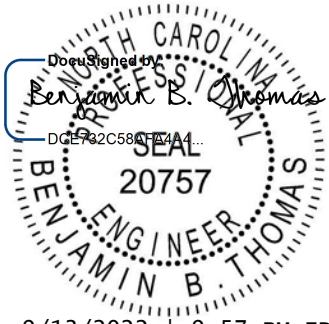
TOWN OF BEECH MOUNTAIN

DROUGHT MITIGATION PROJECT

BENEFIT-COST ANALYSIS and METHODOLOGY

September 12, 2022



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A. Introduction and Limitations

This Benefit-Cost Analysis (BCA) is being provided at the request of the Town of Beech Mountain. The purpose of the analysis is to determine the value of the benefits provided by the proposed project, in relation to its capital and operations cost. The relation of benefits to costs is expressed as a ratio, the Benefit-Cost Ratio (BCR), which is used by FEMA in evaluating the justification of projects. The analysis presented in this report is based on information provided by the Town of Beech Mountain and publicly available information. It is beyond the scope of this report to examine all alternatives that may be available to address any issues with the Town's water system. This BCA is limited to the estimation of costs and benefits. The selection of recurrence intervals for damages due to natural hazards is part of the estimation process, but this report shall not be relied upon for decisions pertaining to the timing of system improvements or other actions.

B. Project Description (Scope of Work) and Analysis Approach

The Town of Beech Mountain operates a drinking water system that suffers every year with insufficient water supply. The problem is described below under "Damages before Mitigation." The proposed project is to construct a secondary reservoir and a pumping station and force main to transport water from the new reservoir to the existing water treatment plant. The new reservoir would be constructed by linking two existing reservoirs, Lakes Coffey and Santis, and increasing their combined storage volume by excavation and by building a larger dam. The existing reservoirs are already adjacent to each other. The preliminary design calls for two 1,050 gallons per minute pumps and 12,500 linear feet of 12" raw water force main. The reservoir and its three tributary streams will supplement the Town's existing source water. The combination will meet the demand of the system through drought periods. A detailed cost opinion is attached which further describes the project scope.

The project will be designed and built in compliance with all applicable federal, state, and local standards and the proposed project will not have adverse upstream or downstream impacts. Applicable regulations include, but are not limited to, the Clean Water Act sections 401 and 404, the Safe Drinking Water Act and NC Public Water Supply Rules, the NC Sedimentation Pollution Control Act, and the NC Dam Safety Act. All work will be designed by qualified NC registered professional engineers using accepted engineering principles.

The Project location is 112 Lakeledge Rd, Banner Elk (Beech Mountain), Watauga County, North Carolina, 28604. The force main will follow utility easements from the new reservoir to the water treatment plant.

This Benefit-Cost Analysis (BCA) uses FEMA's Benefit-Cost Analysis Toolkit version 6.0 and uses default values provided by FEMA's BCA Guidance, unless otherwise stated. This BCA uses the Toolkit with two approaches. The first approach uses the Aquifer Storage and Recovery (ASR) model in the Toolkit to estimate the damages and benefits. Although this project will use a surface water reservoir rather than an aquifer to store wet-season excess water, the model is useful in showing the effects of the "before" and "after" situation based on the actual water supply deficit. Another approach is to use historical stream gauge data in the area to estimate the frequency and duration of droughts. As further described below, this approach uses estimates of historical droughts to predict future estimated damages.

C. Project Costs and Useful Life

The estimated capital cost of the project is $14,000,000, as shown on the attached breakdown.

The estimated annual maintenance cost is $57,158, as shown on the attached breakdown. All annual costs listed are new costs associated with new infrastructure and the modifications to the existing lakes and dams. Existing annual costs for Lake Coffey, which is already owned by the Town of Beech Mountain, are not included.

The useful life of the new reservoir and raw water conveyance system is estimated to be 50 years, based on the standard life listed in Appendix D of the BCA Reference Guide ("Major Infrastructure" and "Major Utility Mitigation - water").

D. Damages before Mitigation

The current and only water source, Buckeye Lake, is out of compliance with minimum release requirements every year (refer to Department of Army and NCDWR permits attached). The Town's water demand has been met only by retaining all water that does not go over the spillway. As shown on the attached stream gauge records, the water supply was insufficient for 26 days in 2020 and 90 days in 2021, i.e., the required downstream flow of 2.53 cfs in the winter and 1.26 cfs in all other seasons, was not met. The Town has been recording stream gauge flows since January 2020. But even before that, plant operators attest that the flow over the spillway decreases to near zero or to zero every summer. Furthermore, the High Country Region 2017 Hazard Mitigation Plan Update states that the region has experienced drought in 16 of the previous 17 years (Table 5.4).

SECTION 5: HAZARD PROFILES

According to the North Carolina Drought Monitor, at least one or more of the counties in the High Country Region has had drought occurrences sixteen of the last seventeen years (2000-2016) (Table 5.4). In addition, Table 5.5 shows the most severe drought classification for each year.

TABLE 5.4: SUMMARY OF DROUGHT OCCURRENCES IN THE HIGH COUNTRY REGION

LOCATION	NUMBER YEARS WITH DROUGHT OCCURRENCES
ALLEGHANY COUNTY	15
ASHE COUNTY	16
WATAUGA COUNTY	16
WILKES COUNTY	16

Source: North Carolina Drought Monitor

Therefore, a recurrence interval of 1 could be used. However, as a more conservative approach to estimating damages associated with drought, a water balance calculation was performed that mimics the function of the Buckeye Lake reservoir. The water flow into the reservoir is modeled as being proportional, on a drainage area basis, to the nearest USGS stream gauge with a long history of flow data (Watauga River at Sugar Grove, Site No. 03479000). The model then estimates flows out of the reservoir due to evaporation, minimum downstream release, and

drinking water withdrawals. The model includes reductions in water outflows during times of drought, based on water restrictions placed on the customers and based on reductions in the required minimum release. (The current permit allows reducing the minimum release during droughts). The model results then show which days over the USGS stream gauge history the water supply would have failed to meet the drinking water demand. Using the BCA Toolkit calculator, the estimated historical damages are converted to annualized damages. In addition, the model is used to estimate the potential yield of the Buckeye Lake water source if it is not supplemented by other sources. Using the same USGS stream gauge historical data, the reservoir is estimated to be capable of yielding 0.21 million gallons per day (MGD) through all droughts of record. This yield of 0.21 MGD is used for the ASR model.

Beech Mountain has many rentals and second homes that are not occupied every month of the year. The seasonal population is approximately 5,179, which is taken from page 13 of the Town of Beech Mountain Comprehensive Plan 2020-2035. This seasonal population is also listed on the 2021 Local Water Supply Plan, page 4. This population was then adjusted to approximate the average number of persons using the water system annually. This was calculated by setting the highest water consumption month as representing a month that housing units are fully occupied, then estimating the other months as having an occupancy that varies proportionately with the residential water consumption. The result was an estimated average annual occupancy (population) of 3,679. A table showing this calculation is attached.

Annual average demand/withdrawal is 0.47 MGD, based on the 2020 Local Water Supply Plan (LWSP). Some of this demand represents system leakage that can be reduced by replacing aging infrastructure. Based on the length of water mains and the operating pressures, the Unavoidable Real Losses (UARL) is estimated to be 0.12 MGD. This is calculated using the American Waterworks Association's (AWWA) water audit software. The definition of UARL, according to the AWWA, is "a theoretical reference value representing the technical low limit of leakage that could be achieved if all of today's best technology could be successfully applied" (see attached excerpts from the 2020 audit). The Town of Beech Mountain is actively replacing its water distribution system. In 2021 the Town completed the replacement of 17,300 linear feet of water main (Project #H-SRP-D-17-0126). At present, engineering is nearly complete for the replacement of 22,700 linear feet water main replacement (Project #SRP-D-ARP-0126 & WIF-2023). Construction will begin in 2023. Another project underway is the replacement of approximately 350 services. According to the AWWA, the best possible reduction in water demand, based on replacement of the distribution system, would be from 0.28 MGD (Current Annual Real Losses, CARL) to 0.12 MGD (UARL). The "avoidable real losses" are estimated to be 0.28 – 0.12 = 0.16 MGD. Whereas this is an idealistic scenario and not achievable in only a few years, it is assumed that about half of the avoidable real loss can be eliminated in the near future. Therefore, an average annual demand of 0.40 MGD was used for purposes of this BCA.

For both approaches, the cost (value) of potable water service is $114 per person per day, based on FEMA's default value. For the ASR model approach, as described above, using the FEMA BCA Toolkit, the annualized damages are calculated to be $10,642,427 and the total damages avoided to be $146,873,424. For the professional expected damages approach, using the FEMA BCA Toolkit, the annualized damages are calculated to be $1,509,900 and total damages avoided to be $20,837,747.

E. Expected Damages after Mitigation

After mitigation by the completion of the project, annual dry weather conditions will no longer impact the water system. This is demonstrated using a water balance model for the proposed Lake Coffey reservoir. Like the model for Buckeye Lake, the model for Lake Coffey uses historical stream gauge data on the Watauga River to mimic droughts of record. Since the Watauga River historical records showed the period of 1951 to 1954 as being the most critical drought period, that flow data was used in the Lake Coffey model. Lakes Coffey and Santis are currently used for snowmaking and irrigation and have been permitted for these uses for many years. Water flows out of the reservoir for these uses were modeled based on actual pumping records. Those records are from 2020 and 2021 and were repeated in the 1951-1954 period of analysis. The withdrawals for drinking water use were modeled as being 0.4 MGD on days that the Buckeye Lake model indicated it would fail to meet the water system demand.

It is known that snowpack on the ski slopes melts and drains back into the reservoir during the ski season, due to the southern climate. The amount of the snow melt within a critical drought period is unpredictable. It is estimated that a snow melt return of 52% will replenish the reservoir sufficiently during the critical simulation month of December 1954, as shown by the model. For future droughts that mimic that extreme, if the snow melt is not that high, then snow production would simply have to be reduced. The primary purpose of the reservoir is for drinking water withdrawals. Other uses will be restricted as needed to meet the primary purpose.

Two printouts from the model show the results and are attached. The drought-simulation graph shows that the water level in the new Lake Coffey would drop from a full pond elevation of 40 feet to a low level of 16 feet in November 1954, if drinking water were the only use. It also shows that the water the level would drop to 2.6 feet in December 1954 if snowmaking continued through the drought and if 52% returned due to melting.

F. Benefit-Cost Ratio Calculation

Using the FEMA BCA Toolkit, the calculated total costs and benefits are as summarized below:

ASR Model approach:
Total Standard Mitigation Benefits: $146,873,424
Total Mitigation Project Cost: $14,788,823
Benefit Cost Ratio - Standard: 9.93

Professional Expected Damages approach:
Total Standard Mitigation Benefits: $20,837,747
Total Mitigation Project Cost: $14,788,823
Benefit Cost Ratio - Standard: 1.41

In conclusion, the proposed project is estimated to have a value of benefits that exceeds the costs (BCA greater than 1.00), using either analysis approach.

APPENDIX 1 - Project Cost Opinion

Town of Beech Mountain

DROUGHT MITIGATION PROJECT (Lake Coffey Expansion)

