USING EXISTING NATURAL RESOURCES CONSERVATION SERVICE FLOOD CONTROL STRUCTURES FOR POTENTIAL WATER SUPPLY IN GEORGIA

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Abstract: The Georgia Soil and Water Conservation Commission (GSWCC) is charged with coordinating the operation and maintenance of 357 USDA/Soil and Water Conservation District sponsored watershed dams in Georgia. A majority of these dams were built during a program that began in 1957 that encouraged the construction of watershed dams designed to serve as sediment traps and to provide flood protection for agricultural lands in what was once considered to be rural Georgia. Most of these watershed dams are maintained and operated by soil and water conservation districts. In a few cases, cities or counties have the responsibility to operate and maintain the structures. GSWCC, in coordination with the USDA Natural Resources Conservation Service (NRCS), completed a study by a private engineering firm to assemble data that established viability for municipal and industrial (M&I) water supply for an abbreviated list of 166 of the 357 watershed structures. This data included a preliminary analysis of yield potential of the watershed structures and associated stream, and dam proximity to existing surface water intake. Environmental issues included trout water, threatened and endangered species, wetlands impacted, streams impacted, and potential impacts to cultural resources. Ultimately 20 dams were selected for detailed water supply assessments. Each assessment included a detailed analysis of yield potential for the structures to include use as pump storage facility, an estimate of current and future water demand based on population projections, and the identity and quantity of environmental issues. Detailed cost estimates addressed construction costs, costs associated with the mitigation of environmental impacts and costs for land rights required to secure ownership of these dams.

EXECUTIVE SUMMARY

GSWCC in partnership with NRCS and the Georgia Environmental Protect Division (GAEPD) evaluated flood control dams designed and constructed under Federal laws PL 544 and PL 566, to determine which structures could be modified to serve as water supply reservoirs.

In excess of 350 dams were constructed under the federal watershed program, implemented in 1957. These dams were principally designed and constructed to serve as sediment traps and to provide flood protection for agricultural interests in rural areas. However, many of these dams are now in or adjacent to urban areas where flood control is even more relevant, and the demand for water is exceeding supply.

GSWCC, with assistance from NRCS and GAEPD, performed an initial assessment of the 357 watershed dams. Initials assessments were based upon the structures' proximity to heavily developed urban areas, and drainage basin or watershed area. If the watershed contributing runoff to the structure was less than 4 square miles (2,560 acres), or the dam was located near a dense urban environment, the structure was eliminated as a viable candidate based on low yield potential or the likelihood of not being able to readily acquire land for an increase in pool area. Based upon the above criteria, 191 structures were determined not to be viable candidates as water supply reservoirs.

GSWCC retained the professional services of the project team of Schnabel Engineering South, LLC (Schnabel), Jordon Jones and Goulding (JJG), Joe Tanner and Associates, and Tommy Craig to further evaluate the remaining 166 structures (Figure 1) based upon environmental impacts, infrastructure impacts, and potential yield. Twenty dams that were identified as having a relatively high potential for yield, relatively moderate potential for environmental or infrastructure impacts, and located in areas in serious need of water, were selected for more detailed studies.

PREFACE

The results of the analysis presented were based upon United States Geological Survey (USGS) quadrangle maps and should be utilized for planning purposes only. If any of the subject projects were identified as having a possibility of progressing past this analysis, additional studies are required. These studies should include, but not be limited to, detailed environmental evaluations, detailed yield analyses, preliminary engineering design, and detailed cost estimating. These additional studies will be required prior to beginning detailed design work and/or land acquisition. The level of study presented should be considered as a screening tool to evaluate the project strengths and weaknesses relative to other projects. Until further studies are performed, actual yield and environmental factors associated with each project cannot be readily determined.

