regular dam safety inspections had identified numerous deficiencies which the dam owner had failed to address. The City of Rochester and the Society for Protection of the New Hampshire Forest Society were interested in obtaining the property but not interested in taking on the liability for the two earth dams which were both in poor condition. In 2005, the New Hampshire Department of Transportation Bureau of Aeronautics was expanding the adjacent Skyhaven Airport and was required to mitigate wetland impacts. Through some creative inter-agency discussions championed by the City of Rochester and the implementation of new compensatory mitigation DES Wetlands rules, the removal of both dams and transfer of adjacent property was used as mitigation for airport expansion impacts. The dam removals were added to the airport expansion project and the transfer of the 184 acre (74.5 ha) parcel to conservation status was made possible. The Champlin Dam was initially to be repaired while the Champlin Farm Pond Dam, approximately 2,000 feet (56.6 m) downstream, was to be removed. However, test borings revealed weak embankment and foundation soils at Champlin Pond Dam, making any potential repair of that structure more complicated and expensive;, thus partial breaching was selected. The dam removal and partial dam breach included the use of bioengineered and on-site materials for channel restoration and stabilization. The measures included stone and log weirs, coir logs, boulder clusters, and planting of live stakes and wetland seed mix. During construction, real-time design modifications were implemented as the dynamic process of dam breaching and channel restoration was occurring. The project alleviated dam safety concerns, enabled the transfer of land to conservation purposes, and restored the stream channel to a natural and stable condition. Lessons learned are summarized at the end of the paper.

Geographic interest: New Hampshire

Subject terms: removal, case studies, state programs, legal aspects, decision-making, environment, design, construction, weirs, partnerships, rehabilitation

Schultz, Mark , Huynh, Phu and Jones, Shawn. *Summary of California Division of Safety of Dams' Tainter Gate Reevaluation Program.* Journal of Dam Safety - Fall 2007 (V. 5 N. 4)

The State of California, Department of Water Resources, Division of Safety of Dams (DSOD) regulates approximately 1,250 non-federal dams of all types and sizes. Many of these dams are considered to have a high hazard potential due to their size and proximity to major population centers. Additionally, many of these dams are located near faults capable of generating major earthquakes. By necessity, DSOD performs a large number of both linear and nonlinear dynamic analyses of all types of dams and appurtenant structures using site-specific ground motions. Of the 1,250 dams that fall under DSOD jurisdiction, 206 (17%) are also regulated by the Federal Energy Regulatory Commission (FERC). The tainter gate failure of Gate 3 at Folsom Dam on July 17, 1995 resulted in long-term wide-ranging ramifications for dam safety in California. Folsom Dam is a 340-foot high (104 m) concrete gravity dam, located on the American River just upstream of Sacramento, California. It was designed and built by the U.S. Army Corps of Engineers (USACE) in the early 1950s, but is owned and operated by the U.S. Bureau of Reclamation (BOR). Folsom Dam is a federal facility, and therefore not under state jurisdiction; however, DSOD played an active role in investigating the gate failure. Then Chief of DSOD, Vernon H. Persson, S.E., G.E., was a member of the forensic team formed to investigate the cause of failure. The

forensic team attributed the primary cause of failure to brace failure leading to strut buckling due to weak-axis bending induced by trunnion friction during lifting of the gate. Ineffective lubrication of the unusually large diameter trunnion pins also played a role. Trunnion friction was not normally accounted for in early gate designs, and was based on a relatively low coefficient of friction (typically 0.1) when it was included. Following the gate failure, DSOD directed dam owners under state jurisdiction to fully inspect, investigate and evaluate the structural integrity of all tainter gates under all phases of planned operation. FERC, in coordination with state dam safety officials, launched a similar reevaluation effort on a nationwide scale. The USACE and BOR also embarked on reevaluations of tainter gates in their inventories.

Geographic interest: California

Subject terms: gates, inspection, state programs, failure analysis, case studies, concrete dams, gravity dams, federal programs, incidents, historical interest

Amos, Peter D , Bruce, Donald A. , Lucchi, Marco, Watkins, Neil and Wharmby, Nick. *Design and construction of seepage cut-off walls under a concrete dam with a full reservoir.* Journal of Dam Safety - 03/2008 (V. 6 N. 1)

A series of foundation leakage events have occurred at Arapuni Dam in New Zealand from the time water was first impounded in 1927. Past foundation leakage incidents at the 64m (210ft) high curved concrete gravity dam were related to erosion and piping of weak clay infilling joints within the volcanic ignimbrite foundation bedrock. Seepage changes often involved sudden and significant increases, and could not usually be related to external events, such as earthquakes. The most recent seepage incident developed from 1995 and required grouting (completed in December 2001) to fill an open void within a foundation joint. This grouting program successfully controlled the deteriorating condition. With the deteriorating condition arrested, the owner of the dam, Mighty River Power Ltd., decided that a high quality and verifiable cut-off solution was to be constructed while the reservoir remained in service. A comprehensive investigation program was completed to determine the extent of foundation features requiring treatment to prevent further incidents from developing. Four zones beneath the dam were identified as requiring permanent cut-off walls. An international Alliance between the dam owner (assisted by their designer) and a consortium of specialist foundation contractors was formed to identify cut-off options, develop them and implement the selected methodology. A cost-effective preferred approach was selected involving drilling and concreting overlapping vertical piles from the dam crest through the dam and underlying rock formation. The overlapping piles extend to a total depth of 90m (295ft) to form four separate cut-off walls. Construction of the cut-off walls commenced in September 2005 and was completed in September 2007. Operation of the reservoir was not affected and electricity generation continued throughout the project works. The project successfully formed a robust and verifiable cut-off wall remediation. With few precedents for this type of work, and none constructed in weak rock or to 90m (295ft) depth, the Arapuni Dam seepage cut-off project significantly