Funding Application

Preliminary Cost Opinion

September 12, 2022

Construction Costs

Item	Description	Quantity	Unit	Unit Cost	Total Cost	Notes
1	Mobilization	30	days	$5,000	$150,000	
2	Demolition/Disposal	4,500	SF	$8	$36,000	Storage building, basketball court, pump houses
3	Drain Ponds (siphon or pump as needed)	5	days	$5,000	$25,000	
4	Temporary Stream Bypass	600	LF	$50	$30,000	
5	Temporary Erosion Control - Sediment Ponds	2	EA	$7,500	$15,000	
6	Temporary Erosion Control - Silt Fence	2,000	LF	$7	$14,000	
7	Clearing, Grubbing, Mucking	6	AC	$10,000	$60,000	
	Relocate Existing Gravity Sewer Main	1,000	LF	$250	$250,000	
8	Emergency Spillway (~50' x 200')	1,100	SY	$150	$165,000	
9	Toe Drain	750	LF	$50	$37,500	
10	Earthwork (Cut/Fill on site)	52,000	CY	$17	$884,000	includes earth fill for dam
11	Mass Rock Excavation	48,000	CY	$40	$1,920,000	
12	Export Soil/Rock	48,000	CY	$20	$960,000	assumes no credit for value of material & only dumping at waste site
13	Liner to Reduce Seepage (soda ash, bentonite, or membrane - TBD)	260,000	SF	$1	$260,000	
14	Slope Matting	80,000	SY	$3	$240,000	
15	Grassing	3	AC	$10,000	$30,000	
16	Anti-Seep/Filter Diaphragm Drainage System - fabric	500	SY	$5	$2,500	
17	Anti-Seep/Filter Diaphragm Drainage System - stone/sand	300	TN	$50	$15,000	
18	Principal Spillway - Riser Structure (reinf. concrete)	140	CY	$2,000	$280,000	
19	Principal Spillway - Riser Trash Rack	1	EA	$15,000	$15,000	
20	Principal Spillway - Pipe/Barrel	500	LF	$300	$150,000	
21	Principal Spillway - Outlet Energy Dissipator (plunge pool)	250	CY	$200	$50,000	use boulders/rock already on site
22	Drain Valve or Gate	1	EA	$30,000	$30,000	
23	Drain Pipe	500	LF	$100	$50,000	
24	Intake Structure - Reinforced Concrete	350	CY	$2,000	$700,000	
25	Intake Structure - Pipe, Valve, Screen	3	EA	$50,000	$150,000	3 levels
26	Intake Structure - Air Burst System	3	EA	$25,000	$75,000	
27	Intake Structure - Air Burst System	3	EA	$25,000	$75,000	
28	Raw Water Pumps (vertical turbine, 1050 gpm, 175 to 200 hp)	2	EA	$200,000	$400,000	
29	Raw Water Pumps Variable Frequency Drives & Controls	2	EA	$50,000	$100,000	
30	Raw Water Pumps Remote Monitoring & Control (SCADA)	1	EA	$100,000	$100,000	
31	Raw Water Pumps Piping	100	LF	$200	$20,000	
32	Raw Water Pumps Valves	8	EA	$10,000	$80,000	
33	Pump Building	1,200	SF	$400	$480,000	includes walls, roof, doors, electrical/lighting; build over intake structure; space for relocated Ski Beech and Club irrigation pumps
34	Pump Building - Security System	1	EA	$40,000	$40,000	
35	Standby Diesel Generator Set (~200 kW)	1	EA	$150,000	$150,000	for raw (drinking) water pumps only
36	Standby Diesel Generator Set Auto Transfer Switch	1	EA	$50,000	$50,000	approx. 600 amps
37	Manganese Reduction - Chemical Feed Pumps	2	EA	$7,500	$15,000	inject KMnO4 or NaMnO4
38	Manganese Reduction - Tank	1	EA	$10,000	$10,000	
39	Relocate Ski Beech Resort Pumps	4	EA	$30,000	$120,000	
40	Relocate Ski Beech Resort Pumps - controls	1	EA	$25,000	$25,000	
41	Relocate Ski Beech Resort Pumps - piping	100	LF	$200	$20,000	
42	Relocate Ski Beech Resort Pumps - valves	10	EA	$10,000	$100,000	
43	Relocate Golf Course Irrigation Pumps	2	EA	$20,000	$40,000	
44	Relocate Golf Course Irrigation Pumps - controls	1	EA	$25,000	$25,000	
45	Relocate Golf Course Irrigation Pumps - piping	100	LF	$200	$20,000	
46	Relocate Golf Course Irrigation Pumps - valves	10	EA	$10,000	$100,000	
47	Replace Walking Trail (8' wide paved)	1,600	SY	$75	$120,000	keep as much of wood walkways as can
48	Existing Fishing Pier - Set aside, put back after project completion	7	days	$5,000	$35,000	
49	Paved Driveway & Parking Lot	1,000	SY	$75	$75,000	
50	12" DIP Raw Water Force Main (includes valves, fittings, appurtenances)	12,500	LF	$125	$1,562,500	
51	Raw Water FM Major Road Crossing (steel encase or open cut)	100	LF	$1,000	$100,000	
52	Raw Water FM Combination Air/Vacuum Release Valve (including manholes)	4	EA	$15,000	$60,000	
53	Raw Water FM Gate Valve and Blowoff Assembly	4	EA	$12,000	$48,000	
54	Raw Water FM Back Pressure Sustaining Valve/Vault	2	EA	$50,000	$100,000	
55	Trench Rock Excavation for Force Main & Pipes Under Dam	3,000	CY	$200	$600,000	
56	Connect to 12" Stub at Water Trmt Plant	1	EA	$50,000	$50,000	
57	Connect to 12" Stub at Water Trmt Plant - add blow-off assembly	1	EA	$75,000	$75,000	
58	Road/Driveway Repair	1,200	SY	$175	$210,000	
59	Relocate Electrical Service to New Pump Building	500	LF	$300	$150,000	
60	Demobilization	30	days	$5,000	$150,000	
				Total Construction Cost	**$11,749,500**	

Other Costs

1	Pre-Award Planning	795	HR	$100	$79,500	
2	Environmental Assessment Professional Services	160	HR	$150	$24,000	
3	Geotechnical Services pre-design investigation - borings	600	VF	$20	$12,000	
4	Geotechnical Services pre-design investigation - lab analysis	10	EA	$300	$3,000	
5	Geotechnical Services pre-design investigation - analysis & report	100	HR	$175	$17,500	
6	Geotechnical Services construction-phase monitoring - technician	500	HR	$75	$37,500	

Item	Description	Quantity	Unit	Unit Cost	Total Cost	Notes
7	Geotechnical Services construction-phase monitoring - engineer	80	HR	$175	$14,000	
8	Geotechnical Services construction-phase monitoring - lab analysis	40	EA	$200	$8,000	
9	Land Surveying - field work	300	HR	$150	$45,000	
10	Land Surveying - office work	100	HR	$100	$10,000	
11	Project Engineer - Design Team Management	500	HR	$100	$50,000	
12	Civil Engineering Design - reservoir/site	600	HR	$100	$60,000	
13	Civil Engineering Design - Pumping Station	1,000	HR	$100	$100,000	
14	Civil Engineering Design - Force Main	600	HR	$100	$60,000	
15	Civil Engineering Design - Tie-in at WTP	120	HR	$100	$12,000	
16	Electrical Engineering	160	HR	$150	$24,000	
17	Dam & Hydraulics Engineering Design	950	HR	$150	$142,500	
18	Stream Impacts Design and Permitting Professional Services	200	HR	$150	$30,000	
19	Stream Impacts Compensatory Mitigation Fees	850	LF	$1,300	$1,105,000	assume 2:1 ratio
20	State Dam Safety Permit Fee	1	EA	$50,000	$50,000	0.5% of the actual cost over $1,000,001 or $50,000 (whichever is less)
21	Other State Permit Fees	10	AC	$250	$2,500	NCDEQ erosion, DWR Public Water Supply
22	Legal Services (agreement with other water users, construction contract review, etc.)	80	HR	$300	$24,000	
23	Construction Administration by Project Engineer	17	months	$8,000	$136,000	
24	Construction Observation (Full Time RPR)	17	months	$12,000	$204,000	RPR = Engineer's "Resident Project Representative"
	TOTAL PROJECT COST				**$ 14,000,000**	

The costs indicated represent my opinion of the probable costs if the project were constructed at present and had been competitively bid. Final design, market conditions for labor and materials, unforseen subsurface conditions, weather-related delays and other factors will affect actual cost.

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APPENDIX 2 - Estimated Annual Maintenance Cost

Town of Beech Mountain

Supplemental Source - Lake Coffey Drought Mitigation Project

September 12, 2022

Estimated Operating Expenses

Intake, Pump Station, Force Main, Dam

Item			Cost per month used	Notes	Non-use Months	Notes
Energy for Pumping:				120 kw (1050 GPM @ 424' TDH @ 70% eff.)		
Mtn. Electric (GSA-2) Base Charge			$92	including 7% tax	$92	
Mtn. Electric (GSA-2) Demand Charge			$1,124	(120-50kw)($15/kw) + 7% tax	$1,124	exercise pumps once per mo.
Mtn. Electric (GSA-2) Distribution Charge	12,000	kgal	$3,171	1.90 kwh/kgal @ $0.13/kwh + 7% tax	$106	exercise pumps once per mo.
SCADA (cellular fee)			$50	Estimate for cell modem bill	$50	
Generator annual service			$100	estimated $1,200 annually	$100	
Chemical Pretreatment			$50	sodium permanganate for oxidation of Mn	$50	
calibration/maintenance			$100	est. $2,400 annually	$100	
Insurance - property			$625	est. 0.25% of $3M = $7,500 annually	$625	
Repairs & Maintenance			$1,000	est. $12,000 annually (pumps, valves, roof, controls)	$1,000	
Dam Maintenance (mowing & miscellaneous)			$250	based on actual cost to maintain Buckeye Lake dam	$250	
Routine Maintenance			$500	Check station weekly, discharge reporting to State, gravel drive replenish, etc	$500	
Subtotal			**$7,062**		**$3,997**	
Annual Total (based on 3 months full use)			**$57,158**	actual use expected to be less than 90 days per year		

Note: all costs are new costs associated with new infrastructure and the modifications to the existing lakes and dams. Existing O&M costs for Lake Coffey, owned by the Town of Beech Mtn., are not included.

RATE SCHEDULE SUMMARY		Base *1 ($) Effective October 1, 2019		
RESIDENTIAL RATE--SCHEDULE RS				
RESIDENTIAL CLASS 22	**Rate 22**	**Summer**	**Winter**	**Spring/Fall**
Customer Charge		**17.71**	**17.71**	**17.71**
First 800 kWH		**0.07561**	**0.07192**	**0.06862**
Additional kWH		**0.06854**	**0.06789**	**0.06789**
Minimum bill		**20.24**	**20.24**	**20.24**
GENERAL POWER--SCHEDULE GSA				
GSA-1 - LESS THAN 50 kW: CLASS 40	**Rate**	**Summer**	**Winter**	**Spring/Fall**
Customer Charge				
Single-phase, self contained	80	**20.24**	**20.24**	**20.24**
Single-phase, transformer-rated	81	**20.24**	**20.24**	**20.24**
Three-phase, self contained	82	**28.40**	**28.40**	**28.40**
Three-phase, transformer-rated	83	**32.48**	**32.48**	**32.48**
kWh (All Rates)		**0.08841**	**0.08584**	**0.08304**
GSA-2 - 51-1000 kW or MORE THAN 15,000 kWh: CLASS 50	**Rate**	**Summer**	**Winter**	**Spring/Fall**
Customer Charge				
Three-phase, transformer-rated	92	**85.65**	**85.65**	**85.65**
Three-phase, self contained	91	**67.30**	**67.30**	**67.30**
Single-phase	90	**37.73**	**37.73**	**37.73**
First 50 kW		**0.00**	**0.00**	**0.00**
Excess over 50 kW		**15.40**	**14.40**	**14.40**
First 15,000 kWh		**0.09700**	**0.09370**	**0.09163**
Additional kWh		**0.04812**	**0.04486**	**0.04362**
GSA-3 - 1001-5000 kW: CLASS 54	**Rate 54**	**Summer**	**Winter**	**Spring/Fall**
Customer Charge		**173.36**	**173.36**	**173.36**
First 1,000 kW		**15.87**	**14.98**	**14.98**
Excess over 1,000		**17.65**	**16.67**	**16.67**
First 15,000 kWh		**0.09760**	**0.09445**	**0.09416**
Additional kWh		**0.04603**	**0.04142**	**0.04093**
OUTDOOR LIGHTING SCHEDULE LS				
	Rate 77	**Summer**	**Winter**	**Spring/Fall**
All kWH		**0.04891**	**0.04560**	**0.04352**
MONTHLY YARD LIGHT RATES	kWh/Month	**$/Month**		
L9 40 LED YD	15	**5.66**	**5.61**	**5.58**
L11 400 LED FLD	67	**20.32**	**20.10**	**19.96**
L 12 1,000 LED FLD	100	**21.93**	**21.60**	**21.39**
L13 250 LED ST	30	**11.21**	**10.92**	**11.05**
Below YLs are no longer available for new installations				
175 WATT MERCURY VAPOR	77	**6.69**	**6.43**	**6.27**
400 WATT METAL HALIDE FLOOD	164	**20.33**	**19.79**	**19.45**
100 WATT HIGH PRESSURE SODIUM	45	**6.74**	**6.59**	**6.50**

*1 - TVA's Total Monthly Fuel Cost (TMFC) is applied to energy (kWh) billing units and is added to the Base Rate to calculate final billing. TVA adjusts the TMFC each month. All TMFC charges are included with energy charges on the first line of the billing invoice. Summer months are June through September. Winter months are December through March. Spring/Fall months are April, May, October and November.

TVA'S TOTAL MONTHLY FUEL COST (TMFC) $-Dollars per kWh

Rate Class	RS	GSA-1	GSA-2		GSA-3		Yard/OD Lighting
	22	40 & 49	50 & 57		54 & 59		
Apr-22	$ 0.02563	$ 0.02508	$ 0.02508	$ 0.02446	$ 0.02446	$ 0.02446	$ 0.02563
May-22	$ 0.02535	$ 0.02481	$ 0.02481	$ 0.02419	$ 0.02419	$ 0.02419	$ 0.02535
Jun-22	$ 0.02994	$ 0.02930	$ 0.02930	$ 0.02857	$ 0.02857	$ 0.02857	$ 0.02994
Jul-22	$ 0.04222	$ 0.04132	$ 0.04132	$ 0.04029	$ 0.04029	$ 0.04029	$ 0.04222
Aug-22	$ 0.05086	$ 0.04977	$ 0.04977	$ 0.04853	$ 0.04853	$ 0.04853	$ 0.05086
Sep-22	$ 0.03379	$ 0.03307	$ 0.03307	$ 0.03224	$ 0.03224	$ 0.03224	$ 0.03379

Additional TVA TOTAL MONTHLY FUEL COST (TMFC) for Yard Lights

Type Yard Light	100 W HPS YARD	175 W MV YARD	L9 40 LED YD	L11 400 LED FLD	L13 250 LED ST	L12 1,000 LED FLD
kWH per Month	45	77	15	67	30	100
Apr-22	$1.15	$1.97	$0.39	$1.71	$0.77	$2.56
May-22	$1.14	$1.95	$0.38	$1.70	$0.76	$2.54
Jun-22	$1.34	$2.30	$0.45	$2.00	$0.90	$2.99
Jul-22	$1.90	$3.25	$0.64	$2.83	$1.26	$4.22
Aug-22	$2.28	$3.92	$0.77	$3.40	$1.52	$5.09
Sep-22	$1.52	$2.60	$0.51	$2.26	$1.01	$3.38

*** A one year contract must be signed when installing a new Yard Light.**

TVA's TOTAL MONTHLY FUEL COST (TMFC) $-Dollars per kWh billing units including Yard Lights. All TMFC charges are included with Base rate energy charges on the first line of the billing invoice.

