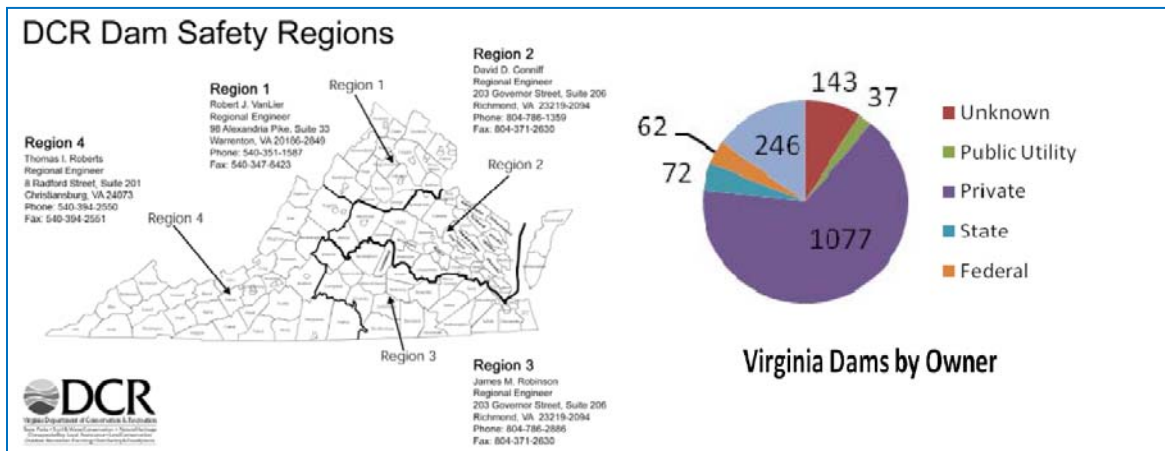


2009 SUMMARY

According to the 2007 National Dam Inventory there are 1,637 regulated dams in Virginia, placing Virginia 18th in the ranking of most dams per state. Based on geographic density of dams, Virginia ranks as 17th with an average of 3.83 dams per 100 square miles. Comparing this to population, Virginia ranks as 25th with an average of 4,750 persons per dam.

These statistics are important as dam safety is directly tied to land use, population density, and the ability to pay for dam management and construction. **It is interesting to note there are only two natural lakes in Virginia, Lake Drummond in the Dismal Swamp and Mountain Lake in Giles County; all other lakes in Virginia are created by dams.** Dams provide numerous benefits to Virginia citizens including places for recreation, water supply, irrigation, flood control, and hydroelectric power generation. Dams improve water quality, act to moderate flooding, and are important components of our urban and rural infrastructure; therefore, it is critical that they are constructed, operated and maintained in accordance with state and federal standards to preserve all of these vital functions.

The Department of Conservation and Recreation (DCR), Division of Dam Safety and Floodplain Management manages 632 regulated dams within the state. The Virginia dam safety program includes a staff of four regional dam safety engineers and a program director. Consequently, each field official is responsible for managing approximately 158 dams assuming equal distribution of structures (a total of only 57 dam inspections were conducted in 2007). The Association of State Dam Safety Officials recommends a ratio of 50 dams per inspector. **Recent state regulatory changes targeted on improved dam safety may add 1,400 dams to DCR’s regulatory program, with provisions to only fund one additional field engineer to help with management of these additional structures.**¹ Recognizing this shortfall, DCR allocated another position from within the department to assist with dam safety management in 2009, however the monitoring and inspection program remains under staffed.