Geographic interest: New Zealand

Subject terms: seepage, foundations, geology, case studies, hydropower, operation, reservoirs

Durst, Sherry Ann, Pacheco, Elaine C. and Haynes, Mark B. *Time for a change - or two: Updating Rules and Regulations.* Journal of Dam Safety - 03/2008 (V. 6 N. 1)

New Mexico, Colorado, and Kansas have recently revised their respective Rules and Regulations pertaining to the permitting, construction, maintenance, restoration, and rehabilitation of new and existing dams. Everyone included in the changes walked through fire, sat through countless meetings - more meetings than should be required of any person in a lifetime, and reviewed and suggested changes until the mere thought of another revision had the ability to reduce one to tears. Change is costly. Change is good. Change is a must. It's worth the time and effort to get it done. Article in three parts:
1) Kansas Dam Safety: Upgrading the Rules, Tightening the Regulations, by Sherry Ann Durst, P.E.,

Water Structures Engineer, Kansas Dam Safety Team
2) New Mexico Dam Safety: There's New Regulations in Town, by Elaine C. Pacheco, P.E., Dam Safety Bureau Chief
3) Colorado Safety of Dams Program: Process of Revising the Rules and Regulations, by Mark Haynes, P.E., Chief, Safety of Dams Program

Geographic interest: Colorado, Kansas, New Mexico

Subject terms: regulations, state programs, financial aspects, rehabilitation, design

Frank, Andrew. *Emergency response at Lake Needwood Dam: An owner's perspective following a severe event.* Journal of Dam Safety - 03/2008 (V. 6 N. 1)

This paper provides a personal account of the emergency at Lake Needwood Dam, in Montgomery County, Maryland. In June 2006, discovery of uncontrolled seepage through the dam required activation of the project's Emergency Action Plan (EAP) while efforts were undertaken to control the seepage. Following a brief description of the event, the paper presents results of a post-event review of the EAP and the owner's project management program and resulting improvements to both.

Geographic interest: Maryland

Subject terms: seepage, emergency action plan, emergency management, ownership, embankment dams, case studies , EAPs

Hunt, Sherry L., Reep, Dennis W. and Kadavy, Kern C. *RCC Stepped Spillway for Renwick Dam - A Partnership in Research and Design.* Journal of Dam Safety - 06/2008 (V. 6 N. 2)

The Small Watershed Program of the USDA Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service) originated in the 1940s with the passage of the Flood Control Act of 1944 (PL 78-534). This statute was soon followed by the passage of the 1952 Appropriations Act that authorized the Pilot Watershed Program in 1953 and 1954, which paved the road to the Watershed Protection and Flood Prevention Act of 1954 (PL 83-566). These three federal authorizations have given the NRCS the authority to provide technical and financial assistance for the construction of nearly 11,000 embankment dams across the U.S. The construction peak for these structures occurred during the 1960s with many structures initially designed to protect agricultural land. Many years of development have led to changes in hazard classification of many structures. Increased urbanization upstream and downstream of the structure and in the immediate vicinity of the embankments have caused many spillways to no longer meet hydrologic criteria. To meet dam safety standards, some of these structures are in need of immediate attention. Altering the dimensions of the existing spillway(s) to increase spillway capacity is often limited by the landscape and/or unobtainable land rights. These constraints have led design engineers to select roller compacted concrete (RCC) stepped spillways as a design alternative to increase spillway capacity. These may often be placed over existing embankments thereby having minimal impact on the surrounding area. Nearly 10% of NRCS structures are expected to use stepped spillways as a design solution for rehabilitation. One advantage of stepped spillways is the significant energy dissipation created in the spillway chute. The energy dissipation in the stepped spillways in turn allows the use of shorter energy dissipating stilling basins as compared to conventional smooth concrete spillways. Yet, little information is provided on the energy dissipation that occurs in stepped spillways with slopes less than or equal to 22° (slopes commonly found among NRCS constructed spillways). Renwick Dam in North Dakota falls in this unique class of planned rehabilitation sites for which a stepped spillway having a rather flat (4H:1V) slope is planned. To assist the NRCS in the design of this spillway, a hydraulic model study was conducted at the USDA-Agricultural Research Service (ARS) Hydraulic Engineering Research Unit (HERU) in Stillwater, Oklahoma. This paper reports the results of that study and may be used to provide design engineers with information regarding stepped spillways designed on a 4(H):1(V) slope.

Geographic interest: North Dakota

Subject terms: spillways, RCC, roller-compacted concrete, design, federal programs, rehabilitation, models, research, hydraulics, development, historical interest, spillway capacity, construction

Mills, George E. and Spragens, Lori C. *Eight Years of Outreach to Dam Owners Through Education and Involvement.* Journal of Dam Safety - 06/2008 (V. 6 N. 2)

One of ASDSO's goals is to provide resources and educational opportunities to owners and continue to try to engage as many owners as possible to join ASDSO and work with regulators to improve dam safety nationwide. In 2000, ASDSO created a dam owner outreach committee. One of the first projects the team produced was a program of workshops developed to increase dam owner/operator education in key areas. It was recognized that this could be a great benefit to many states that do not have the staff or time to implement and run these types of programs for owners.

Geographic interest: U.S., Missouri, Pennsylvania, Virginia, Texas

Subject terms: ownership, training

Schwalbach, Teresa A. *Planning for Emergencies: Lessons Learned from Silver Lake.* Journal of Dam Safety - 06/2008 (V. 6 N. 2)

In the event of a dam failure, emergency responders play a vital role. The author-Emergency Management Coordinator for Marquette County-recounts how an updated emergency action plan and ongoing communications between responders and dam owners contributed to a successful response by emergency personnel during the 2003 Silver Lake dam failure in Marquette County, Michigan.