APPENDIX 3 - Population Information

Town of Beech Mtn						
2021 Local Water Supply Plan:			Leakage/Losses	0.3644	MGD	
		Average Daily Use (MGD)	Customer Use (MGD)	Population	Per Capita Use GPD/cap (incl. com	Max Day Use (MGD)
	Jan	0.615	0.251	4405	57	0.842
	Feb	0.659	0.295	5179	57	0.901
	Mar	0.578	0.214	3755	57	0.730
	Apr	0.575	0.211	3702	57	0.755
	May	0.578	0.214	3755	57	0.829
	Jun	0.555	0.191	3351	57	0.636
	Jul	0.649	0.285	5003	57	0.900
	Aug	0.621	0.257	4511	57	0.972
	Sep	0.538	0.174	3052	57	0.761
	Oct	0.497	0.133	2331	57	0.595
	Nov	0.505	0.141	2472	57	0.621
	Dec	0.514	0.150	2630	57	0.696
	Average	**0.574**	**0.209**	**3679**	57	

CHAPTER 4

Existing Conditions, Trends, and Projections

Demographics

To plan for the future of Beech Mountain, it is critical to know about the Town's population. First and foremost is the straightforward question of growth. How much growth will the Town see? How many people will we have to accommodate? But other questions about our population also carry great weight. What kinds of people make Beech Mountain their home or vacation destination? What kind of housing, recreation, and employment choices do they make? It is important to understand who our population is and how their characteristics will change over the coming decades. The answers to questions such as these will set the background for our Town's plans for the future.

More than just a mechanism to support planning for growth, demographics are also important to consider because many of the decisions that the Town makes, consciously or unconsciously, can make a drastic impact on the level of growth that the town will see in the future. It is important to remember that other scenarios than those presented are possible. By planning to increase density the town could experience levels of growth even greater than in the build-out scenario. By concentrating that density in specific locations and modifying land use controls to allow for compact development, such density could theoretically be achieved without compromising open spaces and environmental characteristics. On the other hand, the Town could drastically limit growth by imposing more severe land usage restrictions and regulations as an alternative means to protecting the town's character and environment.

Current Population Statistics

Baseline Figures

The figures below provide a snapshot of basic and critical current population figures for Beech Mountain:

322 - Number of full-time residents (2017 US Census Population Estimates prepared by the North Carolina Office of State Budget & Management)

Approximately **5179** - Estimated number of seasonal or second home residents (Beech Mtn. est. based on 2.24 persons per housing unit)

2312 - Number of Housing Units (2010 US Census plus Town Building records)

- For seasonal, recreational, occasional use: **2074**
- Full time occupied: **154**

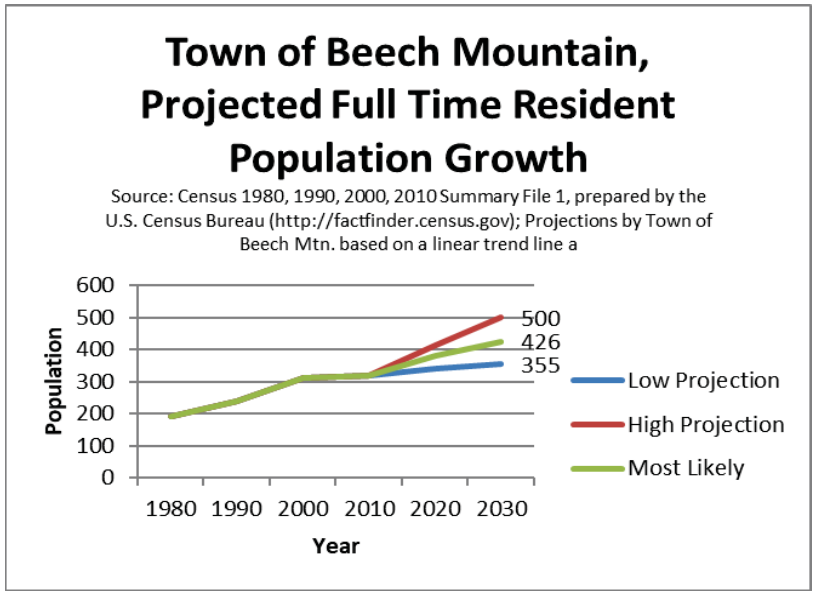
5422 - Number of Parcels of Land (2018 Avery and Watauga County Tax Data)

Demographic Projections for Beech Mountain

As a vacation resort community, Beech Mountain has relatively few full-time residents. But full-time residents only portray a fraction of the picture of Beech Mountain's true population. Beech Mountain's unique situation as a resort community demands that demographic trends for Beech Mountain be analyzed in different ways and that different factors be taken into account. Because Census figures focus on year-round residents, analyzing housing and building trends is one method of accounting for the fact that the majority of homes on Beech Mountain are second homes or vacation homes.

For purposes of forecasting growth, two factors are focused upon in this analysis:

- Population and its contributing factors
- Construction trends

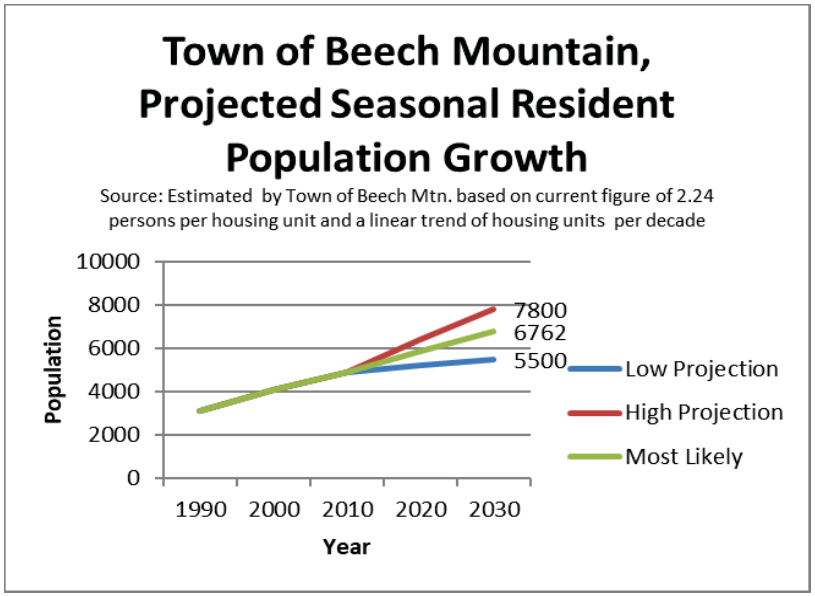


Projected Growth Scenario

This scenario forecasts as closely as possible the growth that Beech Mountain will encounter over the coming decades. It takes into account current growth rates and projects them into the future. The following charts illustrate that ***Beech Mountain will likely have approximately 425 full time and nearly 7000 part time residents by 2030.***

Many factors were considered in developing these estimates, and these considerations will likely determine whether the actual population change over this period errs towards high-growth or low-growth projection. Considerations support a conclusion that steady, robust growth will resume in Beech Mountain in the future include:

- Retirement age baby boomers (people born between 1946-1964). Much of the land and housing in Beech Mountain is

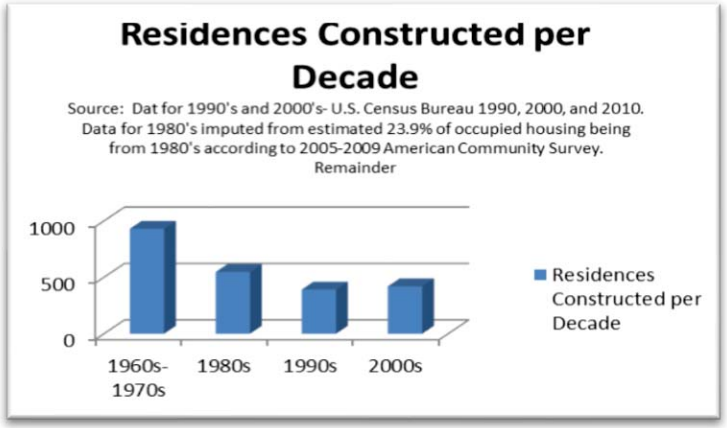


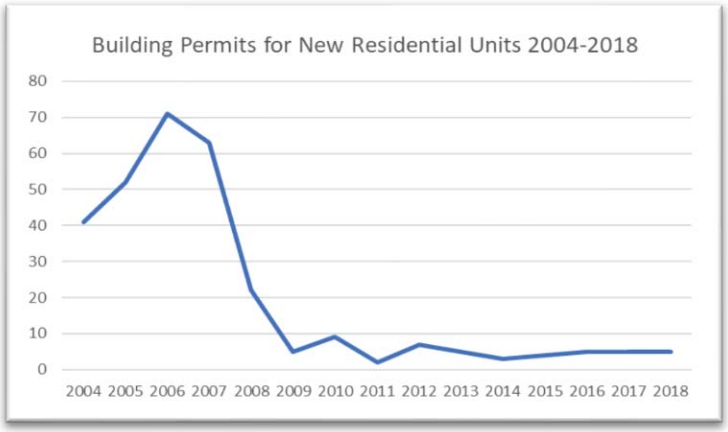
owned by people who are planning to one day "retire to the mountains"
- Rise in number of independently wealthy individuals
- Advent of internet and telecommuting allows individuals to live where they desire, rather than being tied to a work location
- Continued growth in nearby major cities (Charlotte, Piedmont Triad, Tri- Cities, Triangle) and in the State of North Carolina as a whole
- Land and Housing competitively priced for the High Country area of North Carolina

However, there are several factors and trends that will serve to limit Beech Mountain's population growth in the future, including:

- Aging of current population. The age structure of Beech Mountain's residents is very top-heavy, meaning there is a disproportionate number of individuals at the high end of the age spectrum, without a sufficient number of persons in younger age categories to replace them.
- The baby boomer generation has already peaked. The average baby boomer has passed retirement age.
- Competing developments, such as Eagle's Nest, Diamond Ridge, Linville Ridge, etc. that may offer better infrastructure and amenities as the middle class diminishes.

One of the largest factors to consider in this analysis is the long-term impact of the economic recession beginning in 2006. Although recent figures show a sharp decline in the construction of new homes, it is reasonable to predict that the overall growth trend will continue in the future. Even with downturns in the economy and its related impacts on construction, the decade of 2000-2010 taken as a whole echoed the pattern of growth that the Town has experienced since its inception. The first chart below illustrates the sharp curtailing in construction at the latter half of the 2000's, but the second chart documents the overall high and consistent level of development that has occurred here over the last 40 years.





APPENDIX 4
Department of Army and NCDWR permits (Buckeye Lake)

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
151 PATTON AVENUE
ROOM 208
ASHEVILLE, NORTH CAROLINA 28801-5006

November 27, 2019

Regulatory Division

Action ID: SAW-2018-02144

Mr. Tim Holloman
Town Manager
Town of Beech Mountain
403 Beech Mountain Parkway
Beech Mountain, North Carolina 28604

Dear Mr. Holloway,

Please reference your request dated February 21, 2018, to modify the minimum flow release conditions that were associated with a previous Department of the Army standard permit that authorized the initial construction of the Buckeye Creek Reservoir for water supply needs for the Town of Beech Mountain on November 28, 1984. Your request is authorized and the following conditions are hereby incorporated as revised/updated special conditions for the continued operation of this water supply reservoir.

1. The permittee shall operate the Buckeye Creek Reservoir in accordance with the attached minimum flow release schedule.
2. The permittee shall use the recently installed U.S. Geological Survey (USGS) stream gauges upstream and downstream of the Buckeye Creek Reservoir to continuously monitor and record stream flow on Buckeye Creek in order to document adherence to the modified minimum flow release requirements in Condition 1 above.
3. The permittee shall submit quarterly reports to the Winston Salem Regional Office of the Division of Water Resources (DWR) of daily recorded upstream and downstream stream flows as measured by the USGS gauges noted above. These reports should be submitted to DWR in accordance with condition #3 of the corresponding 401 Water Quality Certification dated November 20, 2019 and be made available to our office upon request.
4. The permittee shall maintain the newly installed mechanized dam drain valve in proper functioning condition at all times.

Please feel free to contact Ms. Amanda Jones Fuemmeler at (828) 271-7980, extension 4225, if you have any questions.

Sincerely,

Ron A. Beckwith FOR
Scott Jones, PWS
Chief
Asheville/Charlotte Regulatory Field Offices

Attachment

cc (via Email):

Clearwater Environmental Consultants, Inc. / Attn: Clement Riddle
N.C. Division of Water Resources / Attn: Sue Homewood
N.C. Wildlife Resource Commission / Attn: Andrea Leslie

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
LINDA CULPEPPER
Director

NORTH CAROLINA
Environmental Quality

November 20, 2019

DWR # 20190288
Watauga County

Town of Beech Mountain
Attn: Tim Holloman, Town Manager
403 Beech Mountain Pkwy
Beech Mountain NC 28604

Subject: **Approval of Individual 401 Water Quality Certification with Additional Conditions**
Buckeye Reservoir Modifications
USACE Action ID. No. SAW-2018-02144

Dear Mr. Holloman:

Attached hereto is a copy of Certification No. 1756 issued to Mr. Tim Holloman and Town of Beech Mountain, dated November 20, 2019. The purpose of this modification is to modify the minimum flow release schedule. **This Certification replaces the Certification issued on October 8, 1984.** Please note that you should get any other federal, state or local permits before proceeding with the subject project, including those required by (but not limited to) Sediment and Erosion Control, Non-Discharge, and Water Supply Watershed regulations.

This approval and its conditions are final and binding unless contested. This Certification can be contested as provided in Articles 3 and 4 of General Statute 150B by filing a written petition for an administrative hearing to the Office of Administrative Hearings (hereby known as OAH) **within sixty (60) calendar days**.