DESCRIPTION OF STUDY

Evaluation Factors/Methodology

GSWCC initiated this study in an attempt to determine which, if any, of the 357 watershed projects located throughout the state could be modified to serve as water supply reservoirs. Most of the watershed projects were constructed in the upper reaches of the watersheds. Therefore, the safe yield or the amount of water that the reservoir and associated drainage basin could supply in a drought would be limited. The remaining 166 projects were further evaluated by the consultant team of Schnabel and JJG based upon environmental impacts, infrastructure impacts, and potential yield. The purpose of the further evaluation was to identify 20 projects that had a relatively moderate potential for environmental and infrastructure impact while still providing a safe yield in an area of the state that was in need of a sustainable water supply.

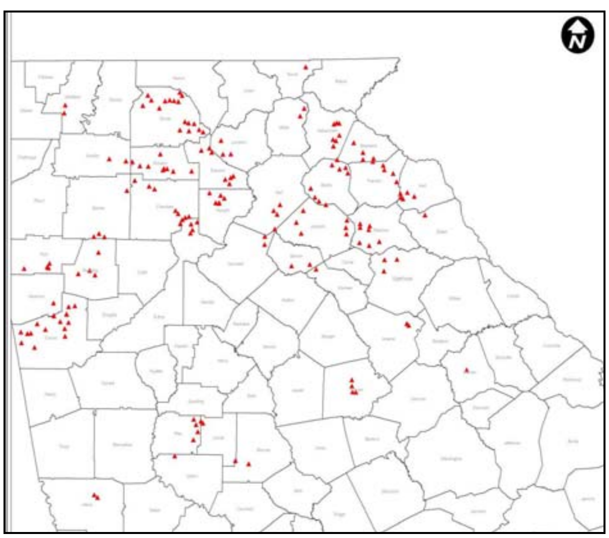

Figure 1. Potential Water Supply Reservoirs

DECISION MATRIX

The study team's approach to analyzing the 166 dams consisted of developing a matrix where multiple parameters could be weighted so that impact of individual parameters could be determined. The weighting of individual parameters allowed the study team to evaluate which of the parameters impacted a project's potential to become a water supply reservoir. The matrix included the following:

- Safe yield
- Time to refill reservoir
- Number of structures
- Number of streets
- Cultural resources
- Historic structures
- Trout streams
- Warm water streams
- Impaired streams
- Open water wetlands
- Other wetlands
- Distance to downstream water intakes
- Endangered flora
- Endangered fauna
- Endangered communities

ENGINEERING FACTORS

The following assumptions or boundary conditions were established in an attempt to provide evaluation equity between the projects:

1. The maximum top of dam elevation would be selected such that only one saddle dam with a height of no more than one contour interval would be required. Contour intervals ranged from 20 to 40 feet, depending on the region of the state. Dams were raised between 0 feet and 465 feet.
2. The maximum top of dam elevation could not impact major infrastructure projects such as U.S interstate highways, hospitals, schools, or military bases.
3. The normal pool of the reservoir was established by providing the same volume of flood storage (acre-feet) to the raised reservoir as was provided in the original design.
4. Pump storage would be considered for a project if a stream within two miles of the existing dam had a contributing watershed area of at least 50 square miles.

TOP OF DAM CONTOUR

The process of developing the maximum dam height began with delineating the drainage area of each dam. The contours were traced as polygon features at each contour interval from the normal pool of the existing dam increasing in elevation until the contour line crossed the drainage area boundary, indicating that impounded water would overtop the watershed boundary.

The footprint of the raised dam was also developed within ArcGIS. A 3.5 horizontal to 1 vertical slope was projected downstream from the centerline of the dam to form a polygon of the downstream slope of a dam embankment at its maximum height. This slope was considered to be a conservative estimate that includes the typical 3H:1V slope of the embankment plus berms and the top of the dam. The results were summarized and included in a Microsoft Access database.

