UPGRADING THE NRCS Y-14 DAM IN GWINNETT COUNTY

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Abstract. Suburban development of Gwinnett County has surrounded many of the flood control watershed dams that were built in the mid-1900s. In many cases, the watersheds and downstream reaches have developed significantly since the time of construction. Development has changed the runoff characteristics of the watershed and many homes are now in the breach zones of these dams. The spillways of many of these dams cannot safely pass flood flows based on current design standards required by the State of Georgia Rules for Dam Safety or the NRCS design criteria for high hazard dams.

The Yellow River Watershed Dam No. 14 (Y-14) is the first of the watershed dams to be upgraded in Gwinnett County. Y-14 was originally constructed in 1967 by the Soil Conservation Service (SCS – currently the USDA Natural Resources Conservation Service or NRCS) to control drainage from a 3.1 square mile watershed. The structure has a 40 feet high embankment dam, a traditional SCS principal spillway structure with a riser tower and outlet pipe, and a 50 ft. wide earthen auxiliary spillway through a saddle on the left abutment.

In 2003, the dam was upgraded to bring it into compliance with modern standards by constructing a new Roller Compacted Concrete (RCC) Stepped Spillway on top of the embankment dam and decommissioning the original auxiliary spillway. This paper describes the evaluation of the original dam and the design of the upgrades to the dam.

INTRODUCTION

357 watershed dams have been constructed in Georgia by the NRCS over the last half-century. Within the next 5 years, 69 of these dams will reach the end of their 50-year design life-span (NRCS, 1999) and many of them will require rehabilitation to bring the structures into compliance with the current NRCS design criteria and the State of Georgia dam safety regulations.

Many of these dams are now an integral part of the community, providing recreation, flood protection, and water supply benefits. In many cases, the watersheds and downstream reaches have developed significantly since the time of construction. In particular, dams in close vicinity to Metropolitan Atlanta have become a specific concern due to increased population density and urbanization of the upstream watersheds and downstream floodplains.

The Yellow River Watershed Dam No. 14 (Y-14) is one of these structures. Constructed in 1967, the dam is within the suburbs of Greater Atlanta near the City of Lawrenceville in Gwinnett County, Georgia. The dam was constructed to protect pasture and farm land and now provides flood protection for downstream subdivisions, apartment complexes, office parks, retail businesses, and bridges.

The Y-14 structure was constructed with an original dam height of 40 feet. It retains 145 acre-feet of water at normal pool level. The watershed drainage area is approximately 3.1 square miles. The dam was constructed with a two-stage principal spillway reinforced concrete riser and 30-inch diameter outlet pipe through the dam embankment and a 50 foot wide grass lined open channel auxiliary spillway in a saddle on the east side of the dam. The combined spillway system was sized to safely pass the flood run-off from a total rainfall amount of 16 inches in 6 hours.

Recent dam breach analyses identified 56 residential and commercial structures that would be inundated within

Figure 1. Existing Y-14 dam prior to rehabilitation.

Table 1. Y-14 dam hydrologic evaluation for existing and rehabilitated structures

Dam & Watershed Conditions	Rainfall			Curve Number	Peak		
	Recurrence	Duration	Depth (in)		Inflow (cfs)	Outflow (cfs)	Stage (ft. MSL)
Existing Dam Present Conditions	100 year	24 hours	7.8	72	1,701	116	951.5
	500 year	24 hours	9.5	72	2,310	125	952.7
	½ PMP	6 hours	15.25	86	8,682	3,469	960.2
	PMP	6 hours	30.5	72	16,968	10,189	965.4
Rehabilitated Dam Future Conditions	100 year	24 hours	7.8	76	2,083	124	952.4
	500 year	24 hours	9.5	76	2,765	468	953.1
	½ PMP	6 hours	15.25	89	9,657	6,403	956.7
	PMP	6 hours	30.5	76	18,863	16,008	959.9

Note: Top of dam elevation for existing and rehabilitated dam is 960.0 ft. MSL. Spillway crest for existing and rehabilitated dam are 954.0 and 925.5 ft. MSL, respectively. Wave action freeboard requirement is 2.7 ft.

the breach zone downstream of the dam if it were to fail. As a result, the dam has been classified as a high hazard Category I or Class C dam according to the Georgia Safe Dams Program (SDP) and NRCS criteria, respectively. As such, it is required to safely pass the one half Probable Maximum Precipitation (½ PMP) combined with wave run-up to comply with the requirements of the Georgia SDP or to pass the full PMP (the NRCS criterion, equivalent to runoff resulting from 30.5 inches of rain in 6 hours) to qualify for partial Federal Funding through the NRCS Watershed Rehabilitation Program. Evaluation of the existing dam during the required design storms is shown in Table 1 for present watershed conditions. The existing earthen spillway does not engage during the 100 or 500 year storms, but the existing dam overtops during the ½ PMP and PMP storms. Peak stage during the ½ PMP storm plus the wave action freeboard requirements is 962.9 ft. MSL.

REMEDIAL OPTION ASSESSMENT

Since there are so many structures within the breach zone, it was not economical to move all the potentially impacted structures out of the breach zone. Removal of the Y-14 dam was not a viable option as 40 homes have valuable lake front property and the structure provides downstream flood protection and recreation benefits for the entire community. Therefore, remedial options evaluated to bring the structure into compliance with the Georgia SDP and the NRCS design criteria included the following structural options:

- Raise the dam crest to contain peak storm runoff;
- Widen the existing auxiliary spillway to pass peak storm runoff; and,
- Construct a new auxiliary spillway on top of the existing dam.