A petition form may be obtained from the OAH at http://www.ncoah.com/ or by calling the OAH Clerk's Office at (919) 431-3000 for information. A petition is considered filed when the original and one (1) copy along with any applicable OAH filing fee is received in the OAH during normal office hours (Monday through Friday between 8:00am and 5:00pm, excluding official state holidays).

The petition may be faxed to the OAH at (919) 431-3100, provided the original and one copy of the petition along with any applicable OAH filing fee is received by the OAH within five (5) business days following the faxed transmission.

Mailing address for the OAH:

If sending via US Postal Service:
Office of Administrative Hearings
6714 Mail Service Center
Raleigh, NC 27699-6714

If sending via delivery service (UPS, FedEx, etc):
Office of Administrative Hearings
1711 New Hope Church Road
Raleigh, NC 27609-6285

One (1) copy of the petition must also be served to DEQ:

William F. Lane, General Counsel
Department of Environmental Quality
1601 Mail Service Center
Raleigh, NC 27699-1601

Unless such a petition is filed, this Certification shall be final and binding.

This certification completes the review of the Division under section 401 of the Clean Water Act and 15A NCAC 02H .0500. Contact Sue Homewood at 336-776-9693 or sue.homewood@ncdenr.gov if you have any questions or concerns.

Sincerely,

Paul Wojcik

Mac Haupt, Acting Supervisor
401 & Buffer Permitting Branch

cc: Clement Riddle, ClearWater Environmental Consultants, Inc. (via email)
Amanda Jones-Fuemmeler, USACE Asheville Regulatory Field Office (via email)
Byron Hamstead, USFWS (via email)
Andrea Leslie, NCWRC (via email)
Todd Bowers, EPA, (via email)
DWR WSRO 401 file
DWR 401 & Buffer Permitting Branch file

Filename: 20190288BuckeyeReservoir(Watauga)_401_IC.docx

NORTH CAROLINA 401 WATER QUALITY CERTIFICATION

CERTIFICATION #1756 is issued in conformity with the requirements of Section 401, Public Laws 92-500 and 95-217 of the United States and subject to North Carolina's Regulations in 15 NCAC 02H .0500, to Mr. Tim Holloman and Town of Beech Mountain, who have authorization for the impacts listed below, as described within your application received by the N.C. Division of Water Resources (Division) on February 26, 2019 and subsequent information on August 15, 2019 and October 17, 2019, and by Public Notice issued by the U. S. Army Corps of Engineers and received by the Division on May 10, 2019.

The State of North Carolina certifies that this activity will not violate the applicable portions of Sections 301, 302, 303, 306, 307 of the Public Laws 92-500 and PL 95-217 if conducted in accordance with the application, the supporting documentation, and conditions hereinafter set forth.

This approval requires you to follow the conditions listed in the certification below.
Conditions of Certification:

1. The Buckeye Creek Reservoir shall continue to be operated as approved in Certification #1756 issued October 8, 1984 with the following modified minimum flow release schedule. [15A NCAC 02H .0506 (b)(2)]

January 1 – April 15

Reservoir Water Surface Elevation	**Action as required by Water Shortage Response Plan (WSRP)**	**Minimum Release MAF = 6.32 CFS**
Flowing over spillway	None	40% MAF = 2.53 CFS
Between top of spillway (but not flowing over) and 4 feet below spillway	Tier 1 Voluntary Restrictions	40% MAF = 2.53 CFS
Between 4 feet below spillway and 6.5 feet below spillway	Tier 2 Mandatory Restrictions 10% reductions	20 % MAF = 1.26 CFS
Between 6.5 feet below spillway and 13.5 feet below spillway	Tier 3 Mandatory Restrictions 20% reductions	Outflow will equal Inflow determined using USGS Stream Gauges (upstream and downstream)
Between 13.5 feet below spillway and 23.5 feet below spillway	Tier 4 Emergency Restrictions 25% reductions	Outflow will equal Inflow determined using USGS Stream Gauges (upstream and downstream)
23.5 feet below spillway	Tier 5 Water Rationing	Outflow will equal Inflow determined using USGS Stream Gauges (upstream and downstream)

April 16 – December 31

Reservoir Water Surface Elevation	Action as required by Water Shortage Response Plan (WSRP)	Minimum Release MAF = 6.32 CFS
Flowing over spillway	None	20% MAF = 1.26 CFS
Between top of spillway (but not flowing over) and 4 feet below spillway	Tier 1 Voluntary Restrictions	20% MAF = 1.26 CFS
Between 4 feet below spillway and 6.5 feet below spillway	Tier 2 Mandatory Restrictions 10% reductions	15 % MAF = 0.95 CFS
Between 6.5 feet below spillway and 13.5 feet below spillway	Tier 3 Mandatory Restrictions 20% reductions	Outflow will equal Inflow determined using USGS Stream Gauges (upstream and downstream)
Between 13.5 feet below spillway and 23.5 feet below spillway	Tier 4 Emergency Restrictions 25% reductions	Outflow will equal Inflow determined using USGS Stream Gauges (upstream and downstream)
23.5 feet below spillway	Tier 5 Water Rationing	Outflow will equal Inflow determined using USGS Stream Gauges (upstream and downstream)

2. The Permittee shall use the US Geological Survey Stream Gauges installed immediately upstream and downstream of Buckeye Creek Reservoir to continuously monitor and record stream flow on Buckeye Creek and to meet the minimum release flow requirements in Condition 1 of this Certification. [15A NCAC 02H .0506 (b)(2)]

3. The Permittee shall submit a quarterly report to the Winston Salem Regional Office of the Division of Water Resources of daily recorded upstream and downstream stream flows as measured by the USGS gauges noted above. The first quarterly report shall be submitted by April 15, 2020 and shall include data from January 1, 2020 through March 31, 2020. The report shall include any relevant information regarding USGS continued calibration activities as they relate to the reported data. [15A NCAC 02H .0506 (b)(2)]

4. The Permittee shall maintain the newly installed electronically mechanized dam drain valve in proper functional condition at all times. [15A NCAC 02H .0506 (b)(2)]

5. The Permittee shall continue to take all reasonable steps towards a future alternative water supply in accordance with recommendations by the Division of Water Resources – Water Planning Section. [15A NCAC 02H .0506 (b)(1)]

6. This approval is for the purpose and design described in your application and as described in the Public Notice. The plans and specifications for this project are incorporated by reference and are an enforceable part of the Certification. Any modifications to the project require notification to DWR and may require an application submittal to DWR with the appropriate fee. [15A NCAC 02H .0501 and .0502]

7. This Certification does not relieve the applicant of the responsibility to obtain all other required Federal, State, or Local approvals before proceeding with the project, including those required by, but not limited to Sediment and Erosion Control, Non-Discharge, Water Supply Watershed, and Trout Buffer regulations.

8. Mr. Tim Holloman and Town of Beech Mountain shall conduct activities in a manner consistent with State water quality standards (including any requirements resulting from compliance with section 303(d) of the Clean Water Act) and any other appropriate requirements of State and Federal law. [15A NCAC 02B .0200] If the Division determines that such standards or laws are not being met (including the failure to sustain a designated or achieved use) or that State or federal law is being violated, or that further conditions are necessary to assure compliance, the Division may reevaluate and modify this Certification. Before modifying the Certification, the Division shall notify Mr. Tim Holloman and Town of Beech Mountain and the U.S. Army Corps of Engineers, provide public notice in accordance with 15A NCAC 02H .0503 and provide opportunity for public hearing in accordance with 15A NCAC 02H .0504. Any new or revised conditions shall be provided to Mr. Tim Holloman and Town of Beech Mountain in writing, shall be provided to the U.S. Army Corps of Engineers for reference in any Permit issued pursuant to Section 404 of the Clean Water Act, and shall also become conditions of the 404 Permit for the project.

9. If the property or project is sold or transferred, the new Permittee shall be given a copy of this Certification (and written authorization if applicable) and is responsible for complying with all conditions. [15A NCAC 02H .0501 and .0502]

10. This Certification neither grants nor affirms any property right, license, or privilege in any waters, or any right of use in any waters. This Certification does not authorize any person to interfere with the riparian rights, littoral rights, or water use rights of any other person and this Certification does not create any prescriptive right or any right of priority regarding any usage of water. This Certification shall not be interposed as a defense in any action respecting the determination of riparian or littoral rights or other rights to water use. No consumptive user is deemed by virtue of this Certification to possess any prescriptive or other right of priority with respect to any other consumptive user regardless of the quantity of the withdrawal or the date on which the withdrawal was initiated or expanded.

11. This certification grants permission to the director, an authorized representative of the Director, or DENR staff, upon the presentation of proper credentials, to enter the property during normal business hours. [15A NCAC 02H .0502(e)]

12. Non-compliance with or violation of the conditions herein set forth by a specific project may result in revocation of this General Certification for the project and may also result in criminal and/or civil penalties.

13. The permittee shall report to the Winston Salem Regional Office any noncompliance with this certification, any violation of stream or wetland standards [15A NCAC 02B .0200] including but not limited to sediment impacts, and any violation of state regulated riparian buffer rules [15A NCAC 02B .0200]. Information shall be provided orally within 24 hours (or the next business day if a weekend or holiday) from the time the applicant became aware of the circumstances. A written submission shall also be provided within 5 business days of the time the applicant becomes aware of the circumstances. The written submission shall contain a description of the noncompliance, and its causes; the period of noncompliance, including exact dates and times, if the noncompliance has not been corrected, the anticipated time compliance is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. The Division may waive the written submission requirement on a case-by-case basis.

This approval to proceed with your proposed impacts or to conduct impacts to waters as depicted in your application shall expire upon expiration of the 404 or CAMA Permit. The conditions in effect on the date of issuance shall remain in effect for the life of the project, regardless of the expiration date of this Certification. [15A NCAC 02H .0507(d)(2) and 15A NCAC 02H .0506]

This the 20th day of November 2019

Paul Wojcik
for

Mac Haupt, Acting Supervisor
401 & Buffer Permitting Branch

SLH

WQC#001756

APPENDIX 5 - Buckeye Lake Discharge Data

Town of Beech Mountain
Discharge Below Dam of Buckeye Lake
(highlighted cells are days that discharge was less than the required minimum release)

Daily Mean Discharge, cubic feet per second

DATE	Jan 2020	Feb 2020	Mar 2020	Apr 2020	May 2020	Jun 2020	Jul 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020
1	3.86P	6.73P	10.3P	8.81P	51.1P	4.30P	17.4P	4.86P	2.19P	3.04P	21.0P	2.83P
2	4.04P	6.16P	9.78P	7.57P	33.3P	3.79P	12.1P	3.93P	1.85P	2.68P	13.1P	2.53P
3	7.02P	6.43P	21.0P	6.63P	22.6P	3.19P	8.28P	36.6P	1.15P	2.49P	9.22P	2.60P
4	9.69P	7.80P	22.8P	6.04P	16.6P	2.75P	5.84P	30.8P	0.99P	2.15P	6.93P	10.2P
5	11.2P	14.5P	19.6P	5.54P	12.9P	2.63P	6.20P	17.2P	0.71P	1.81P	5.48P	28.9P
6	10.8P	145P e	15.1P	5.06P	12.5P	2.36P	3.98P	10.5P	---	1.57P	4.52P	19.4P
7	10.6P	118P	11.6P	5.19P	10.8P	1.84P	3.40P	7.68P	---	0.99P	3.86P	13.8P
8	8.61P	55.7P	9.34P	5.10P	10.5P	1.55P	3.22P	5.65P	---	1.10P	3.32P	9.37P
9	7.27P	33.5P	7.57P	21.7P	10.7P	1.36P	2.44P	4.07P	---	0.84P	2.89P	7.37P
10	6.96P	25.3P	6.85P	15.6P	9.16P	1.68P	1.90P	3.19P	---	9.58P	2.80P	6.33P
11	20.2P	36.2P	6.49P	12.8P	8.41P	1.54P	1.63P	2.96P	---	20.4P	13.2P	5.45P
12	52.2P	42.0P	5.35P	15.7P	7.00P	1.04P	1.16P	4.10P	1.53P	13.7P	61.0P	4.59P
13	35.5P	74.1P	8.84P	173P e	6.32P	0.84P	---	2.91P	1.68P	10.8P	36.7P	4.31P
14	27.6P	55.9P	7.13P	55.6P	5.45P	4.17P	0.28P	14.1P	---	7.75P	21.3P	29.0P
15	21.7P	34.7P	7.33P	31.3P	4.71P	3.19P	---	18.6P	0.95P	6.23P	14.0P	25.7P
16	20.6P	22.3P	6.79P	19.8P	4.22P	2.74P	---	17.0P	0.75P	5.12P	9.83P	22.2P
17	16.9P	15.4P	7.42P	13.8P	3.70P	4.69P	---	11.6P	5.83P	3.99P	7.55P	17.7P
18	15.0P	11.9P	7.04P	17.4P	4.00P	5.15P	---	8.26P	4.43P	3.44P	5.71P	13.1P
19	13.2P	10.1P	7.17P	12.6P	38.7P	5.16P	---	5.89P	3.55P	2.97P	4.80P	10.1P
20	9.92P	8.38P	11.8P	18.0P	80.7P	5.60P	8.11P	4.71P	3.11P	2.57P	4.14P	8.39P
21	8.19P	6.83P	19.0P	15.9P	90.8P	5.00P	3.03P	4.11P	2.63P	2.00P	3.57P	7.21P
22	6.95P	6.03P	16.5P	13.6P	53.6P	4.22P	4.26P	3.94P	2.07P	1.92P	2.98P	5.53P
23	6.25P	5.91P	18.8P	12.9P	33.3P	4.10P	16.9P	2.94P	1.90P	1.69P	3.10P	4.32P
24	11.6P	7.80P	21.3P	14.1P	21.6P	3.46P	30.2P	2.24P	2.10P	1.67P	2.54P	11.4P
25	11.2P	15.7P	48.9P	13.3P	21.4P	6.10P	24.5P	2.16P	6.68P	1.68P	2.33P	12.4P
26	10.4P	16.9P	38.8P	15.3P	17.8P	3.49P	20.3P	1.65P	3.40P	1.44P	2.14P	11.8P
27	10.5P	17.9P	25.3P	16.6P	13.4P	3.28P	13.2P	1.58P	2.54P	1.26P	2.03P	10.4P
28	9.21P	15.1P	17.8P	15.0P	9.98P	25.4P	8.59P	1.34P	2.30P	2.33P	1.68P	9.75P
29	8.19P	12.4P	12.7P	30.1P	8.44P	23.1P	5.86P	1.97P	4.48P	45.2P	1.78P	9.85P
30	7.56P		9.37P	85.4P	7.14P	21.0P	5.60P	1.55P	4.18P	62.1P	3.74P	10.1P
31	7.27P		8.59P		5.38P		5.32P	1.77P		36.7P		12.2P
COUNT	31	29	31	30	31	30	25	31	23	31	30	31
MAX	52.2	145	48.9	173	90.8	25.4	30.2	36.6	6.68	62.1	61	29
MIN	3.86	5.91	5.35	5.06	3.7	0.84	0.28	1.34	0.71	0.84	1.68	2.53