Geographic interest: Michigan

Subject terms: emergency action plan, failures, EAPs, emergency management, ownership, public safety

Baston, Conrad R. and Hibbs, David O. *A Case History for the Rehabilitation of the Lake Forest Estates Dams.* Journal of Dam Safety - 09/2008 (V. 6 N. 3)

The Lake Forest Estate dams in West Virginia include primary and secondary earth fill dams located in adjacent valleys. The dams are connected by an open channel originally thought to be the principal spillway for the primary dam. The dams were rehabilitated during the 2006-2007 construction season to comply with current state dam safety requirements. Three unusual conditions were encountered during the rehabilitation: (1) a "bucket pipe" principal spillway buried in the primary dam embankment, (2) occurrence of an upstream slope failure during drawdown of the primary dam reservoir, and (3) running clear seeps beneath the toe of the secondary embankment. This case history reflects some of the design and construction issues faced by owners, dam safety engineers, regulators and contractors, particularly the differences between initial assumptions used in the design phase and actual conditions discovered during the construction phase. As unforeseen obstacles arose throughout the project, each party had to respond promptly and effectively to address each issue. Cooperative efforts between the owner-contractor, design engineer, and regulatory engineer led to the project's successful completion.

Geographic interest: West Virginia

Subject terms: case studies, design, construction, embankment dams, rehabilitation, spillways, slope stability, seepage, partnering

Hampton, Neill J. and Constantino, James. *Innovative Rehabilitation at Cobble Mountain Dam*

Outlet Works. **Journal of Dam Safety - 09/2008 (V. 6 N. 3)**

In 2005 the Springfield Water and Sewer Commission (SWSC) rehabilitated its diversion tunnel high-head outlet works facility at Cobble Mountain Reservoir Dam, which retains the water supply for 250,000 residents in Springfield, Massachusetts and surrounding communities. The work was prompted by the failure of the existing water-operated differential needle valves, and numerous failures of needle valves, similar to those in operation at Cobble Mountain and at dams across the U.S. These cases had resulted in the deaths of several workers and millions of dollars in damages to hydraulic structures. Valve failure at Cobble Mountain would have been similarly overwhelming: loss of redundancy in the system's entire water supply-and thus drinking water and fire protection. Over the past 15 years, however, no practical, or even possible, solution had surfaced for rehabilitating these valves that were more than 200 feet below ground in a confined space and under high reservoir pressure. The valves would have to be worked on in place and "in the dry," even though there were no isolation gates upstream to allow dewatering prior to disassembly. To address the problem, SWSC and Camp Dresser & McKee Inc. (CDM) developed an original, affordable, and safe design. The solution was a first-of-its-kind mechanical plugging system that isolated the outlet valves in the dry and resulted in a fully rehabilitated, reliable, and secure alternative water supply, completed under budget and without one safety incident or interruption of service. Specifically, the innovative plugging system allowed for the replacement of two 42- x 30-inch Larner-Johnson differential needle valves with 30-inch-diameter U.S. Bureau of Reclamation (USBR)-style jet-flow gates and rehabilitation of two corroded 40-inch Escher Wyss & Co. rotary (ball) style isolation valves.

Geographic interest: Massachusetts

Subject terms: rehabilitation, design, outlet works, spillway capacity, failures, construction, gates, testing

Tatro, Stephen B., Hinds, James K. and West, Jana L. ***Properties of Grout Enriched Roller Compacted Concrete.*** **Journal of Dam Safety - 09/2008 (V. 6 N. 3)**

Grout enriched roller compacted concrete (GERCC) has gained acceptance for constructing vertical and sloped facings for RCC dams, abutment contacts, interior encasements, and other features that previously used conventional concrete. Compared to the concurrent production and placement of conventional concrete for these applications, GERCC provides an economical and less intrusive process resulting in minimal impact to RCC production operations. An investigation was done to evaluate the properties and performance characteristics of various factors of GERCC. Various properties of grout and methods of mixing were investigated including materials and mixing methods for grout and RCC, grout dosages, grout locations, and compaction variations were examined. This paper summarizes the GERCC field evaluations, reports the significant results, and provides conclusions and recommendations for GERCC use.

Subject terms: grouting, roller-compacted concrete, design, construction, concrete, guidelines, testing, inspection, federal programs

Ferentchak, James A. and Jamieson, Stephen L. ***Using Erosion Rate To Refine Earth Dam Breach Parameters.*** **Journal of Dam Safety - 12/2008 (V. 6 N. 4)**

This article was developed from a paper that was presented at Dam Safety 2008 and reflects more than 50 years of combined experience by the authors in estimating breach parameters for the computer simulation of earth dam failures. Simulating the failure of earth dams is a key analysis step in the development of dam-failure flood inundation maps for dam emergency action plans, evaluating dam hazard classifications, and performing risk assessments for dams. One of the most important results from these evaluations is an estimate of the peak breach discharge that can be expected if a dam were to fail during either sunny-day or extreme flood events. The peak flow from a dam breach is very sensitive to breach development time, final breach width, and breach initiation elevation. The appropriate selection of

these and other breach parameters requires considerable engineering judgment. This article describes a five-step process that relies on the erosion rate to minimize the subjective judgment that can occur when selecting breach parameters. This article also presents several case studies to illustrate how this process can be used to develop realistic dam breach parameters for earth dams.

Subject terms: erosion, dambreak analysis, case studies, embankment dams, models, testing, failures, mapping, EAPs, risk assessment, failure analysis, flood analysis, floods, hazard classification, research

Lemieux, Michele and Robinson, Arthur. *Evacuation Vs. Inundation: Which Map Should Your Emergency Action Plan Contain?* Journal of Dam Safety - 12/2008 (V. 6 N. 4)

This article makes a case for using simple conservative evacuation maps in dam emergency action plans instead of the detailed inundation maps that are commonly used. Six "lessons learned" from Montana's experiences with tabletop exercises and a survey of local emergency responders are used to make the case.