Virginia DCR Regions and Virginia Dams on National Dam Inventory, (Source: VADCR/2007 NDI)

Numerous federal agencies are also involved with dam regulation and management in Virginia, they include the Department of Agriculture National Resource Conservation Service (USDA/NRCS), the Federal Energy Regulatory Commission (FERC), Nuclear Regulatory Commission (NRC), and the Federal Emergency Management Agency (FEMA). However the bulk of dams in Virginia are privately owned and depend on private funds to maintain and operate these structures. **Unfortunately, Virginia regulations do not require proof of long term financial stability as part of dam construction permitting, and, therefore, long term viability of privately owned dams is often problematic as repairs can be expensive and maintenance can be easily overlooked.**

INTRODUCTION AND BACKGROUND

The 2008 updates to Virginia's Dam Safety Regulations have significantly expanded the scope and coverage of the state's program. These regulations have gone from average to a model for all other dam safety programs in the nation. They are a positive step to provide the tools for DCR to assist dam owners with bringing the inventory of dams up to acceptable levels. However with these improved regulations there comes an ever-increasing cost of dam ownership.

Virginia has made a strong effort to mitigate this burden by including ground breaking provisions in the regulations which attempts to control downstream development in the dam break inundation zones, and by establishing the Dam Safety, Flood Prevention and Protection Assistance Fund which will be a continued source of funding for dam engineering and upgrade work.

However this legislative effort has not resulted in significant improvement to dam safety around Virginia as adequate funding to implement the program has not been forthcoming, with only \$2.5M provided to initiate work in 2009. Meanwhile, Virginia's dam inventory continues to grow older and more susceptible to damage. The majority of dams in the state are earthen embankments originally constructed between 1950 and 1975, with an average age of over 50 years. Virginia's population has also grown by 4.5M people between 1950 and 2009 placing increasing numbers of people and valuable property within dam break inundation zones, increasing the consequences of failure.

Recognizing these risks, the new regulations classify a dam as "high hazard" if inundation studies project that the failure of a dam will result in the loss of one or more lives or significant property damage. It is anticipated that completion of these new inundation studies will result in re-classification of many former Class II, Class I, and Significant and Low Hazard dams as High Hazard dams. **This regulatory change is expected to double the number of the dams which will be subject to Virginia dam safety regulation.**

CONDITION AND ADEQUACY

In 2004 tropical storm Gaston dropped 10-12 inches of rain in Central Virginia, causing serious damage to 22 dams and breaching or overtopping 29 more. The majority of these failures occurred in two day period in Chesterfield, Henrico, and Hanover Counties, some of the more populated areas of the state. The vulnerability of these structures to storm events was clearly demonstrated.⁵ Storm damage in Richmond alone totaled over \$20M, and there were three fatalities associated with the storm.⁶

This event led DCR to the use of the 100% Probable Maximum Flood (PMF) stability design criteria for dams in the 2008 regulations, consistent with federal dam safety criteria. **In Virginia this PMF relates to receiving between 28-38 inches of rain in a 24 hour period, Probable Maximum Precipitation (PMP) .** While this seems an extremely conservative design practice, storms approaching this magnitude occur periodically in the Mid-Atlantic region as evidenced in 1969 in Nelson County (28-inches of rain in 8 hours) and in Madison County Virginia in 1995 (30-inches of rain in 16 hours), these storms are estimated to have approached over eighty percent of the PMP in these areas.⁵

Many dams in the Commonwealth have been subject to little or no appropriate maintenance. Despite regulatory requirements for inspection and maintenance of impoundments, most property owners' associations with small lakes do not budget for dam maintenance. This places up to 50,000 individuals within dam break inundation zones of noncompliant dams in Virginia.

INVESTMENT NEEDS AND FUNDING DEDICATED

The economic analysis conducted in conjunction with implementation of the new dam safety regulations in 2008, projects a need for \$223,397,500 to upgrade the dams that were in compliance with the former regulations, and attributes a requirement for another \$25,556,875 for increased upgrades required at dams that didn't meet the former regulations. **Thus the total estimated construction cost impact of the new regulation was projected at \$248,954,375 in 2008.**² This cost which will be borne by dam owners, averages out to a cost of \$1.76M per dam, based on the projected number of structures requiring upgrades. Recent case studies suggest that individual upgrades to privately owned dams may be as high as \$4-6M each, indicating that the 2008 economic impact may be significantly under estimated.