IMPACTED FACILITIES

The number of buildings impacted was estimated by digitizing the structures (Figure 2) that fell within the contour lines using aerial photographs obtained from ESRI's Online Services Beta Program. Most of these aerial photos are seamless color mosaic from various sources including 2-foot imagery for metropolitan areas and USDA NAIP and USGS enhanced DOQQ photos for all other areas. Dates of the aerial photos for Northern Georgia range from 2004-2006.

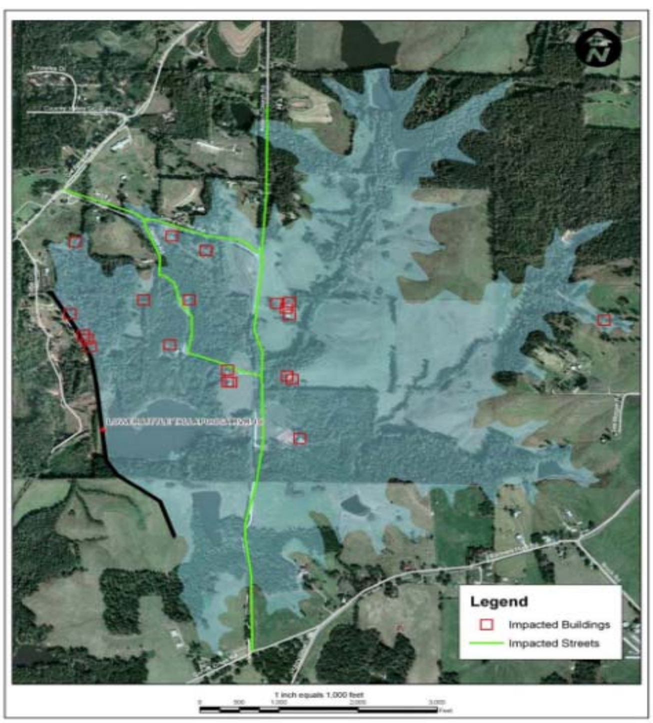

Figure 2. Structures Potentially Impacted by Increased Reservoir Storage

YIELD ANALYSIS

Reservoir safe yield is generally defined as the reliable withdrawal rate of acceptable quality water that can be provided by reservoir storage through a critical drought period. While total water demands during a defined drought condition are usually less than normal, this situation is typically offset by higher than average demands prior to the clear definition of a drought condition. Safe yield is dependent upon the storage and hydrologic (rainfall/runoff/evaporation) characteristics of the source and source facilities, the selected critical drought, upstream and downstream permitted withdrawals, and the minimum in-stream flow requirements.

For the initial phase of yield assessments, the safe yield of the 166 dams was estimated as follows. The study area was divided into six hydrologically-similar regions, with a representative stream gage selected for each region. Similar regions were initially identified as those having similar average annual runoff (as presented on Plate 1 of *Storage Requirements of Georgia Streams*, USGS Open-File Report 82-557), and subsequently by graphing unit discharge (cfs per square mile of drainage area) of daily gage data for several streams in each area. Of these, a representative stream gage was selected in each region based on length of record, drought periods reflected in the records, absence of significant in-basin withdrawals, and input from GAEPD. The various regions are presented in Figure 3, and the representative gages are presented below in Table 1.

The yields presented in this report should be considered approximate. All yield calculations are based on topographic information from USGS quadrangle maps, which can have an appreciable effect on real reservoir storage volumes.