Geographic interest: Montana

Subject terms: EAPs, emergency action plan, mapping, emergency management, state programs, partnering, public awareness, public safety, risk assessment, floods

Twing, David R. and McMaster, Kevin. *The Delaware Dam Inventory 2008: A Comprehensive Approach To Finding Regulated Dams in the First State.* Journal of Dam Safety - 12/2008 (V. 6 N. 4)

In 2004 the Delaware legislature passed a dam safety law, authorizing the Department of Natural Resources and Environmental Control (DNREC) to implement a Dam Safety Program for the state. Delaware was one of the last states in the country to start a dam safety program, and the State had very little information about the location and nature of the dams that would be regulated. DNREC realized that a statewide dam inventory update was needed, not only to locate dams, but to also determine which dams would be regulated. The Delaware dam safety law limits regulatory authority to publicly owned, high and significant hazard potential dams. To establish a modern inventory of Delaware dams meeting the law's criteria, DNREC retained and worked with URS Corporation to determine the location of all potentially regulated dams within the state, and to conduct a hazard potential and risk assessment for each identified dam. Dam ownership, dam characteristics and reservoir size were used to prioritize the field investigation of all potentially regulated dams. Because the Delaware law does not regulate low hazard potential dams, it was necessary to conduct a preliminary hazard potential assessment to determine whether a dam would be regulated or not. Approximate methods were used for this assessment (based on downstream impacts identified during field investigations), because funding was not available to perform detailed studies for each dam. A preliminary risk assessment was also conducted based on dam and reservoir observations. The end goal of the risk assessment was to prioritize the Delaware statewide dam inventory into high, medium and low risk categories for the purpose of future resource allocation. Risk assessment tools and strategies were designed to be flexible in nature, so that more accurate data can be easily incorporated into the process. Accurate data will be obtained through future detailed hydraulic modeling and comprehensive field inspection of each dam.

Geographic interest: Delaware

Subject terms: state programs, legislation, regulations, hazard classification, risk assessment, partnering

Cahill, Scott P. *Underwater Valve Replacement at Radnor Lake.* Journal of Dam Safety - 03/2009 (V. 7 N. 1)

Radnor Dam is a high-hazard-potential 54'-high earthen dam in a state-designated "natural area." The

project involved replacing a failed upstream 36-inch diameter butterfly valve with a new stainless steel knife gate valve, a hydraulic actuation system, and a structure to support the valve and trash rack on the lake bottom, to be completed with no discernable impact to the lake and with disturbance to the surrounding area kept to a minimum.

Geographic interest: Tennessee

Subject terms: rehabilitation, conduits, environment, design, underwater investigations, joints

Graham, Wayne J. *Get out - Get OUT - GET OUT! Getting People Out of Harm's Way.* Journal of Dam Safety - 03/2009 (V. 7 N. 1)

Emergency action planning for dams started in earnest in the 1970s after a rash of lethal dam failures. Excluding failure of Teton Dam, there were four dam failures in the 1970s with more than 25 fatalities. These failures, plus the Teton Dam failure, were a wake-up-call that something needed to be done to improve the safety of the nation's dams. Cited dam failures: Taum Sauk, Kelly Barnes (Toccoa Falls), Teton, Buffalo Creek, Laurel Run, Canyon Lake, Mill River (Williamsburg, MA), South Fork (Johnstown), Walnut Grove, Austin (PA), Lower Otay, St. Francis.

Geographic interest: U.S., Georgia, Idaho, Arizona, California, Pennsylvania, Missouri, South Dakota, West Virginia

Subject terms: public awareness, public safety, failures, emergency action plan, EAPs, emergency management, historical interest, legislation, state programs, federal programs, case studies

O'Leary, Timothy M. *Interim Risk Reduction Measures for Dam Safety.* Journal of Dam Safety - 03/2009 (V. 7 N. 1)

Interim Risk Reduction Measures (IRRM) are an integral part of the risk-informed management of the Dam Safety Program of the U.S. Army Corps of Engineers (USACE). IRRM are an "in-the-meantime plan" for dam operations to reduce the probability and consequences of catastrophic failure to the maximum extent reasonably practical while inspections, investigations, testing, and studies take place, which could ultimately determine whether or not the project is a candidate for significant repairs. This paper provides a general overview of IRRM from USACE's EC 1110-2-6064 and the author's experience with development, implementation, and review of IRRM Plans.

Geographic interest: Tennessee

Subject terms: risk assessment, federal programs, public safety, guidelines, monitoring, inspection, mapping, training, EAPs, warning systems, emergency action plan, emergency management

Allen, Dave, Boyle, Jason, Campbell, Jason, Clay, Robert, Galloway, Meg, Kannik, Mia and Nance, David. *Midwest Flooding in 2008: State Dam Safety Officials' Response.* Journal of Dam Safety - 06/2009 (V. 7 N. 2)

2008 was a record year of precipitation and flooding for the Midwest. The first six months of the year had multiple periods of heavy rainfall leading up to the largest wide-spread rain event, which happened in the first half of June. During this period, a large-scale weather pattern consisting of a high pressure system over the southern plains and Ohio Valley and abnormally low pressure situated over the northern Plains created a focal point at its boundary for the development of heavy rainfall and severe storms. According to the NOAA Climate Prediction Center, the three factors that played an important role in the June 2008 Midwest flooding included: 1) above-average precipitation the previous months, which caused high soil moisture and high river levels, 2) an atmospheric circulation pattern during this time that was similar to the Great Midwest floods of 1993, and 3) the combined influence of two prominent tropical

climate patterns, La Nina and Madden-Julian oscillation (MJO), that contributed to several exceptionally heavy precipitation events during February-June 2008. A precipitation map for the first 15 days of June 2008, developed by NOAA Midwest Regional Climate Center, shows that the hardest hit areas were parts of southeast Minnesota, southern Wisconsin, northeast Iowa and parts of Illinois and Indiana. The rains did not stop in June. At the end of July, the northeastern half of Missouri received 15 inches in three days. This area received more than three times the normal monthly rainfall. The total January-July precipitation for the Midwest as a whole was the highest on record. This paper is a state-by-state account of how dams and levees in this region performed during this period and how the state dam safety officials responded.