In addition to the construction costs required to meet the new regulations, DCR estimated another \$7,633,905 will be needed to conduct mapping of the dam break inundation zones (based on 465 dams requiring mapping). New emergency action plans required by the regulations are projected to require another \$1,450,000. With the new regulations and anticipated additional dams being brought into regulation these projected costs could easily double. **Because the study predates the new regulations, and includes only the 1,763 Virginia dams currently listed, this \$9M estimate of engineering costs appears to be underestimated**

DCR's Division of Dam Safety currently does not have enough staff or funding to manage the additional dams and requirements that must be addressed under the new regulations. The total budget programmed for this Division was \$2,564,174 in 2009 and is programmed to shrink to \$1,951,612 in 2010 based on Virginia's 2009-2010 biennial budget. Intermediate budget cuts in 2009 included elimination of general fund support for repairs to the Soil and Water Conservation District (SWCD) owned dams in October 2009, deferring them to \$20M funding provided by the 2008 Virginia Public Building Authority for repairs to state owned dams. Commentary associated with these cuts suggested the SWCD will obtain local funding for repairs, (funding which is even more constrained). These cuts continued in December 2009 with reduced annual operating support to the 47 local Soil and Water Conservation Districts further curtailing dam repair and maintenance activities.

Initial funding to support implementation of the new regulations included \$25,000 in matching grant funds (50% local match required to qualify for grants), and \$1,770,000 in loans for required engineering studies and dam rehabilitation work, (10% local match required to qualify for loans). An additional \$250,000 in loans for flood hazard mitigation were also included in funding appropriated to support implementation of these new regulations. **Comparing this to the needs estimated by DCR above which are believed to be low, this level of funding is inadequate to address Virginia's needs.**

Federal funding of dam rehabilitation work in Virginia has improved over the past seven years, with DCR and the Natural Resources Conservation Service (NRCS) partnering to fund work on Marrowbone Dam in Henry County, Inch Branch, Robinson Hollow and Toms Branch in Augusta County, and Royal Lake in Fairfax County. Construction was completed on the Marrowbone Creek dam in 2005 at a cost of \$2.6 million, costs for the rehabilitation of the Augusta County dams is projected at \$4.1M, Royal Lake upgrades are projected to cost \$3.1M. Additional work funded in part with stimulus money is programmed for Lake Barton (\$2.6M) and Woodglen Lake (\$2.5M) in 2009, both of these lakes are also in Fairfax County. Requests for additional NRCS program support have also been received for 4 dams in Craig County; 5 more dams in Augusta County; 1 dam in Shenandoah County; 3 more dams in Henry County; and 1 dam in the Upper Blackwater River Watershed in Franklin County; currently, these are unfunded.

BASIS OF GRADE

Even with the improvements to the Dam Safety Program over the past few years, the performance of regulated dams has continued to erode over this period. It is estimate that approximately 50,000 Virginians occupy homes in the dam break inundation zones of dams that do not meet the minimum required safety standards. Numerous High Hazard dams within Virginia have continued on extensions to conditional permits for many years, which has delayed or avoided upgrades required for safe operation. Due to the large number of dams in Virginia that do not meet minimum safety standards; the large populations living in inundation zones downstream of these structures; the increase in number and hazard classifications of regulated structures within the Commonwealth, and the lack of sustained funding programs to assist private dam owners with required upgrades, **ASCE-VA has assigned an overall grade of “D-” to the Dams segment of the 2009 Report Card.** This compares to an overall “D” grade for the nation as shown in the National Infrastructure Report Card extract below.

Dams As dams age and downstream development increases, the number of deficient dams has risen to more than 4,000, including 1,819 high hazard potential dams. Over the past six years, for every deficient, high hazard potential dam repaired, nearly two more were declared deficient. There are more than 85,000 dams in the U.S., and the average age is just over 51 years old.

WATER AND ENVIRONMENT
DAMS | 2009
GRADE | **D**

ESTIMATED 5-YEAR FUNDING REQUIREMENTS FOR DAMS

Total investment needs
\$12.5 BILLION

Estimated spending
\$5.05 BILLION

Projected shortfall
\$7.45 BILLION

Solutions

- Encourage or require effective state dam safety programs that provide adequate funding, staff, and statutory authorities;
- Develop emergency action plans for every high hazard dam by 2011;
- Establish a national funding program and parallel state programs to repair nonfederally owned dams;
- Include dam failure inundation mapping as part of the National Flood Insurance Program;
- Educate the public about dam safety risks;
- Encourage individuals to educate themselves on the location and condition of dams in their area.