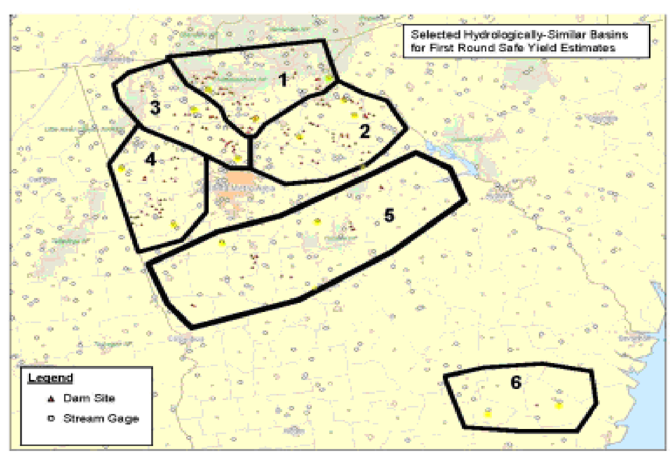

Figure 3. Hydrological Regions

Table 1. Selected USGS gages for six study regions

Region	*USGS gage*	*Record Period*
1	02333500 Chestatee River Near Dahlonega, GA	April 1940 - Present
2	02217000 Allen Creek at Talmo, GA	Aug 1951 - Sept 1971
3	02382200 Talking Rock Creek near Hinton, GA	Nov 1973 - Present
4	02412000 Tallapoosa River near Heflin, AL	July 1952 - Present
5	02193500 Little River near Washington, GA	Oct 1949 - May 1971 May 1989 - Present
6	02227500 Little Satilla River near Offerman, GA	Feb 1951 – Present

DESIGN ASSUMPTIONS

1. Dead storage of 20% of gross reservoir storage was incorporated to allow for sediment storage and poor water quality in lower reservoir strata.
2. Water supply storage for expanded reservoir sites (including dead storage) was estimated by subtracting existing flood and surcharge storage (between normal pool and top of dam) from maximum computed storage at top of proposed raised dam.
3. There was no consideration of upstream or downstream withdrawals in the initial assessment.
4. For dam sites, minimum in-stream flow (MIF) of 30/60/40% average annual flow (AAF) was used.
5. For pumped-diversion sources, minimum in-stream flow of 30% AAF was used.
6. Evaporation loss was based upon net historical evaporation rates. Lake evaporation was assumed to be equal to 70% of pan evaporation during each month. Generalized reservoir shape parameters reflective of each region's physiography were incorporated into each model.
7. Direct drainage area ratio of gauging station to dam and pumped diversion drainage areas was applied to flows.
8. For sites considered as pumped-diversion projects, pump capacity was generally assumed to be in the range of 0.2 to 0.5 mgd/mi2 of diversion drainage area, and typically did not exceed 1.7 times to 2.5 times the safe yield of the project. Pumped diversions in the model were bounded by pumping capacity and diversion MIF requirements.
9. Total seepage losses would be less than the MIF requirements and, therefore, did not need to be separately considered.
10. For the dam to be considered as a pump storage scheme, a large stream had to be within 2 miles of the existing dam and have a drainage area of at least 50 square miles.

The attainable safe yield during the analyzed period was found by iteration of the daily mass balance equation:

Ending Storage = (Beginning Storage) + (Natural Inflow) + (Pumped Inflow) – (Water Supply) – (Evaporation) – (MIF)

**Note pumped inflow only applied to pumped-storage projects.*

SAFE YIELD

Incorporating the above assumptions, the safe yield of each site was computed. Table 2 demonstrates an example of the results of the on-stream safe yield analysis.

The table presents the names of the dams with safe yield and refill time. In addition, notes are included in the table to denote special conditions encountered in the analysis. For example, for many sites the refill time of the reservoir extended more than 8 years, preventing refill from the 1999-2001 drawdown and thereby extending into the present drought. In many of these cases, the safe yield was estimated based on simulated reservoir drawdown through September 2007. The continuation of the drought could cause reduction in safe yield for the assumed conditions.

PUMP-STORAGE ANALYSIS

The results of the pumped-storage yield analyses are presented in Table 3. In addition to the data presented in this table, other information was also tabulated, including diversion drainage area, straight-line distance to the diversion source, and pump capacity. These initial analyses did not incorporate spillway sizing for the probable maximum flood, nor did they account for upstream and downstream withdrawals at the diversion source. The tabulated values represent maximum values that will likely be reduced in subsequent detailed safe yield analyses.