DATE	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021
1	21.2P	15.5P	15.5P	32.1P	3.59P	1.07P		---	20.8P	0.08A	10.1P	2.00P
2	28.4P	12.7P	14.8P	24.1P	3.51P	1.08P	45.0P	---	18.7P	0.01	8.55P	1.76P
3	23.1P	9.88P	13.9P	17.4P	3.67P	1.06P	16.4P	---	12.6P	0.00A	7.02P	1.63P
4	16.5P	7.88P	11.7P	12.9P	4.10P	0.82P	9.58P	---	8.34P	1.17A	5.91P	1.45P
5	12.8P	6.76P	9.40P	9.94P	4.15P	0.60P	5.89P	---	5.87P	2.53A	4.80P	1.48P
6	9.24P	5.15P	7.64P	7.88P	3.93P	0.58P	4.46P	---	4.63P	4.93A	3.99P	1.49P
7	7.31P	5.06P	6.30P	6.55P	4.14P	0.53P	3.24P	---	3.47P	54.4A	3.38P	1.24P
8	6.73P	4.38P	5.60P	5.77P	3.75P	---	2.92P	---	2.68P	29.5A	2.97P	1.24P
9	5.02P	4.72P	4.91P	4.77P	4.51P	4.89P	2.81P	---	2.30P	18.9A	2.56P	1.06P
10	4.37P	6.65P	4.43P	19.4P	7.99P	3.96P	2.10P	---	1.79P	12.7A	2.19P	1.12P
11	4.03P	15.1P	3.93P	29.3P	6.65P	6.12P	1.56P	---	1.13P	9.16A	2.66P	2.60P
12	3.65P	26.6P	3.62P	19.9P	8.64P	36.1P	1.22P	---	1.14P	6.75A	13.4P	2.50P
13	3.26P	57.3P	3.46P	13.8P	7.83P	30.1P	1.03P	---	1.10P	5.19A	7.66P	1.92P
14	3.14P	50.4P	2.95P	10.3P	6.83P	17.4P	0.69P	---	0.84P	4.11A	6.64P	1.79P
15	2.94P	34.2P	3.02P	8.68P	5.88P	10.8P	---	---	---	3.22A	5.84P	1.76P
16	2.54P	27.9P	2.90P	6.56P	5.07P	7.01P	---	---	---	3.10A	4.93P	1.85P
17	2.34P	19.7P	2.75P	5.41P	4.44P	5.00P	---	---	---	2.37A	4.19P	1.68P
18	2.33P	33.4P	11.3P	4.46P	3.90P	3.74P	---	28.5P	---	2.13A	3.70P	1.83P
19	2.22P	31.8P	47.3P	4.24P	3.35P	2.85P	3.69P	12.5P	---	1.86P	3.39P	2.54P
20	2.10P	23.5P	31.8P	3.43P	2.80P	2.40P	1.60P	---	---	1.44P	2.84P	1.96P
21	2.17P	17.0P	20.3P	3.08P	2.33P	2.60P	---	29.9P	1.35P	1.52P	2.62P	1.92P
22	1.91P	14.7P	14.4P	2.73P	2.08P	7.41P	---	14.7P	1.69P	1.52P	3.96P	1.85P
23	1.59P	11.3P	11.2P	2.42P	1.75P	2.92P	---	8.95P	1.25P	1.13P	2.81P	1.68P
24	1.57P	9.13P	9.01P	3.28P	1.65P	2.13P	---	6.41P	---	1.02P	2.50P	1.67P
25	8.93P	7.58P	22.0P	3.97P	2.26P	1.52P	---	5.03P	---	1.31P	2.39P	1.63P
26	24.9P	9.61P	48.8P	2.91P	3.72P	1.17P	---	3.69P	---	2.02P	2.55P	1.61P
27	23.1P	10.0P	41.8P	2.72P	1.84P	1.10P	---	3.23P	---	1.56P	2.13P	1.33P
28	20.4P	9.29P	65.1P	2.59P	1.74P	0.81P	---	2.47P	---	1.50P	2.17P	1.24P
29	14.2P		55.5P	2.66P	1.93P	---	---	1.94P	---	8.46P	2.02P	1.23P
30	11.3P		35.6P	5.22P	1.91P	---	---	1.52P	---	9.31P	1.86P	1.67P
31	11.2P		37.6P		1.42P		---	3.36P	---	10.8P		1.24P
COUNT	31	28	31	30	31	27	15	13	17	31	30	31
MAX	28.4	57.3	65.1	32.1	8.64	36.1	45	29.9	20.8	54.4	13.4	2.6
MIN	1.57	4.38	2.75	2.42	1.42	0.53	0.69	1.52	0.84	0	1.86	1.06

DATE	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	Jun 2022
1	1.26P	1.67P	15.5P	5.80P	2.15P	6.62P
2	12.5P	1.97P	12.0P	5.31P	2.09P	4.82P
3	22.0P	49.6P	9.29P	4.86P	5.88P	4.04P
4	18.2P	112P	7.45P	4.41P	5.83P	3.18P
5	13.9P	48.9P	6.00P	5.93P	4.33P	2.45P
6	11.1P	25.0P	5.04P	6.99P	7.89P	2.16P
7	8.82P	16.1P	7.33P	18.7P	18.9P	2.08P
8	7.11P	11.6P	7.53P	16.0P	23.1P	1.28P
9	14.7P	8.86P	18.4P	13.4P	18.1P	1.22P
10	25.3P	7.07P	17.8P	11.6P	13.2P	0.84P
11	17.4P	5.72P	14.4P	10.4P	9.70P	0.69P
12	12.7P	4.85P	13.5P	9.35P	7.52P	0.62P
13	9.91P	4.29P	10.5P	8.15P	6.27P	0.54P
14	7.71P	3.64P	9.66P	7.21P	5.24P	3.28P
15	5.93P	3.26P	8.78P	5.99P	4.81P	0.83P
16	5.91P	3.16P	8.27P	5.89P	4.06P	0.57P
17	4.67P	4.05P	7.20P	4.84P	3.39P	0.52P
18	4.11P	35.0P	6.29P	5.99P	3.07P	---
19	3.87P	20.2P	5.57P	5.31P	2.72P	---
20	5.15P	14.9P	4.77P	4.62P	2.42P	---
21	4.43P	11.4P	4.23P	4.14P	2.72P	---
22	3.72P	11.2P	3.87P	3.96P	2.51P	---
23	3.22P	32.1P	6.13P	3.69P	23.9P	---
24	3.04P	49.6P	5.03P	3.29P	28.4P	---
25	2.87P	52.1P	4.63P	3.09P	18.5P	---
26	2.54P	33.8P	4.36P	3.17P	20.5P	---
27	2.34P	27.7P	4.01P	2.72P	73.0P	---
28	2.20P	20.4P	3.65P	2.47P	45.2P	---
29	1.89P		3.44P	2.33P	24.0P	---
30	1.83P		3.25P	2.19P	14.2P	0.07P
31	1.83P		7.65P		9.40P	
COUNT	31	29	31	30	31	30
MAX	25.3	112	18.4	18.7	73	6.62
MIN	1.26	1.67	3.25	2.19	2.09	0.07

APPENDIX 6 - 2020 AWWA Water Audit (excerpts)

AWWA Free Water Audit Software:
System Attributes and Performance Indicators

WAS v5.0
American Water Works Association.

Water Audit Report for: TOWN OF BEECH MOUNTAIN (0195104)
Reporting Year: 2020 | 1/2020 - 12/2020

*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 78 out of 100 ***

System Attributes:

	Apparent Losses:	0.701	MG/Yr
+	Real Losses:	101.929	MG/Yr
=	**Water Losses:**	102.631	MG/Yr
?	Unavoidable Annual Real Losses (UARL):	43.77	MG/Yr = 0.12 MGD
	Annual cost of Apparent Losses:	$9,238	
	Annual cost of Real Losses:	$559,353	Valued at **Variable Production Cost**

Return to Reporting Worksheet to change this assumpiton

Performance Indicators:

Financial:	Non-revenue water as percent by volume of Water Supplied:	64.1%	
	Non-revenue water as percent by cost of operating system:	26.5%	Real Losses valued at Variable Production Cost
Operational Efficiency:	Apparent Losses per service connection per day:	0.88	gallons/connection/day
	Real Losses per service connection per day:	127.63	gallons/connection/day
	Real Losses per length of main per day*:	N/A	
	Real Losses per service connection per day per psi pressure:	0.73	gallons/connection/day/psi
	From Above, Real Losses = Current Annual Real Losses (CARL):	101.93	million gallons/year
?	Infrastructure Leakage Index (ILI) [CARL/UARL]:	2.33	

* This performance indicator applies for systems with a low service connection density of less than 32 service connections/mile of pipeline

Description
UARL (gallons/day)=(5.41Lm + 0.15Nc + 7.5Lc) xP, or UARL (litres/day)=(18.0Lm + 0.8Nc + 25.0Lc) xP where: Lm = length of mains (miles or kilometres) Nc = number of customer service connections Lp = the average distance of customer service connection piping (feet or metres) (see the Worksheet "Service Connection Diagram" for guidance on deterring the value of Lp) Lc = total length of customer service connection piping (miles or km) Lc = Nc X Lp (miles or kilometres) P = Pressure (psi or metres) The UARL is a theoretical reference value representing the technical low limit of leakage that could be achieved if all of today's best technology could be successfully applied. It is a key variable in the calculation of the Infrastructure Leakage Index (ILI). Striving to reduce system leakage to a level close to the UARL is usually not needed unless the water supply is unusually expensive, scarce or both. NOTE: The UARL calculation has not yet been proven as fully valid for very small, or low pressure water distribution systems. If, in gallons per day: (Lm x 32) + Nc < 3000 or P <35psi in litres per day: (Lm x 20) + Nc < 3000 or P < 25m then the calculated UARL value may not be valid. The software does not display a value of UARL or ILI if either of these conditions is true.

APPENDIX 7 - 2020 and 2021 Local Water Supply Plans

Beech Mountain

2020

The Division of Water Resources (DWR) provides the data contained within this Local Water Supply Plan (LWSP) as a courtesy and service to our customers. DWR staff does not field verify data. Neither DWR, nor any other party involved in the preparation of this LWSP attests that the data is completely free of errors and omissions. Furthermore, data users are cautioned that LWSPs labeled **PROVISIONAL** have yet to be reviewed by DWR staff. Subsequent review may result in significant revision. Questions regarding the accuracy or limitations of usage of this data should be directed to the water system and/or DWR.

1. System Information

Contact Information

Complete

Water System Name:	Beech Mountain	PWSID:	01-95-104
Mailing Address:	403 Beech Mountain Parkway Beech Mountain, NC 28604	Ownership:	Municipality
Contact Person:	Daniel Davis	Title:	Public Utilities Superintendent
Phone:	828-387-9282	Cell/Mobile:	--

Distribution System

Line Type	Size Range (Inches)	Estimated % of lines
Ductile Iron	4-8	10.00 %
Galvanized Iron	2-12	89.00 %
Polyvinyl Chloride	6	1.00 %

What are the estimated total miles of distribution system lines? 66 Miles

How many feet of distribution lines were replaced during 2020? 15,000 Feet

How many feet of new water mains were added during 2020? 0 Feet

How many meters were replaced in 2020? 80

How old are the oldest meters in this system? 14 Year(s)

How many meters for outdoor water use, such as irrigation, are not billed for sewer services? 0

What is this system's finished water storage capacity? 1.5000 Million Gallons

Has water pressure been inadequate in any part of the system since last update? *Line breaks that were repaired quickly should not be included.* No

In 2020 the Mid-Range feed zone continues forward to the 17,000 feet now bid out for completion in the 2020/2021 FY. This project is part of the continuing water main upgrades plans to replace large areas of galvanized piping installed in the late 1960;s by the original developer before the township was incorporated. It also includes 142 service connections to be replaced. This year we achieved 13,000 feet of line replaced through the project which is on schedule for full completion in 2021. We have began a 10 year initiative to begin replacing as a target number 150 service connections annually, removing 3/4" galvanized piping and replacing with a polyethylene(PexA) product as further effort to reduce loss throughout the system. In 2020, we replaced 103 services at an estimated 2000 feet of service connections as well.