Geographic interest: Iowa, Illinois, Minnesota, Mississippi, Wisconsin, Ohio, Indiana

Subject terms: floods, state programs, incidents, emergency management, emergency action plan, EAPs, guidelines, failures, hydrology

Farrell, Laurence M. and Dillabough, Michael. *Warm Springs Dam and the Motorized Outlet Tunnel Inspection Vehicle (MOTIV).* Journal of Dam Safety - 06/2009 (V. 7 N. 2)

The unique Motorized Outlet Tunnel Inspection Vehicle (MOTIV) completed its maiden voyage in Sonoma County, Northern California in September 2008 as part of the 5-year inspection of Warm Springs Dam. Past inspections required complete shut-off of the water flow within the outlet tunnel, but due to recently discovered endangered species in the area, this practice is no longer viable. A new inspection method that did not interrupt the water flow hinged on building a vehicle that could safely travel above the water flow in the tunnel: the MOTIV.

Geographic interest: California

Subject terms: technology, inspection, outlet works, conduits, environment, embankment dams, instrumentation, design

France, John W. and Winckler, Christina J.C. *Rapid drawdown analysis - What is an analyst to do?* Journal of Dam Safety - 06/2009 (V. 7 N. 2)

In the authors' experience rapid drawdown analysis of embankment dams is one of the most misunderstood slope stability analysis cases. As a result, inappropriate analysis methods have often been used. This paper begins with a review of fundamental soil behavior during rapid drawdown, followed by a discussion of both appropriate and inappropriate analysis methods. An example dam illustrates the differences in results obtained with different methods and, finally, the authors' conclusions are provided.

Subject terms: embankment dams, drawdown, stability analysis, slope stability, guidelines, models, computer programs, federal programs

Noble-Blair, Mishelle R., Zamensky, Erica D. and Zamensky, Greg. *There and back again: A dam owner's tale of emergency action planning.* Journal of Dam Safety - 09/2009 (V. 7 N. 3)

Development and implementation of an emergency action plan (EAP) may overwhelm dam owners; however, all dam owners - especially those of high or significant hazard dams - have an obligation to engage in the emergency planning process. Moreover, some owners are required by law to exercise their EAP to ensure its adequacy and functionality. One dam owner, Fairfax Water (Fairfax, Virginia), has realized the immeasurable value gained by putting their plan to the test. Drills, tabletop exercises and functional exercises allowed Fairfax Water to improve communication and planning processes associated with their EAP. Additionally, Fairfax Water realized the importance of full owner and emergency management agency involvement in all aspects of the dam emergency planning process. These

approaches ensure an exceptional emergency plan that reflects the best response that emergency management agencies and dam owners can provide. Understanding that emergency planning must evolve to meet changing conditions, Fairfax Water has adopted a process focused on continual improvement, using the Plan-Do-Check-Act model to guide their emergency planning efforts. Includes lessons learned during 1864 Mill River Dam catastrophe in Massachusetts.

Geographic interest: U.S., Massachusetts, Virginia

Subject terms: EAPs, emergency action plan, ownership, public awareness, failures, historical interest, training

Stoessel, John, Charlwood, Robin G. and Knarr, C. Michael. *The Installation of a geomembrane liner At Gem Lake Dam.* Journal of Dam Safety - 09/2009 (V. 7 N. 3)

Gem Lake Dam, owned and operated by Southern California Edison (SCE), is located in on the Eastern Slope of the Sierra Nevada Mountains, about 300 miles northeast of Los Angeles, California. This multiple arch, concrete dam serves to impound water used by Rush Meadows Powerhouse to generate up to 13 megawatts of electric power.

Geographic interest: California

Subject terms: case studies, design, construction, geosynthetics, concrete dams, arch dams, Reservoirs, concrete, seepage, freeze-thaw deterioration

Van Aller, Hal. *Failure of bonneted sluice gate system at Savage River Dam.* Journal of Dam Safety - 09/2009 (V. 7 N. 3)

The Upper Potomac River Commission (UPRC) owns and operates the Savage River Dam (Figure 1) in Garrett County, Maryland. In December 2007, during normal operation of the Savage River Reservoir, the UPRC discovered that one of the four large gates at the bottom of the reservoir could not be opened, eliminating the ability to control outflow through half of the facility's outlet structure. Currently, only the left side gates can be operated. The existing gates were installed during the original construction of the facility and have been in service since 1952. The engineer has recommended that all four gates be replaced, which will require temporarily draining the reservoir during the winter of 2009-2010.