Table 2. Georgia NRCS watershed dams safe yield assessment safe yield of on-stream sites

Dam Name	Reg	D.A. (Sq.Ml)	Max Storage (BG)	Existing Surcharge Storage (BG)	Based on Maximum Storage: Available Water Supply Storage (Including Dead Storage)(BG)	Safe Yield (mgd)	Refill Time (Yrs)	Note
Amicalola Cr 02	1	4.38	3.89	0.58	3.13	2.1	7	
Amicalola Cr 03	1	6.08	8.00	0.72	7.28	4.2	13	C
Amicalola Cr 04	1	4.13	2.70	0.36	2.34	1.8	7	
Barber Cr 08	2	5.84	22.67	0.17	22.70	0	N	
Barber Cr 28	2	2.01	3.03	0.16	2.87	0.12	15	F
Beaver Dam Cr 04	2	0.94	2.42	0.09	2.33	0	N	N
Beaver Dam Cr 05	2	1.15	2.49	0.15	2.33	0	N	N
Beaver Dam Cr 06	2	1.56	0.19	0.19	0	0	N	N
Beaver Dam Cr 08	2	4.39	19.64	0.57	19.07	0	N	N
Beaver Dam Cr 17	2	5.36	7.60	0.83	6.77	1.4	15	F
Beaver Dam Cr 30	2	22.61	18.97	2.40	16.57	8.6	10	
Big Cedar Cr	4	3.83	2.83	0.90	1.98	1	11	C
Bishop Cr 07	4	18.73	1.40	0.64	0.76	0		

C=Current drought controls; does not refill using current data
N=Never refills to normal pool over period of record (66 yrs)
F=Fraction of storage used. Safe Yield based on requirement to refill at least once in analysis period
Existing Surcharge Storage=Storage Between Top of Dam + Normal Pool

Table 3. Safe yield of pumped storage sites

Dam Name	*Reg*	*Straight Pipe Length (miles)*	*Diversion River Name*	*Diver-sion D.A. (sq.ml)*	*Dam D.A. (sq.ml)*	*Water Supply Storage (BG)*	*Pump Capacity (mgd)*	*Safe Yield (mgd)*	*Refill Time (Yrs)*
Cartecay R 01	1	0.4	Cartecay R	57	9.06	2.82	20	12.6	3
Cartecay R 03	1	0.9	Cartecay R	51	6.42	0.86	8	4.6	1
Cartecay R 10	1	1.7	Cartecay R	66	6.60	0.18	3	1.3	1
Ellijay R 01	1	1.8	Ellijay R	75	8.38	3.82	30	17	3
Etowah R 01	1	1.5	Etowah R	310	6.74	0.78	75	42.4	2
Etowah R 09	1	0.7	Etowah R	117	1.87	0.34	10	2.6	1
Etowah R 10	1	0.9	Etowah R	120	2.13	11.13	80	36.6	4
Etowah R 12	1	1.0	Etowah R	110	3.76	0.9	15	5.6	1
Etowah R 13	1	0.9	Etowah R	104	2.62	4.55	40	21.6	3
Etowah R 26	1	0.4	Etowah R	62	10.82	1.08	10	5.9	1
Lit Satilla C 07	6	2.0	Satilla Cr	110	28.20	3.84	55	0.5	4
Lit Tallapoosa R 19	4	0.7	Little Tallapoosa R	53	8.88	10.04	25	12.2	5
Lit Tallapoosa R 20	4	0.7	Little Tallapoosa R	67	5.18	9.22	25	11.9	6
Lower Lit Tallapoosa R 14	4	0.3	Big Indian Cr	55	4.13	6.71	20	9.2	5
Lower Lit Tallapoosa R 19	4	1.6	Little Tallapoosa R	210	2.66	6.76	35	16.3	4
M. Fork Broad R 28	2	0.9	Broad R, Middle Fork	50	2.45	12.89	30	14.6	10
M. F0rk Broad R 30	2	0.6	Broad R, Middle Fork	52	2.15	1.31	10	5	3
Mid-Oconee-Walnut C 05	2	1.7	M Oconee R	49	2.53	3.58	20	8.9	5
N. Broad R 32	2	1.2	Broad R, N Fork	57	1.90	1.6	12	5.9	3
N. Broad R 35	2	0.6	Broad R, N Fork	66	2.63	0.06	2	0.42	1
Potato C 82	5	1.9	Potato C	52	4.66	11.31	15	4.2	13*
Pumpkinvine C 02	4	1.6	Etowah R	1282	4.20	2.34	20	8.6	2
Pumpkinvine C 11	4	2.0	Pumpkinvine C	48	3.71	0.65	5	2.15	2
Pumpkinvine C 16	4	1.0	Pumpkinvine C	81	2.89	7.85	25	11.5	5
Raccoon C 07	4	1.3	Raccoon C	51	3.62	4.44	20	7.8	4
Raccoon C 08	4	1.0	Etowah R	1284	1.38	3.2	20	9.5	4
Sallacoa C 062	3	0.4	Salacoa C	85	3.63	0.01	0.5	0.05	1
Sautee C 13	1	2.0	Chattahoochee R	107	2.95	3.42	30	16.2	2
Up.Mulberry R 08	2	2.0	Mulberry C	51	2.84	2.63	20	8.4	3