Programs

Does this system have a program to work or flush hydrants? Yes, Monthly

Does this system have a valve exercise program? No

Does this system have a cross-connection program? Yes

Does this system have a program to replace meters? Yes

Does this system have a plumbing retrofit program? No

Does this system have an active water conservation public education program? No

Does this system have a leak detection program? Yes

We use digital meters which allow for weekly readings of the service meters to monitor meter usage, totals, and leakage as well as leak listening devices and correlators to identify main line leakage in suspect areas. We also have a monthly, quarterly, and annual hydrant flushing program that is utilized to maintain pleasing water to our citizens. We work each year with the NC Rural Water Association on a system wide leak detection effort.

Water Conservation

What type of rate structure is used? Increasing Block, Uniform

How much reclaimed water does this system use? 0.0000 MGD For how many connections? 0

Does this system have an interconnection with another system capable of providing water in an emergency? No

Beech Mountain has no feasible access to its nearest neighboring water systems due to elevation and terrain. Also, the neighboring water systems treatment capacities are too small for support of Beech Mountains needs in an emergency. Recent situation has also proven that the hauling of water in an emergency situation is unable to sustain the system as well. Beech Mountain has sought assistance through the Legislative House Bill 609 process in order to identify the town's future water supply needs and the options available to meet those needs.

2. Water Use Information

Service Area

Sub-Basin(s)	% of Service Population	County(s)	% of Service Population
Watauga River (16-1)	100 %	Watauga	85 %
		Avery	15 %

What was the year-round population served in 2020? 346

What was the seasonal population and months served in 2020? (if applicable) 5,306 (Jan Feb Mar Jun Jul Aug Dec)

Has this system acquired another system since last report? No

Nearly all the population at Beech Mountain is transient. Population data sources: current year-round population from Office of State Management and Budget (OSMB), current seasonal population from Town of Beech Mountain 2020-35 Comprehensive Plan chapter 4, page 12.

Water Use by Type

Type of Use	Metered Connections	Metered Average Use (MGD)	Non-Metered Connections	Non-Metered Estimated Use (MGD)
Residential	2,013	0.1300	0	0.0000
Commercial	64	0.0300	0	0.0000
Industrial	0	0.0000	0	0.0000
Institutional	0	0.0000	0	0.0000

How much water was used for system processes (backwash, line cleaning, flushing, etc.)? 0.0252 MGD

In 2020, Beech Mountain accounted for 0.0196 MGD through process water at the water treatment plant. The additional 0.0056 MGD provides for system processes including an estimated value for firefighting, general hydrant use, and for the automatic flushers we use in the distribution system. This is increased from previous years due to hiring of personnel to manage and operate a more productive flushing program in order to maintain water quality in our system. There are no churches, schools, or industry in Beech Mountain. Our Town Hall, Public Works, Fire Department, WTP and WWTP are included in our commercial accounts. System data and accounting research and evaluation has shown updated numbers in the metered connections totals from the 2019 report.

3. Water Supply Sources

Monthly Withdrawals & Purchases

	Average Daily Use (MGD)	Max Day Use (MGD)		Average Daily Use (MGD)	Max Day Use (MGD)		Average Daily Use (MGD)	Max Day Use (MGD)
Jan	0.4410	0.5670	May	0.4260	0.5300	Sep	0.4930	0.6710
Feb	0.4160	0.5570	Jun	0.5150	0.6650	Oct	0.5200	0.6540
Mar	0.3720	0.4360	Jul	0.5420	0.8100	Nov	0.4820	0.6890
Apr	0.3470	0.4560	Aug	0.4820	0.5990	Dec	0.6340	0.8840

Surface Water Sources

Stream	Reservoir	Average Daily Withdrawal		Maximum Day Withdrawal (MGD)	Available Raw Water Supply		Usable On-Stream Raw Water Supply Storage (MG)
		MGD	Days Used		MGD	* Qualifier	
Buckeye Creek	Buckeye Lake	0.4730	365	0.8840	0.2400	SY50	30.0000
Pond Creek	Lake Coffey	0.0000	0	0.0000	0.0300	F	7.0000

* Qualifier: C=Contract Amount, SY20=20-year Safe Yield, SY50=50-year Safe Yield, F=20% of 7Q10 or other instream flow requirement, CUA=Capacity Use Area Permit

Surface Water Sources (continued)

Stream	Reservoir	Drainage Area (sq mi)	Metered?	Sub-Basin	County	Year Offline	Use Type
Buckeye Creek	Buckeye Lake	3	Yes	Watauga River (16-1)	Watauga		Regular
Pond Creek	Lake Coffey	1	No	Watauga River (16-1)	Watauga		Emergency

What is this system's off-stream raw water supply storage capacity? 0 Million gallons

Are surface water sources monitored? Yes, Daily

Are you required to maintain minimum flows downstream of its intake or dam? Yes

Does this system anticipate transferring surface water between river basins? No

Buckeye Lake was constructed in 1985/1986 and was at operational water levels by 1987. The 20- year safe yield for Buckeye Lake was reported in the 1989 DWR Water Supply System Report to be 2.0 mgd. The basis for this estimate is unknown. Since construction, the actual available safe yield of Buckeye Lake has been found to be significantly less than the originally reported 2.0 mgd estimation. According to the February 2014 Buckeye Lake Yield Analysis document by West Consultants, the safe yield of Buckeye Lake is approximately 0.3 mgd; however, this value is only valid under specific qualifying conditions. The most important condition is that this value does not include the existing minimum release requirements set forth in the United States Army Corps of Engineers (USACE) Permit (i.e., Section 404- Clean Water Act) for construction of the Buckeye Lake dam. The permit, issued November 1984, requires a minimum flow release from the dam of 2.8 cfs (1.8 mgd) through October, November and December, intended to provide needed flows during the native brook trout spawning period. The remainder of the year (i.e., January through September), the required minimum release is 1.5 cfs (0.97 mgd), intended to maintain the existing water quality of Buckeye Creek. The 2014 Yield Analysis report makes it clear that when including the required minimum releases, as dictated by the USACE permit, the safe yield should be considered zero under low flow conditions or in times of drought. It should also be noted that similar to the Buckeye Creek flow estimations, the safe yield calculations used USGS gage data from the Watauga and Elk Rivers. In light of recent DWR modelling difficulties regarding Buckeye Creek, use of these values should be considered questionable, even though this methodology is the only available means to make such estimations.

The 1984 minimum release requirements used in the 2014 Buckeye Lake Yield Analysis document by West Consultants were not achievable during droughts such as the town experienced in 2010. Therefore, the town requested a modification to the dam permit issued by US Army Corps of Engineers.

On November 20th, 2019 The Town of Beech Mountain received approval of Individual 401 Water Quality Certification (Certification #1756)(USACE Action ID. No. SAW-2018-02144) which replaces the certification based on October 8th, 1984. Based on this certification protocol, West Consultants has calculated the current estimated yield of Buckeye Lake to be 0.240 MGD. The minimums approved are still significant (up to 1.64 MGD) but are more achievable, however, yields shown are theoretical based on assumption that the Buckeye Lake watershed characteristics mimic the Watauga River watershed. Actual yields may be lower than shown.

In 2019 Beech Mountain moved forward to aid this calculation process by partnering with the U.S. Department of the Interior; U.S. Geological Survey to install and maintain stream gage stations upstream and downstream of the Buckeye Lake Reservoir. This data will be used to provide accurate stream flow calculations into the future aiding the ability to accurately meet USACE permit requirements. This data will be used to build a historical database for more accurate stream flow calculations.

Water Treatment Plants

Plant Name	Permitted Capacity (MGD)	Is Raw Water Metered?	Is Finished Water Ouput Metered?	Source
Buckeye Treatment Plant	1.0000	Yes	Yes	Buckeye Lake

Did average daily water production exceed 80% of approved plant capacity for five consecutive days during 2020? No

If yes, was any water conservation implemented?

Did average daily water production exceed 90% of approved plant capacity for five consecutive days during 2020? No

If yes, was any water conservation implemented?

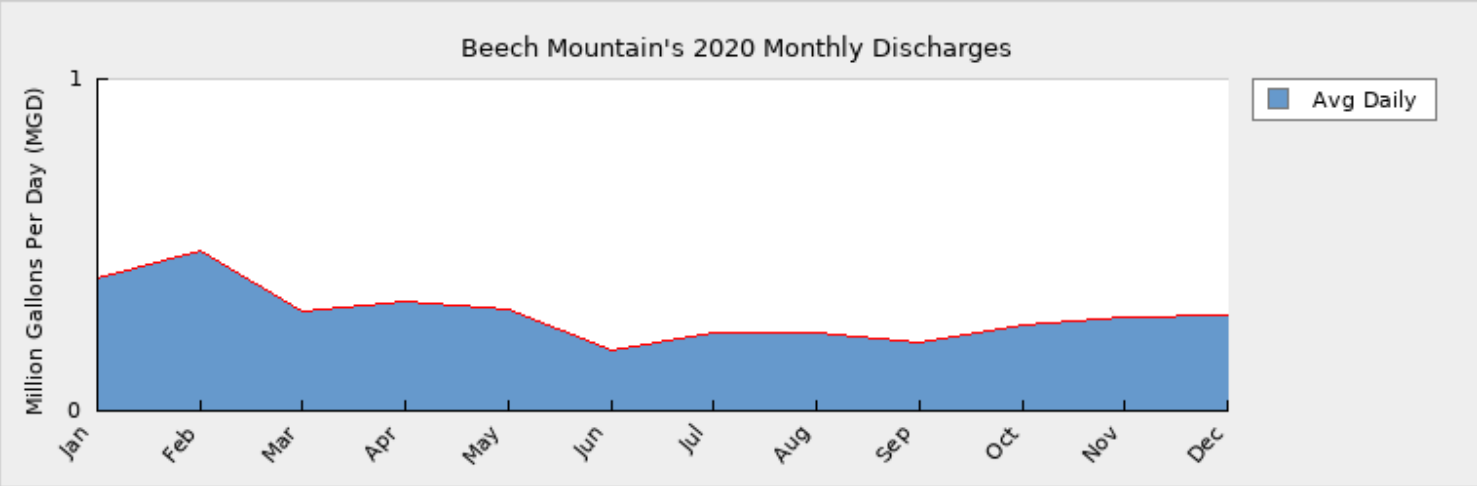
Are peak day demands expected to exceed the water treatment plant capacity in the next 10 years? No

Beech Mountain completed the construction of the Buckeye Creek Water Treatment Facility in 2017.

4. Wastewater Information

Monthly Discharges

	Average Daily Discharge (MGD)		Average Daily Discharge (MGD)		Average Daily Discharge (MGD)
Jan	0.3990	May	0.3080	Sep	0.2030
Feb	0.4820	Jun	0.1810	Oct	0.2580
Mar	0.3010	Jul	0.2360	Nov	0.2850
Apr	0.3290	Aug	0.2380	Dec	0.2880



How many sewer connections does this system have? 1,740

How many water service connections with septic systems does this system have? 315

Are there plans to build or expand wastewater treatment facilities in the next 10 years? No

Wastewater Permits

Permit Number	Permitted Capacity (MGD)	Design Capacity (MGD)	Average Annual Daily Discharge (MGD)	Maximum Day Discharge (MGD)	Receiving Stream	Receiving Basin
NC0022730	0.0800	0.0800	0.0500		Grassy Gap Creek	Watauga River (16-1)
NC0069761	0.4000	0.4000	0.2340		Pond Creek	Watauga River (16-1)
NC0088099	0.0500	0.0500	0.0080		Buckeye Creek	Watauga River (16-1)

5. Planning

Projections

	2020	2030	2040	2050	2060	2070
Year-Round Population	346	441	562	716	912	1,162
Seasonal Population	5,306	6,759	8,610	10,968	12,500	12,826
Residential	0.1300	0.1168	0.1488	0.1895	0.2414	0.2823
Commercial	0.0300	0.0277	0.0352	0.0449	0.0572	0.0669
Industrial	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Institutional	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
System Process	0.0252	0.0306	0.0374	0.0461	0.0518	0.0526
Unaccounted-for	0.2865	0.2370	0.2170	0.1970	0.1570	0.1370

Population data sources: current year-round population from Office of State Management and Budget (OSMB), current seasonal population from Town of Beech Mountain 2020-35 Comprehensive Plan chapter 4, future populations based on the Comprehensive Plan and projecting the same rate of growth into the future (2.45% per year). But the build-out population of the town is estimated to be about 2,312 current units + 3,100 future units @2.37 persons per unit = 12,826.

Growth in residential and commercial water demand is assumed to be proportional with the growth in population. System process water use is based on 0.0056 MGD for distribution system uses and on the remainder being water plant processes (filter-to-waste and backwashing). Unaccounted-for water is projected to be reduced to approximately 30% by the year 2060 as the Town gradually replaces aging infrastructure and reduces system pressure where feasible. We assume a reduction of 0.02 MGD per decade as we replace infrastructure. Note that unavoidable annual real losses (UARL) = 0.12 MGD per AWWA water audit template.

Future Supply Sources

Source Name	PWSID	Source Type	Additional Supply	Year Online	Year Offline	Type
Town of Beech Mountain	01-95-104	Ground	0.1870	2021		Regular
Watauga River	01-95-104	Surface	2.0000	2024		Regular

The future surface water source is needed to meet the current and future water supply needs of the Town of Beech Mountain. The future ground source needs are also being evaluated by drilling test wells with a minimum flow of 54,000 GPD for full development as additional measures to find suitable source water volume.

The Watauga River source was change from emergency to regular use type.