Geographic interest: Maryland

Subject terms: incidents, gates, case studies, historical interest, outlet works, Rehabilitation

Paul, Dave, Cyganiewicz, John, Slaven, Chris and France, John. *Assessment of Potential Failure Modes for the Truckee Canal at Fernley, Nevada.* Journal of Dam Safety - 12/2009 (V. 7 N. 4)

At approximately 4:00 AM on January 5, 2008, the downhill embankment of the Truckee Canal failed at approximate canal station 714+00, releasing water into the town of Fernley, Nevada. Approximately five hundred and ninety homes were flooded. The canal drained through the breach from both the upstream and downstream directions. Reportedly, water flowed through the breach for up to 9 hours and water depths of up to 8 feet occurred in some locations in the town of Fernley, with water depths of 1 to 4 feet common throughout housing developments in the town. No fatalities occurred as a result of the flooding. Damages were estimated to be approximately $50,000,000. Prior to January 4, 2008, the Truckee Carson Irrigation District (TCID) had been diverting water through the canal at an approximate average daily rate of 370 cfs. A storm event in the Reno/Sparks area on January 4, 2008 generated 1.91 inches of precipitation, which resulted in significant increases in the Truckee River flows and diversions into the Truckee Canal. Based on data from a USGS gauging station about 4 miles upstream of the breach site, it is estimated that the flow in the canal was approximately 750 cfs at the time the breach occurred. This

paper includes discussion of: 1) technical information pertinent to the failure, 2) investigations of the canal and breach site, 3) the potential failure modes to help explain the cause of the failure, 4) details of the breach repair.

Geographic interest: Nevada

Subject terms: canals, failures, financial aspects, damages, failure analysis, failure modes

Robison, E. George and Craven, Michael. *Room to Spare? A systematic evaluation of spillway sizing for existing high and significant hazard dams in Oregon.* Journal of Dam Safety - 12/2009 (V. 7 N. 4)

According to one compilation of dam failures, approximately 34% of failures are caused by overtopping during floods, with spillway capacity playing a significant role in failure (ICOLD, 1995). In another compilation, the percent of failures related to overtopping is 66% (Salisbury, 1998). Even though inadequate spillway sizing can be a significant factor in dam failures, systematic evaluations of spillway sizes over large populations of dams are rare. In Oregon, dams range in age from new to over 100 years old. The standards and methods for spillway sizing have evolved over this period. Dams built in certain time periods may not be up to current standards and practices. To determine the extent to which dams in Oregon may have inadequate spillway discharge capacity, the Dam Safety Section of the Oregon Water Resources Department evaluated spillway capacity for 208 high and significant hazard embankment dams in Oregon with sizable watersheds upstream. As part of this study, spillway capacity was evaluated dam by dam and also by region and the time at which it was designed and built. For each dam, a ratio of the spillway capacity to the peak 100-year flow was computed. Reasons for differences in this ratio among dams were then examined by analyzing long-term hydrologic records for given streamflow gages near two case study dams with problematic spillway sizing. This study focused on high and significant hazard dams because of the consequences of their failure. Since concrete dams can generally withstand some overtopping without failure, they were excluded from this study. Furthermore, earth and rock embankment dams that have small watersheds and are filled by canals and pumping were also excluded because the 100-year peak flow analysis is not relevant in the design of the spillways for these structures. This left a data set of 208 dams to be evaluated. For each of these 208 dams, the ratio of the spillway capacity to the peak 100-year flow was computed.

Geographic interest: Oregon

Subject terms: state programs, spillway capacity, spillways, hazard classification, standards, design, design flood

Schultz, Mark, Lessman, Jim and Pi, Melissa. *A regulatory perspective on the St. Francis Dam failure.* Journal of Dam Safety - 12/2009 (V. 7 N. 4)

When St. Francis Dam failed near the stroke of midnight on March 12, 1928, it released a devastating 38,000 acre-feet of water in a massive wave of destruction. At least 450 people were killed, and many others were never accounted for. By several measures, this tragedy was the worst engineering disaster of the 20th century in the United States. Public outrage from the engineering failure of the 205-ft high concrete gravity-arch dam led to comprehensive dam safety regulation in California and initiated the licensing of professional engineers. This article reviews forensic evidence regarding the mode of failure, the regulatory environment in which the dam was constructed, and the effect that additional oversight might have had. The design and construction of St. Francis Dam was exempt from regulatory oversight in place at the time, enacted in 1917 state dam safety legislation. For comparison, the authors examine two similar dams constructed in the same period under regulatory review by the State Engineer.

Geographic interest: California

Subject terms: failures, state programs, Regulations, seepage, design, construction, historical interest,

Regulatory exemptions, failure analysis, failure modes, arch dams, gravity dams, concrete dams

Roberts, Thomas l. *Graded Filter Drains in Dams – Successes and Failures in the Western Part of Virginia.* Journal of Dam Safety - 03/2010 (V. 8 N. 1)

Hundreds of dams fail suddenly every year due to preventable internal erosion (soil piping), yet the intuitive approaches used by some professional engineers to address dam seepage problems often exacerbate the problems by making the seepage less inspectable, initiating or increasing the internal erosion rates, and creating a false appearance and sense of security. The application of intuitive, but inappropriate, approaches to seepage control to dams can be a formula for disaster. This paper includes discussion of: (1) General information on the basic components of a properly designed and constructed graded filter drain (2) Several examples of dams successfully retrofitted with graded filter drains (3) Several examples of dams with improperly designed or installed graded filter drains.

Geographic interest: Virginia

Subject terms: state programs, drainage systems, filters, design, permits, construction, geotechnical investigations, seepage, piping, erosion, case studies

Scott, Gregg A. *Shedding some light on this thing called risk assessment: Part I – Risk Analysis Basics.* Journal of Dam Safety - 03/2010 (V. 8 N. 1)

Although dam safety risk assessment has been around for decades, recently it has become a hot topic and has found its way into the dam safety conferences and literature. However, the papers and explanations often assume the audience has some familiarity with probabilistic methodology and terminology. For those who have had limited exposure to these concepts, including most engineers and scientists who had a single college level course in probability and statistics, it is difficult to follow the discussion. This article is intended to provide some basic background information to help dam safety professionals understand what this thing called risk assessment is all about, drawing upon the more practical methods in use at the Bureau of Reclamation.