**1999-present is current drought of record for this reservoir, yield may ultimately be lower than shown*

ENVIRONMENTAL FACTORS

Environmental factors were selected based on the impact they would have on the expanded reservoir permitting process:

- Streams
- Wetlands
- Impaired Streams
- Trout Streams
- Threatened and Endangered Species
- Cultural Resources
- Historic Resources

GIS DATABASE DEVELOPMENT

A GIS database was developed using the maps and aerial photographs. The database contains the original maps and aerial photographs obtained by the methods described, and the extracted information related to each specific reservoir.

DECISION MATRIX

Upon development of the GIS database, the sums of the various environmental and engineering impacts from the 166 dams were imported into a spreadsheet for evaluation. The spreadsheet was formatted as a decision matrix so that rankings could be developed to facilitate the selection of the final 20 dams. The decision matrix consisted of three ranking procedures, each independent of the other so that a comparison of the methods could be made. Each ranking procedure also included two iterations, one ranking with no pump-storage facilities and one ranking that included all pump-storage facilities. Within each procedure, the individual factors were ranked. The sums of these individual rankings were used to extract the dams with highest overall rank. Note that ranking matrix 1 only summed the raw values from each individual category. From these top ranked dams, the final 20 dams were selected.

FACTORS

1. Environmental

- Cultural Resources–Number of sites impacted
- Historic Resources–Number of sites impacted
- Trout Streams–Linear feet impacted
- USGS Streams–Linear feet impacted
- Impaired Streams–Linear feet impacted
- Lacustrine Wetlands–Acres impacted
- Palustrine Wetlands–Acres impacted
- Threatened and Endangered Species–Number of fauna impacted
- Threatened and Endangered Species–Number of flora impacted
- Threatened and Endangered Species–Number of natural communities impacted

2. Economic

• Streets–Number of streets impacted
• Structures–Number of structures impacted

3. Engineering

• Approximate Yield–In MGD
• Reservoir Fill Time–In years
• Pumping Distance–In miles, for pump-storage facilities only, non-pump storage facilities were automatically given a default advantage with a distance of 0.
• Surface Water Intakes–Linear feet to nearest downstream intake

SELECTION CRITERIA FOR TOP 20 DAMS

The GIS database allowed the study team to evaluate the scoring weight of the previously discussed parameters in the selection matrix. In the final analysis, after evaluating how the ranking values could be normalized and what range of weights were appropriate for each category, the project team, along with GSWCC and NRCS decided to place yield potential as the first priority, and time to refill as the second priority. In effect, the various weighting schemes identified above were not used in the final selection process. The project team concluded that the projects selected for further evaluation should have a safe yield of at least 1 mgd and a refill time not exceeding five years.