Demand v/s Percent of Supply

	2020	2030	2040	2050	2060	2070
Surface Water Supply	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400
Ground Water Supply	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Purchases	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Future Supplies		2.1870	2.1870	2.1870	2.1870	2.1870
Total Available Supply (MGD)	0.2400	2.4270	2.4270	2.4270	2.4270	2.4270
Service Area Demand	0.4717	0.4121	0.4384	0.4775	0.5074	0.5388
Sales	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Future Sales		0.0000	0.0000	0.0000	0.0000	0.0000
Total Demand (MGD)	0.4717	0.4121	0.4384	0.4775	0.5074	0.5388
Demand as Percent of Supply	197%	17%	18%	20%	21%	22%

The purpose of the above chart is to show a general indication of how the long-term per capita water demand changes over time. The per capita water demand may actually be different than indicated due to seasonal populations and the accuracy of data submitted. Water systems that have calculated long-term per capita water demand based on a methodology that produces different results may submit their information in the notes field.

Your long-term water demand is 376 gallons per capita per day. What demand management practices do you plan to implement to reduce the per capita water demand (i.e. conduct regular water audits, implement a plumbing retrofit program, employ practices such as rainwater harvesting or reclaimed water)? If these practices are covered elsewhere in your plan, indicate where the practices are discussed here. The 376 gpcd is based on the current residential demand of 0.130 MGD divided by the year-round population of 346. A more realistic estimation of per capita water demand would be to divide the maximum day demand in July (0.81 MGD less non-residential uses of 0.34 MGD) by the estimated seasonal peak population of 5,652. This yields 83 gpcd.

Are there other demand management practices you will implement to reduce your future supply needs? Beech Mountain's system wide water loss is the primary reason for the high water demand. Virtually all of the substandard distribution water lines and service connections were installed by developers before the town was incorporated. As was done this year, the town plans to target and replace sections of the distribution system each year. Beech Mountain continues to operate with new accounting and billing practices in an effort to monitor and reduce water loss through digital meters and reading practices. The town continues to use leak detection equipment and practices to identify and repair water loss sources that are found.

What supplies other than the ones listed in future supplies are being considered to meet your future supply needs? The Town of Beech Mountain has sought assistance through the legislative House Bill 609 process in order to identify the town's future water supply needs and the options to meet these needs. Per the recommendation in the State's report, the town continues to work toward a potential emergency water intake on the Watauga River. The Town is also pursuing other options including groundwater wells and increased impounded storage.

How does the water system intend to implement the demand management and supply planning components above? Beech Mountain has obtained a potential intake site on the Watauga River, which NC DWR has concurred is needed. Beech Mountain water lines and water taps are being systematically replaced over the course of several years. Beech Mountain water rates have been increased, and will need to continue to be increased.

Additional Information

Has this system participated in regional water supply or water use planning? No

What major water supply reports or studies were used for planning? Town of Beech Mountain Water and Sewer Study by" Rothrock Engineering (P. Marion Rothrock, P.E. date 2/28/2011). Town of Beech Mountain -Buckeye Lake Yield Analysis by West Consultants dated February 7, 2014. Town of Beech Mountain Analysis of Future Water Supply Needs and Availability by the NC Division of Water Resources – Water Supply Planning Branch dated September 1, 2015. Beech Mountain Town Council Special Work Session Watauga Water Intake project Agenda Packet-February 25th 2020, 401 Water Quality Certification No. 1756 – November 2019.

Please describe any other needs or issues regarding your water supply sources, any water system deficiencies or needed improvements (storage, treatment, etc.) or your ability to meet present and future water needs. Include both quantity and quality considerations, as well as financial, technical, managerial, permitting, and compliance issues: According to the February 2014 Buckeye Lake Yield Analysis document by West Consultants, the safe yield of Buckeye Lake is approximately 0.3 mgd; however, this value is only valid under specific qualifying conditions. The most important condition is that this value does not include the existing minimum release requirements set forth in the United States Army Corps of Engineers (USACE) Permit (i.e., Section 404 of the Clean Water Act) for construction of the Buckeye Lake dam. The permit, issued November 1984, requires a minimum flow release from the dam of 2.8 cfs (1.8 mgd) through October, November and December, intended to provide needed flows during the native brook trout spawning period. The remainder of the year (i.e., January through September), the required minimum release is 1.5 cfs (0.97 mgd), intended to maintain the existing water quality of Buckeye Creek. The 2014 Yield Analysis report makes it clear that when including the required minimum releases, as dictated by the USACE permit, the safe yield should be considered zero under low flow conditions or in times of drought. It should also be noted that similar to the Buckeye Creek flow estimations, the safe yield calculations used USGS gage data from the Watauga and Elk Rivers. In light of recent DWR modelling difficulties regarding Buckeye Creek, use of these values should be considered questionable, even though this methodology is the only available means to make such estimations.

The 1984 minimum release requirements used in the 2014 Buckeye Lake Yield Analysis document by West Consultants were not achievable during droughts such as the town experienced in 2010. Therefore, the town requested a modification to the dam permit issued by US Army Corps of Engineers.
On November 20th, 2019 The Town of Beech Mountain received approval of Individual 401 Water Quality Certification (Certification #1756)(USACE Action ID. No. SAW-2018-02144) which replaces the certification based on October 8th, 1984. The new minimums approved are still significant (up to 1.64 MGD) but are more achievable. Based on this new certification protocol, West Consultants has re-calculated the estimated yield of Buckeye Lake to be 0.240 MGD. However, yields shown are theoretical and based on the assumption that the Buckeye Lake watershed characteristics mimic the Watauga River watershed. Actual yields may be lower.

In 2019 Beech Mountain moved forward to aid this calculation process by partnering with the U.S. Department of the Interior; U.S. Geological Survey to install and maintain stream gage stations upstream and downstream of the Buckeye Lake Reservoir. This data will be used to provide accurate stream flow calculations into the future aiding the ability to accurately meet USACE permit requirements. This data will be used to build a historical database for more accurate stream flow calculations.

Beech Mountain

2021

The Division of Water Resources (DWR) provides the data contained within this Local Water Supply Plan (LWSP) as a courtesy and service to our customers. DWR staff does not field verify data. Neither DWR, nor any other party involved in the preparation of this LWSP attests that the data is completely free of errors and omissions. Furthermore, data users are cautioned that LWSPs labeled **PROVISIONAL** have yet to be reviewed by DWR staff. Subsequent review may result in significant revision. Questions regarding the accuracy or limitations of usage of this data should be directed to the water system and/or DWR.

1. System Information

Contact Information

Water System Name:	Beech Mountain	PWSID:	01-95-104
Mailing Address:	403 Beech Mountain Parkway Beech Mountain, NC 28604	Ownership:	Municipality
Contact Person:	Daniel Davis	Title:	Public Utilities Superintendent
Phone:	828-387-9282	Cell/Mobile:	--

Complete

Distribution System

Line Type	Size Range (Inches)	Estimated % of lines
Ductile Iron	4-8	11.00 %
Galvanized Iron	2-12	88.00 %
Polyvinyl Chloride	6	1.00 %

What are the estimated total miles of distribution system lines? 66 Miles

How many feet of distribution lines were replaced during 2021? 4,000 Feet

How many feet of new water mains were added during 2021? 0 Feet

How many meters were replaced in 2021? 127

How old are the oldest meters in this system? 15 Year(s)

How many meters for outdoor water use, such as irrigation, are not billed for sewer services? 0

What is this system's finished water storage capacity? 1.5000 Million Gallons

Has water pressure been inadequate in any part of the system since last update? *Line breaks that were repaired quickly should not be included.* No

In 2021, we completed the 2020/2021 FY project totaling 17,000 feet of water main and associated service connections. We have further scheduled the next project including an estimated 22,700 feet of water main and associated service connections for the 2022/2023 FY. This project is part of the continuing water main upgrades plans to replace large areas of galvanized piping installed in the late 1960's by the original developer before the township was incorporated. This year we achieved the remaining 4,000 feet of line completing the previous replacement project. We continue a 10 year initiative to begin replacing as a target number 150 service connections annually, removing 3/4" galvanized piping and replacing with a polyethylene(PexA) product as further effort to reduce loss throughout the system. In 2021, we replaced 127 services at an estimated 3,810 feet of service connections as well. We also have a planned program to replace an additional 400 3/4" galvanized service connections as a special service line replacement project over the next 2 years.

Programs

Does this system have a program to work or flush hydrants? Yes, Monthly

Does this system have a valve exercise program? No

Does this system have a cross-connection program? Yes

Does this system have a program to replace meters? Yes

Does this system have a plumbing retrofit program? No

Does this system have an active water conservation public education program? No

Does this system have a leak detection program? Yes

We use digital meters which allow for weekly readings of the service meters to monitor meter usage, totals, and leakage as well as leak listening devices and correlators to identify main line leakage in suspect areas. We also have a monthly, quarterly, and annual hydrant flushing program that is utilized to maintain pleasing water to our citizens. We work each year with the NC Rural Water Association on a system wide leak detection effort.

Water Conservation

What type of rate structure is used? Increasing Block, Uniform

How much reclaimed water does this system use? 0.0000 MGD For how many connections? 0

Does this system have an interconnection with another system capable of providing water in an emergency? No

Beech Mountain has no feasible access to its nearest neighboring water systems due to elevation and terrain. Also, the neighboring water systems treatment capacities are too small for support of Beech Mountains needs in an emergency. Recent situation has also proven that the hauling of water in an emergency situation is unable to sustain the system as well. Beech Mountain has sought assistance through the Legislative House Bill 609 process in order to identify the town's future water supply needs and the options available to meet those needs.

2. Water Use Information

Service Area

Sub-Basin(s)	% of Service Population	County(s)	% of Service Population
Watauga River (16-1)	100 %	Watauga	85 %
		Avery	15 %

What was the year-round population served in 2021? 675

What was the seasonal population and months served in 2021? (if applicable) 5,179 (Jan Feb Mar Jun Jul Aug Dec)

Has this system acquired another system since last report? No

Nearly all the population at Beech Mountain is transient. Population data sources: current year-round population from Office of State Management and Budget (OSMB), current seasonal population from Town of Beech Mountain 2020-35 Comprehensive Plan chapter 4, page 13.

Water Use by Type

Type of Use	Metered Connections	Metered Average Use (MGD)	Non-Metered Connections	Non-Metered Estimated Use (MGD)
Residential	2,044	0.1330	0	0.0000
Commercial	64	0.0310	0	0.0000
Industrial	0	0.0000	0	0.0000
Institutional	0	0.0000	0	0.0000

How much water was used for system processes (backwash, line cleaning, flushing, etc.)? 0.0456 MGD

In 2021, Beech Mountain accounted for 0.040 MGD through process water at the water treatment plant. The additional 0.0056 MGD provides for system processes including an estimated value for firefighting, general hydrant use, and for the automatic flushers we use in the distribution system. There are no churches, schools, or industry in Beech Mountain. Our Town Hall, Public Works, Fire Department, WTP and WWTP are included in our commercial accounts. System data, accounting research and evaluation has shown updated numbers in the metered connections totals from the 2020 report.

3. Water Supply Sources

Monthly Withdrawals & Purchases

	Average Daily Use (MGD)	Max Day Use (MGD)		Average Daily Use (MGD)	Max Day Use (MGD)		Average Daily Use (MGD)	Max Day Use (MGD)
Jan	0.6150	0.8420	May	0.5780	0.8290	Sep	0.5380	0.7610
Feb	0.6590	0.9010	Jun	0.5550	0.6360	Oct	0.4970	0.5950
Mar	0.5780	0.7300	Jul	0.6490	0.9000	Nov	0.5050	0.6210
Apr	0.5750	0.7550	Aug	0.6210	0.9720	Dec	0.5140	0.6960

Surface Water Sources

Stream	Reservoir	Average Daily Withdrawal		Maximum Day Withdrawal (MGD)	Available Raw Water Supply		Usable On-Stream Raw Water Supply Storage (MG)
		MGD	Days Used		MGD	* Qualifier	
Buckeye Creek	Buckeye Lake	0.5740	365	0.9720	0.2400	SY50	30.0000
Pond Creek	Lake Coffey	0.0000	0	0.0000	0.0300	F	7.0000

* Qualifier: C=Contract Amount, SY20=20-year Safe Yield, SY50=50-year Safe Yield, F=20% of 7Q10 or other instream flow requirement, CUA=Capacity Use Area Permit

Surface Water Sources (continued)

Stream	Reservoir	Drainage Area (sq mi)	Metered?	Sub-Basin	County	Year Offline	Use Type
Buckeye Creek	Buckeye Lake	3	Yes	Watauga River (16-1)	Watauga		Regular
Pond Creek	Lake Coffey	1	No	Watauga River (16-1)	Watauga		Emergency

What is this system's off-stream raw water supply storage capacity? 0 Million gallons

Are surface water sources monitored? Yes, Daily

Are you required to maintain minimum flows downstream of its intake or dam? Yes

Does this system anticipate transferring surface water between river basins? No

Buckeye Lake was constructed in 1985/1986 and was at operational water levels by 1987. The 20- year safe yield for Buckeye Lake was reported in the 1989 DWR Water Supply System Report to be 2.0 mgd. The basis for this estimate is unknown. Since construction, the actual available safe yield of Buckeye Lake has been found to be significantly less than the originally reported 2.0 mgd estimation. According to the February 2014 Buckeye Lake Yield Analysis document by West Consultants, the safe yield of Buckeye Lake is approximately 0.3 mgd; however, this value is only valid under specific qualifying conditions. The most important condition is that this value does not include the existing minimum release requirements set forth in the United States Army Corps of Engineers (USACE) Permit (i.e., Section 404- Clean Water Act) for construction of the Buckeye Lake dam. The permit, issued November 1984, requires a minimum flow release from the dam of 2.8 cfs (1.8 mgd) through October, November and December, intended to provide needed flows during the native brook trout spawning period. The remainder of the year (i.e., January through September), the required minimum release is 1.5 cfs (0.97 mgd), intended to maintain the existing water quality of Buckeye Creek. The 2014 Yield Analysis report makes it clear that when including the required minimum releases, as dictated by the USACE permit, the safe yield should be considered zero under low flow conditions or in times of drought. It should also be noted that similar to the Buckeye Creek flow estimations, the safe yield calculations used USGS gage data from the Watauga and Elk Rivers. In light of recent DWR modelling difficulties regarding Buckeye Creek, use of these values should be considered questionable, even though this methodology is the only available means to make such estimations.