Geographic interest: U.S.

Subject terms: Risk assessment, federal programs, guidelines

Turner, Kenneth R. and Wooten, R. Lee. *Lake Burnt Mills Dam Rehabilitation.* Journal of Dam Safety - 03/2010 (V. 8 N. 1)

Lake Burnt Mills Dam is one of seven reservoirs that supply fresh water to Norfolk and adjacent communities. Beginning in 2006, the City undertook remedial measures to address several dam safety deficiencies; the most urgent included the inability to safely pass the Probable Maximum Flood , inadequate safety factor of the intake tower and training walls, severe deterioration of concrete below the waterline and the inadequate shape of the spillway crest for the loads and flow at the maximum design head. GEI Consultants designed several remedial measures. Due to the condition of the low-level outlet, the entire system was replaced. The replacement system included a new intake tower and a micro-tunneled low-level outlet. The spillway and embankment were modified by:
--extending and raising the existing parapet wall and the ends of the embankment to prevent overtopping;
--a partial demolition and reconstruction of the existing ogee crest to match the high flow expected from the PMF;
--repair of the spillway channel floor and walls to include filtered seepage collection and drainage interceptor trenches; and
--replacement of the riprap on the upper channel side slopes to provide suitable erosion protection and repair of the deteriorated concrete.

The major challenge of this project was to maintain dam safety and allow continued operation of the reservoir during remedial construction. Another major challenge was the change of design for the low-level outlet during the design phase. The initial low-level outlet design was a siphon structure which was replaced by a large diameter micro-tunneled low-level outlet. The City chose the micro-tunneled low-level outlet, with its increased risks of tunneling into full reservoirs, due to concerns about safe yield during times of low reservoir levels and because of its increased reliability and ease of operations compared to the siphon option.

Geographic interest: Virginia

Subject terms: Rehabilitation, design, construction, case studies, Embankment dams, outlet works, Riprap, spillways, Erosion, concrete, seepage, drainage systems, dam raising

R. Cannon, G. Robblee, T. Marshall, G. Paxson, M. King and A. Williams. *Replacing Lake Townsend Dam*. The Journal of Dam Safety - 06/2010 (V. 8 N. 2)

Lake Townsend Dam impounds the primary water supply for the City of Greensboro, North Carolina. The concrete gated spillway is suffering from severe deterioration due to alkali silica reactivity (ASR) and has inadequate hydraulic capacity to meet spillway design storm (SDS) requirements of North Carolina Dam Safety. The project includes a replacement spillway designed to have hydraulic capacity similar to the existing gated spillway. The embankment will be armored to allow overtopping for storms up to the SDS. Subsurface investigations revealed soft and loose alluvial soils in the original stream and floodplain. Excavation and replacement of these soils is necessary for support of the new spillway and earth embankments. The effect of spillway submergence suggests that a fixed crest labyrinth weir is more appropriate than a gated spillway. In addition, the City of Greensboro prefers the limited operation and maintenance requirements of a fixed crest spillway. The replacement spillway is a seven cycle, 300 ft wide, 20 foot high labyrinth weir. The embankment will be armored with articulating concrete blocks (ACB) to protect against failure from overtopping. The design included hydraulic modeling using computational fluid dynamics (CFD) and a physical model study of the labyrinth and energy dissipater. The structural design included finite element modeling of the labyrinth weir. Plans and specifications were completed in 2008 and construction began in spring 2009.

Geographic interest: North Carolina

Subject terms: spillway capacity, Rehabilitation, concrete growth, spillways, design flood, state programs, design, construction, geotechnical investigations, weirs, models

S. Carter, E. Guy and G. Hensley. *Indiana Dam and Levee Distress Observations during 2008 Midwest Flooding*. The Journal of Dam Safety - 06/2010 (V. 8 N. 2)

Record precipitation during the first half of 2008 caused widespread flooding in the Midwest. In central and southern Indiana, historic flooding occurred in June during the largest rainfall period of the year. Flood levels in several regions exceeded records set in 1913, and a major disaster declaration issued for 29 counties enabled the state to receive federal assistance. The State of Indiana requested federal support in performing geotechnical assessments of more than 100 privately owned, high-hazard-potential dams in flood-affected counties, and the Federal Emergency Management Agency (FEMA) tasked the U.S. Army Corps of Engineers (USACE) with this mission. Within a few days after the heavy June rainfall, teams of USACE and state personnel completed these assessments. Field evaluations determined whether dams had survived the event and remaining threat levels to downstream life and property. Immediately following this mission, USACE personnel traveled to southwestern Indiana to complete assessments of levee systems along the White and Wabash rivers, which were nearing or surpassing record levels. These field evaluations also assessed current threat levels to landward life and property and provided situational awareness and flood fighting guidance to local sponsors and levee board members. This article briefly presents examples of dam and levee distress observations made in

June 2008 during the above-stated missions. Included are examples of conditions posing threats to earthen structures, such as overtopping, spillway erosion, slope instability, foundation piping/erosion, and inadequate project design and maintenance.

Geographic interest: Indiana

Subject terms: floods, levees, geotechnical investigations, Embankment dams, state programs, federal programs, overtopping, Erosion, slope stability, foundations, piping, design, maintenance, vegetation, spillway capacity, incidents, operation

D. M. Temple, S. L. Hunt and G. J. Hanson. *Observations on Dam Overtopping Breach Processes and Prediction*. The Journal of Dam Safety - 06/2010 (V. 8 N. 2)

Research conducted over the last decade has led to an improved understanding of the physical processes associated with the response of an earthen embankment to overtopping flows. This research has demonstrated that vegetation and cohesive soil material properties play an important role in the erosion processes and rate of erosion during overtopping. The overall breach process has been observed to involve vegetation failure, surface detachment, headcut development and migration, and breach widening. Computational procedures based on the results of this research are being incorporated into new software tools for use in evaluating the safety of dams and levees subjected to overtopping during extreme flood events. Proper application of these tools and correct interpretation of the computational results require that the user understand the concepts represented and the extent to which simplification of complex processes is required in development of the computational procedures.