The process followed to arrive at the twenty dams was as follows. The 166 dams were sorted based on descending yields with refill times equal to or less than five years. This approach produced 37 dams, several of which met the requirements discussed above for both for on-stream and pump storage. Table 4 shows the 37 dams and indicates why 17 of the dams were eliminated.

After reviewing the geographic location of these dams in relation to demand and need for water, and if the reservoirs were on primary trout streams, a list of 20 dams was developed. Two dams in Gilmer County, located on existing trout streams, were maintained on the final selection list because all streams in Gilmer County are considered as trout streams. Table 5 lists the final selected 20 dams. Figure 4 shows the final 20 dam locations

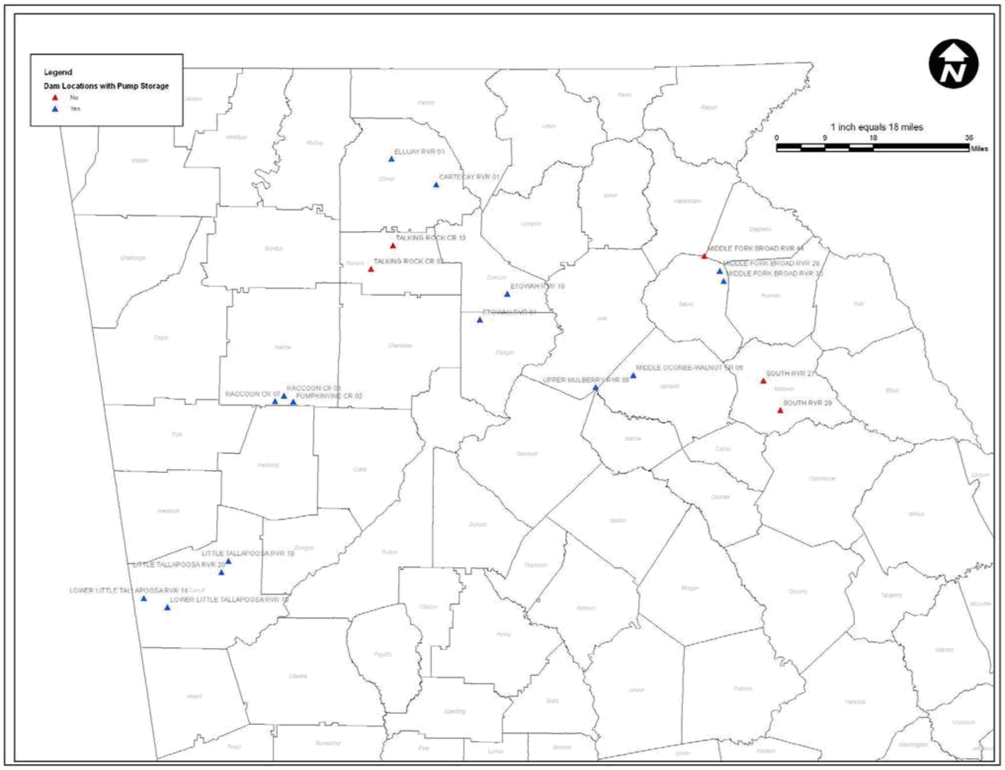

Figure 4. Top Twenty Dams

Table 4. Initial selection of dams with refill times equal to or less than 5 years (37 dams)