ASCE 2009 National Infrastructure Report Card Needs – Dams Category (Source: 2009 ASCE IRC)

CONCLUSIONS AND RECOMMENDATIONS / POLICY OPTIONS

Virginia has a growing inventory of defined rehabilitation and upgrade needs for dam structures around the state. **However, current investments and funding mechanisms are inadequate to address the growing needs of this vital aspect of our infrastructure.**

The 2008 dam safety regulation changes are a positive step, but the economic impact of these regulations should be re-assessed and improved funding methods defined to assist with required upgrade and repair of these structures. The following key recommendations should also be pursued:

- **Due to funding limits, DCR should place a priority on completing Emergency Action Plans (EAP) on all regulated dams to ensure downstream citizens are aware of potential dam hazards. This effort will assist with public education and outreach and build support for sustained funding of Virginia's dam safety program.**
- **DCR's Division of Dam Safety staffing levels should be aligned with the Association of Dam Safety Officials recommendations. Initial staff focus should be on updating the regulated dam inventory, conducting an accurate statewide needs assessment and resourcing EAPs for all regulated structures.**
- **Presentation and delineation protocols and standards for dam break inundation zone mapping should be set statewide for program consistency. This will expedite preparation of plan development, regulatory review and reduce errors and inconsistency in analysis.**
- **The process of submittal and approval of information on dams to the state inventory must be simplified and streamlined to improve efficiency as more dams will need to be managed with limited resources. Detailed data will be instrumental in obtaining further federal funding.**
- **Identify a tiered structure of program funding through assessment of function and benefits of structures, employ a user/owner/beneficiary fee structure to fund program administration and build a sustainable revolving loan fund balance sufficient to meet projected upgrade needs.**
- **Maximize the use of available GIS imagery, remote inspection technology and survey techniques to improve the accuracy, precision and efficiency of field inspections. Use locally available certified professionals to supplement limited staff resources.**
- **Develop a worksheet and programic guide to define standards and acceptable methods for assessing existing structures not currently on regulatory inventory and procedures for appropriately registering them.**
- **Develop a standard enforcement guideline for dam safety issues, ensuring timely and responsive direction to owners, focused on minimizing immediate threats to public safety and property.**
- **Require a financial plan and life-cycle stability certification for new dam construction permits identifying a permanent source of revenue to maintain and operate new dams constructed in Virginia.**

FOOTNOTES

- 1) Virginia Department of Planning and Budget, Economic Impact Analysis 4 VAC 50-20, Impounding Structure Regulations, Department of Conservation and Recreation, May 4, 2007
- 2) Senate Finance Economic Development/Natural Resources Subcommittee Briefing, Virginia Department of Conservation and Recreation, Joseph H. Maroon, Director, January 23, 2008
- 3) 2007 State Dam Safety Program Performance Information – Legislation & Regulations
- 4) Virginia Dam Safety, Flood Prevention & Protection Assistance Fund, Loan and Grant Manual, (DCR – VSWCB – 018) (06/09), Department of Conservation and Recreation and the Virginia Resources Authority
- 5) Report of the Ad Hoc Dam Safety Study Committee to the Virginia Soil and Water Conservation Board, April 30, 2005
- 6) National Climatic Data Center, Event Record Details, Flash Flood, August 30, 2004

REFERENCES

Report Card for America’s Infrastructure, American Society of Civil Engineers, 2009.

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Association of State Dam Safety Officials, website www.damsafety.org

Virginia Association of Soil and Water Conservation Districts

Virginia Department of Conservation and Recreation/Division of Soil and Water Conservation

Virginia Department of Conservation and Recreation/Dam Safety and Floodplain Management

Watershed Services, Inc. Corporate Datafiles