Subject terms: Research, overtopping, models, Embankment dams, Erosion, vegetation, federal programs, sedimentation, dambreak analysis

B. Harrington and R. Tinsley. *Monocacy Boulevard Dam in Karst Topography* The Journal of Dam Safety - 09/2010 (V. 8 N. 3)

Monocacy Boulevard Dam, a high hazard stormwater management dam and reservoir in the City of Frederick, Maryland were completed in July 2010. The Maryland State Highway Administration (SHA) applied for a permit through the MD Department of the Environment's Dam Safety Division in 2004 to construct Monocacy Boulevard Dam for stormwater management control in karst topography. The dam and reservoir are part of a larger project involving Interstate I-70 widening, the extension of MD 85 and a new East Street to provide a third "gate way" to the City of Frederick. Monocacy Boulevard was extended to the west and north of I-70 approximately 2,800 feet to MD 85. The roadway embankment for Monocacy Boulevard includes a 600-foot long earth dam with geotechnical instrumentation, and is built adjacent to a 12-acre reservoir and high capacity pump station. The dam is located on Monocacy Boulevard between South and East Streets on the north side of I-70. The dam captures runoff from an approximate 400-acre watershed.

Geographic interest: Virginia

Subject terms: design, construction, rehabilitation, state programs, geotechnical investigations, geology, Embankment dams, monitoring, stormwater management

S. McCubbin-Cain and B. A. Tschantz. *Wanted: More Dam Engineers*. The Journal of Dam Safety - 09/2010 (V. 8 N. 3)

This paper was originally published in the Proceedings of the 2010 Annual Conference and Exposition of the American Society for Engineering Education (ASEE), held June 20-23, 2010 in Louisville, Kentucky. It was reprinted in the Journal of Dam Safety by courtesy of ASEE, the copyright owner. It discusses the

student outreach initiatives of the Association of State Dam Safety Officials (ASDSO), a national non-profit association of more than 2,800 members representing state and federal agencies, consulting firms, dam and levee owners, manufacturers and suppliers, researchers, college faculty, students and others dedicated to ensuring the safety of our nation's dams. According to surveys conducted by the authors in 2004 and 2009, there is an inadequate supply of qualified candidates for jobs relating to dam and levee safety, and the shortage will likely increase as "boomer-era" experts retire. This paper looks at current hiring needs within government and private sector communities; outlines how ASDSO's projects are helping to attract students to professions in dam and levee safety; and challenges the industry and the engineering education community to foster greater collaboration between universities and practicing engineers who specialize in dam engineering.

Geographic interest: U.S.

Subject terms: training programs, public awareness, partnerships

G. A. Scott and W. F. Fiedler. *Shedding some light on this thing called risk assessment: Part II – Example Risk Analysis*. The Journal of Dam Safety - 09/2010 (V. 8 N. 3)

Part I of this article was published in Volume 8, Issue 1 of the Journal (April, 2010). It covered the basics of performing risk analyses and the process of developing risk estimates. Risk, by definition, must consider both the likelihood of failure and the consequences of failure. In Part II, the risk analysis process is solidified through presentation of an example.

Subject terms: risk assessment, federal programs, decision-making, failure analysis, case studies, failure modes, failures, stability analysis

W. J. Graham. *The Banqiao and Shimantan Dam Failures*. The Journal of Dam Safety - 12/2010 (V. 8 N. 4)

Banqiao and Shimantan dams and 60 others failed in Henan Province, China, in August 1975. Information on these failures remained hidden from the outside world for two decades. The failures resulted in the largest loss of life ever from any dam failure, with fatality estimates ranging from 26,000 to 230,000. More than 10 million people were impacted by the floods, and 5,240,000 houses collapsed. Why did the dam failures occur and why did so many people die? Could a similar event occur in the United States or in other developed countries?

Geographic interest: China

Subject terms: failures, floods, fatalities, historical interest, international programs, public awareness

D. L. Johnson. *The Unpermitted Dam Initiative in Washington State*. The Journal of Dam Safety - 12/2010 (V. 8 N. 4)

This paper discusses an initiative by Washington State's dam safety program to find, inspect and bring into compliance dams constructed without state approval. The Dam Safety Office (DSO) of the Washington State Department of Ecology has jurisdiction over any dam that can impound 10 or more acre-feet of water at its crest. In March 2008, the DSO began an effort to find unpermitted dams that met this threshold. Over the next four months, this search uncovered some 600 water bodies that appeared to be impounded behind unpermitted dams. DSO personnel visited each site where aerial photos suggested the presence of a high-hazard-potential dam, and assessed the condition and hazard-potential classification of those confirmed. Following these evaluations, the DSO required the dams' owners to first make emergency repairs; then hire engineers to perform further assessments and design needed modifications based on current standards. Provided these modifications were completed within the time

frame specified by the DSO, the dams would be considered in compliance with state law.

Geographic interest: Washington

Subject terms: state programs, ownership, legal aspects, Enforcement, Regulations, Regulatory exemptions, permits

D. T. Woosley. *Have You Ever Seen the Rain? Georgia Flood Event of September 2009*. The Journal of Dam Safety - 12/2010 (V. 8 N. 4)

In September 2009, parts of Georgia experienced record-breaking rainfall, with some areas recording more than 20 inches of rain in a 24-hour period. This paper describes how the Georgia Safe Dams Program responded to this extreme event.

Geographic interest: Georgia

Subject terms: floods, failures, Emergency management, state programs