Dam *(P refers to pump storage)*	***County***	***Selection/ Elimination Criteria***
Beaverdam Creek 30	Elbert	N
Cartecay River 01	Gilmer	P
Cartecay River 01P	Gilmer	S
Cartecay River 03	Gilmer	T
Cartecay River 03P	Gilmer	T
Cartecay River 08	Gilmer	T
Cartecay River 10P	Gilmer	T
Ellijay River 01P	Gilmer	S
Ellijay River 04	Gilmer	T
Etowah River 01P	Forsyth	S
Etowah River 09P	Dawson	C
Etowah River 10P	Dawson	S
Etowah River 12	Dawson	C
Etowah River 12P	Dawson	C
Etowah 13P	Dawson	C
Etowah River 26	Lumpkin	T
Etowah River 26P	Lumpkin	T
Etowah River 32	Lumpkin	T
Little Tallapoosa River 16	Carroll	Y
Little Tallapoosa River 19P	Carroll	S
Little Tallapoosa River 20P	Carroll	S
Lower Little Tallapoosa River 14P	Carroll	S
Lower Little Tallapoosa River 19P	Carroll	S
Middle Fork Broad 44	Habersham	S
Middle Fork Broad River 28P	Franklin	S
Middle Fork Broad River 30P	Franklin	S

Middle Oconee-Walnut Creek 06P	Jackson	S
Mountaintown Creek 01	Gilmer	T
Mountaintown Creek 02	Gilmer	T
North Broad River 32P	Franklin	A
Pumpkinvine Creek 02P	Bartow	S
Pumpkinvine Creek 11P	Paulding	P
Pumpkinvine Creek 16P	Paulding	P
Raccoon Creek 07P	Bartow	S
Raccoon Creek 08P	Bartow	S
Sautee Creek 13P	White	T/A
South River 27	Madison	S
South River 29	Madison	S
Talking Rock Creek 02	Pickens	S
Talking Rock Creek 13	Pickens	S
Upper Mulberry River 08P	Hall	S

Key:
S - Selected
N - No High Demand for Water
T – Located on primary Trout Stream
C – New Project already under development
A- Alternate to Top 20 dams
P – Potential Permit Issues
Y-Low Yield Among Adjacent Projects

Table 5. Top 20 dams

Dam Name	County	Safe Yield (mgd)	Refill Time (years)	Estimated Cost
Lower Little Tallapoosa 14P*	Carroll	7.5	4-5	$112,000,000
Lower Little Tallapoosa 19P	Carroll	9.9	4-5	$115,000,000
Little Tallapoosa 20P	Carroll	0.9	0.8	$71,000,000
Little Tallapoosa 19P	Carroll	5.5	4-5	$212,000,000
Raccoon Creek 7P	Bartow	4.1	4-5	$96,000,000
Raccoon Creek 8P	Bartow	11.5	4-5	$91,000,000
Pumpkinvine Creek 2P	Bartow	6.8	4-5	$78,000,000
Ellijay River 1P	Gilmer	9.6	2	$118,000,000
Cartecay River 1P	Gilmer	8.6	2	$79,000,000
Talking Rock Creek 2	Pickens	1.0	4	$48,000,000
Talking Rock Creek 13	Pickens	2.3	5	$73,000,000
Etowah River 10P	Dawson	17.8	4-5	$153,000,000
Etowah River 1P	Forsyth	24.3	4-5	$256,000,000
Upper Mulberry River 8P	Hall	2.6	4-5	$113,000,000
Middle Oconee-Walnut Creek 6P	Jackson	3.0	4-5	$79,000,000
Middle Fork Broad River 28P	Banks	8.0	4-5	$101,000,000
Middle Fork Broad River 44	Habersham	1.5	2	$59,000,000
Middle Fork Broad River 30P	Banks	3.5	4-5	$57,000,000
South River No. 27	Madison	3.9	5.5	$191,000,000
South River No. 29	Madison	5.7	5.5	$243,000,000

CONCLUSION

The Georgia Soil & Water Conservation Commission is meeting with county commissioners, water authorities and others in the affected counties, providing study data concerning the use of local flood control reservoirs as potential water supply. GSWCC believes that these reservoirs provide viable alternatives to be considered as part of a long term strategy for solving local water supply needs for the next 50 years.

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