The area around the Y-14 lake is almost fully developed; therefore, raising the crest of the dam to contain the design storms could inundate existing upstream structures. Likewise, widening the existing earthen spillway would also impact property owners near the spillway. For both options, Gwinnett County would have to purchase costly easements for the areas impacted by the storm water flows. Erosion of the earthen spillway could cause the spillway to breach, thereby inundating downstream structures identified in the breach analysis. For these reason, analyses identified that the most cost effective, environmentally acceptable and technically sound solution to bring the structure into compliance was to construct a roller compacted concrete (RCC) spillway on top of the existing embankment dam and abandon the existing auxiliary spillway. RCC is similar to lean conventional concrete, but has a lower cement content, a slightly lower strength and a substantially lower cost than conventional concrete. It is placed and compacted by conventional earth moving equipment (Carter, 1992). This solution of placing a concrete or RCC spillway on top of an embankment cannot be used for new dams because the embankment continues to settle for some time after construction and the settlement would cause the concrete or RCC to crack. The RCC spillway crest was set at the 100-year flood level so that it is not activated in lesser return period storms and so that the FEMA mapped floodplain downstream of the structure is not affected.

The selected design has an arch shaped spillway crest and chute. The crest is 180 feet wide and the chute is formed by one foot high steps. The energy at the base of the spillway is dissipated in a hydraulic jump which is contained within a RCC lined stilling basin. The arch shape was selected to maximize the length of the overflow crest and to gradually converge the flow down the chute so that the stilling basin can be constructed within the river valley at the downstream toe of the dam. The principal spillway riser and pipe effectively remain

unchanged. Table 1 illustrates the hydraulic performance of the rehabilitated Y-14 structure for future watershed conditions. The plan shape of the spillway is shown in Figure 2.

SPILLWAY CONSTRUCTION

RCC placement began on August 28, 2003 and was completed on October 2, 2003. The RCC was mixed in the original earthen auxiliary spillway and transported to the dam site using off road and street approved end dump trucks. The RCC was removed from the trucks using an excavator equipped with a flat tipped bucket and spread using a Caterpillar D-4C dozer. The RCC was then compacted with small vibratory rollers. Construction techniques are illustrated in Figure 3.

The RCC spillway steps were constructed by forming the front edge of the one foot high, ten foot wide steps. The spillway steps have an overall slope of 3 Horizontal (H) to 1 Vertical (V), whereas the abutment walls and spillway crest walls have an overall slope of 2H to 1V. The spillway's arc shape was formed using 10 feet long connected concrete forms. The entire project was completed by November 7, 2003.

CONCLUSIONS

Gwinnett County brought the Y-14 structure into compliance with the Georgia SDP and NRCS design criteria without increasing upstream and downstream flooding. Because the dam was originally constructed by the NRCS, Gwinnett County was responsible for only 35% of the estimated total project cost of $1.7 million. Funding available through the NRCS Watershed Rehabilitation Program supplied the remaining 65%.

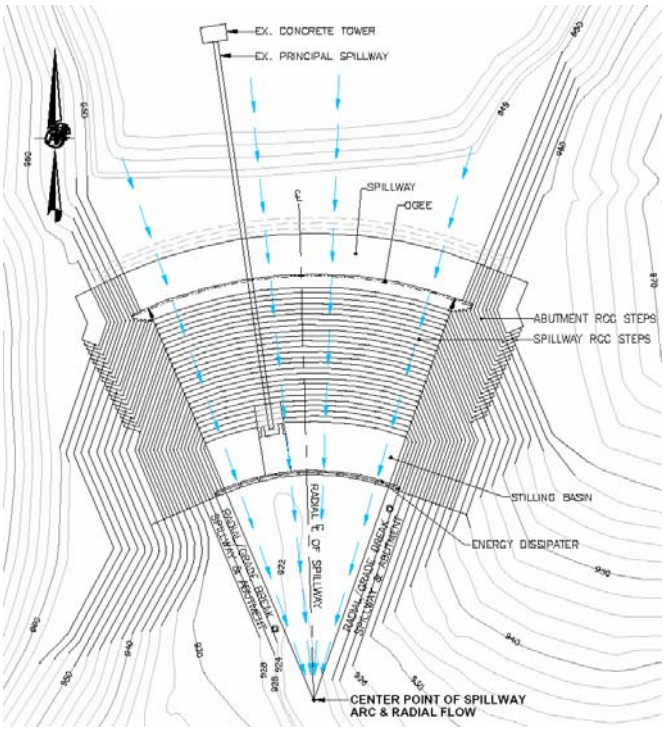

Figure 2. Plan view of the proposed Y-14 structure.

The geometry of the Y-14 site influenced the design of a converging arc-shaped spillway that required overcoming complex hydraulic constraints. These project constraints have resulted in the NRCS and the Agricultural Research Service (ARS) conducting a model study of converging RCC spillways to evaluate hydraulic performance for future projects. Figures 4 and 5 illustrates the completed RCC spillway one year after completion.

Figure 3. Construction of the RCC spillway steps using conventional earth moving equipment.

Figure 4. Completed Y-14 arced RCC spillway and ogee weir.

Figure 5. Y-14 RCC Spillway one year after completion.

PROJECT ACKNOWLEDGMENTS

The Yellow River Watershed Dam No. 14 is operated and maintained by Gwinnett County and the Gwinnett County Soil and Water Conservation District. The authors wish to thank all the NRCS and Georgia Safe Dams Program personnel who contributed to the success of this project.

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