The 1984 minimum release requirements used in the 2014 Buckeye Lake Yield Analysis document by West Consultants were not achievable during droughts such as the town experienced in 2010. Therefore, the town requested a modification to the dam permit issued by US Army Corps of Engineers.

On November 20th, 2019 The Town of Beech Mountain received approval of Individual 401 Water Quality Certification (Certification #1756)(USACE Action ID. No. SAW-2018-02144) which replaces the certification based on October 8th, 1984. Based on this certification protocol, West Consultants has calculated the current estimated yield of Buckeye Lake to be 0.240 MGD. The minimums approved are still significant (up to 1.64 MGD) but are more achievable, however, yields shown are theoretical based on assumption that the Buckeye Lake watershed characteristics mimic the Watauga River watershed. Actual yields may be lower than shown.

In 2019 Beech Mountain moved forward to aid this calculation process by partnering with the U.S. Department of the Interior; U.S. Geological Survey to install and maintain stream gage stations upstream and downstream of the Buckeye Lake Reservoir. This data will be used to provide accurate stream flow calculations into the future aiding the ability to accurately meet USACE permit requirements. This data will be used to build a historical database for more accurate stream flow calculations.

In 2021, Beech Mountain began engineering design on expansion of the Lake Coffey water supply source. We are currently in discussions with NCDEQ, NC Wildlife, and US Army Corps. of Engineers on feasibility of the project.

Water Treatment Plants

Plant Name	Permitted Capacity (MGD)	Is Raw Water Metered?	Is Finished Water Ouput Metered?	Source
Buckeye Treatment Plant	1.0000	Yes	Yes	Buckeye Lake

Did average daily water production exceed 80% of approved plant capacity for five consecutive days during 2021? No

If yes, was any water conservation implemented?

Did average daily water production exceed 90% of approved plant capacity for five consecutive days during 2021? No

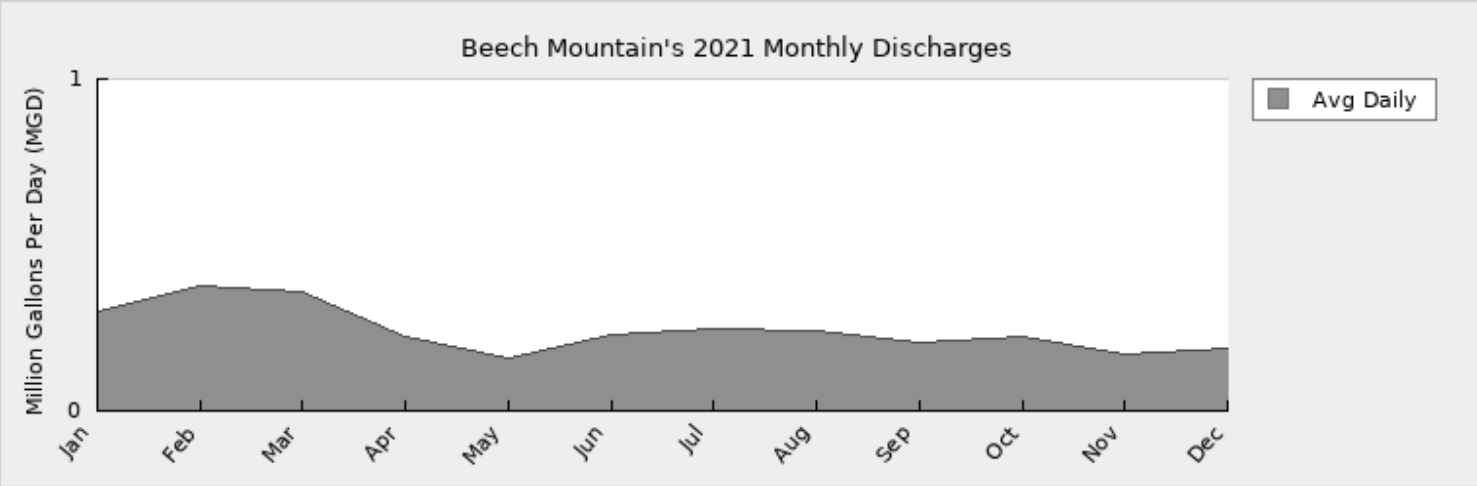
If yes, was any water conservation implemented?

Are peak day demands expected to exceed the water treatment plant capacity in the next 10 years? No

4. Wastewater Information

Monthly Discharges

	Average Daily Discharge (MGD)		Average Daily Discharge (MGD)		Average Daily Discharge (MGD)
Jan	0.2986	May	0.1589	Sep	0.2083
Feb	0.3751	Jun	0.2278	Oct	0.2234
Mar	0.3573	Jul	0.2451	Nov	0.1683
Apr	0.2252	Aug	0.2439	Dec	0.1887



How many sewer connections does this system have? 1,771

How many water service connections with septic systems does this system have? 315

Are there plans to build or expand wastewater treatment facilities in the next 10 years? No

Wastewater Permits

Permit Number	Permitted Capacity (MGD)	Design Capacity (MGD)	Average Annual Daily Discharge (MGD)	Maximum Day Discharge (MGD)	Receiving Stream	Receiving Basin
NC0022730	0.0800	0.0800	0.0343		Grassy Gap Creek	Watauga River (16-1)
NC0069761	0.4000	0.4000	0.1946		Pond Creek	Watauga River (16-1)
NC0088099	0.0500	0.0500	0.0145		Buckeye Creek	Watauga River (16-1)

5. Planning

Projections

	2021	2030	2040	2050	2060	2070
Year-Round Population	675	839	1,069	1,362	1,735	2,210
Seasonal Population	5,179	6,759	8,610	10,968	12,500	12,556
Residential	0.1330	0.1654	0.2107	0.2683	0.3058	0.3072
Commercial	0.0310	0.0385	0.0491	0.0625	0.0713	0.0716
Industrial	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Institutional	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
System Process	0.0456	0.0526	0.0526	0.0526	0.0526	0.0526
Unaccounted-for	0.3644	0.3444	0.3244	0.3044	0.2844	0.2644

Population data sources: current year-round population from Office of State Management and Budget (OSMB), current seasonal population from Town of Beech Mountain 2020-35 Comprehensive Plan chapter 4, future populations based on the Comprehensive Plan and projecting the same rate of growth into the future (2.45% per year). But the build-out population of the town is estimated to be about (2,312 current units + 3,100 future units) @2.32 persons per unit = 12,556.

Growth in residential and commercial water demand is assumed to be proportional with the growth in population. System process water use is based on 0.0056 MGD for distribution system uses and on the remainder being water plant processes (filter-to-waste and backwashing). Unaccounted-for water is projected to be reduced to approximately 40% by the year 2060 as the Town gradually replaces aging infrastructure and reduces system pressure where feasible. We assume a reduction of 0.02 MGD per decade as we replace infrastructure.

Future Supply Sources

Source Name	PWSID	Source Type	Additional Supply	Year Online	Year Offline	Type
Lake Coffey	01-95-104	Surface	0.1870	2026		Emergency
Town of Beech Mountain Wells	01-95-104	Ground	0.1870	2022		Regular
Watauga River	01-95-104	Surface	2.0000	2026		Regular

The future surface water source is needed to meet the current and future water supply needs of the Town of Beech Mountain. The future ground source needs are also being evaluated by drilling test wells with a minimum flow of 54,000 GPD for full development as additional measures to find suitable source water volume.

Lake Coffey is being designed and reviewed for expansion as an acceptable emergency supply source.

The Watauga River source was changed from emergency to regular use type.

Demand v/s Percent of Supply

	2021	2030	2040	2050	2060	2070
Surface Water Supply	0.2400	0.2400	0.2400	0.2400	0.2400	0.2400
Ground Water Supply	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Purchases	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Future Supplies		2.1870	2.1870	2.1870	2.1870	2.1870
Total Available Supply (MGD)	0.2400	2.4270	2.4270	2.4270	2.4270	2.4270
Service Area Demand	0.5740	0.6009	0.6368	0.6878	0.7141	0.6958
Sales	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Future Sales		0.0000	0.0000	0.0000	0.0000	0.0000
Total Demand (MGD)	0.5740	0.6009	0.6368	0.6878	0.7141	0.6958
Demand as Percent of Supply	239%	25%	26%	28%	29%	29%

The purpose of the above chart is to show a general indication of how the long-term per capita water demand changes over time. The per capita water demand may actually be different than indicated due to seasonal populations and the accuracy of data submitted. Water systems that have calculated long-term per capita water demand based on a methodology that produces different results may submit their information in the notes field.

Your long-term water demand is 197 gallons per capita per day. What demand management practices do you plan to implement to reduce the per capita water demand (i.e. conduct regular water audits, implement a plumbing retrofit program, employ practices such as rainwater harvesting or reclaimed water)? If these practices are covered elsewhere in your plan, indicate where the practices are discussed here. The 197 gpcd is based on the current residential demand of 0.133 MGD divided by the year-round population of 675. A more realistic estimation of per capita water demand would be to divide the maximum day demand in August (0.97 MGD less non-residential uses of 0.031 MGD) by the estimated seasonal peak population of 5,436. This yields 173 gpcd.

Are there other demand management practices you will implement to reduce your future supply needs? Beech Mountain's system wide water loss is the primary reason for the high water demand. Virtually all of the substandard distribution water lines and service connections were installed by developers before the town was incorporated. As was done this year, the town plans to target and replace sections of the distribution system each year. Beech Mountain continues to operate with new accounting and billing practices in an effort to monitor and reduce water loss through digital meters and reading practices. The town continues to use leak detection equipment and practices to identify and repair water loss sources that are found.

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APPENDIX 8 - Buckeye Lake Hydrologic Model Results

Town of Beech Mountain - Buckeye Lake Reservoir Model

	Sugar Grove gaging station	Buckeye Lake drainage area	Proportion		Proposed Withdrawal			Storage full	2' above Lowest Intake Elev.	Zfull		Number of Days Could not Withdraw Water	0	
	92.1	3.0	3.26%		0.205	MGD		110.47	18.5	40		No. Days Suppl. Pumped	0	
	sq. mi.	sq. mi.			0.63	ac-ft/day		acre-feet	feet	feet				
	Autumn Min. Release	varies	cfs		0.32	cfs		Results:	0.2	Min. Depth of Water Above Low Level		11/16/1954		MG pumped in 1954
	Rest of Year Min. Release	varies	cfs		Pump from Supplemental Source when Stage drops X feet below Spillway:			20.0	Supplemental Pumping Rate:	0.00	MGD	Sup. Pumping (avg over 82 years)- MG/YR	-	0

		Qin		Qe		Qw	Qr		Qin-Qw-Qr-Qe	S	Z				
DATE	Watauga River historical	Buckeye Lake Stream Inflow		Surface Area	Evaporation	Withdrawal (reduced during WSRP activation)	Minimum Release		Net Change in Storage (incl. volume over spillway if any)	Total Storage (end of day, before supplementing)	Depth (from drain valve) prior to Supplementing	Supplement (pump from Watauga River)	Total Storage (after supplementing, if any)	Depth (from drain valve) After Supplementing	
	cfs (day's avg)	cfs (day's avg)	acre-feet	acres	acre-feet	acre-feet	Req'd cfs	acre-feet	acre-feet	acre-feet	feet	acre-feet	acre-feet	feet	
4/1/1940	300	9.8	19.38	5.29		0.50		0.00	18.88	110.47	40.0	0.00	110.47	40.0	4/1/1940
4/2/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/2/1940
4/3/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/3/1940
4/4/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/4/1940
4/5/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/5/1940
4/6/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/6/1940
4/7/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/7/1940
4/8/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/8/1940
4/9/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/9/1940
4/10/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/10/1940
4/11/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/11/1940
4/12/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/12/1940
4/13/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/13/1940
4/14/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/14/1940
4/15/1940	300	9.8	19.38	5.29	0.06	0.50	2.528	5.01	13.80	110.47	40.0	0.00	110.47	40.0	4/15/1940
4/16/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/16/1940
4/17/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/17/1940
4/18/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/18/1940
4/19/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/19/1940
4/20/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/20/1940
4/21/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/21/1940
4/22/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/22/1940
4/23/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/23/1940
4/24/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/24/1940
4/25/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/25/1940
4/26/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/26/1940
4/27/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/27/1940
4/28/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/28/1940
4/29/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/29/1940
4/30/1940	300	9.8	19.38	5.29	0.06	0.50	1.264	2.51	16.31	110.47	40.0	0.00	110.47	40.0	4/30/1940
5/1/1940	155	5.0	10.01	5.29	0.03	0.50	1.264	2.51	6.98	110.47	40.0	0.00	110.47	40.0	5/1/1940
5/2/1940	160	5.2	10.34	5.29	0.03	0.58	1.264	2.51	7.23	110.47	40.0	0.00	110.47	40.0	5/2/1940
5/3/1940	140	4.6	9.05	5.29	0.03	0.58	1.264	2.51	5.94	110.47	40.0	0.00	110.47	40.0	5/3/1940
5/4/1940	130	4.2	8.40	5.29	0.03	0.58	1.264	2.51	5.29	110.47	40.0	0.00	110.47	40.0	5/4/1940
5/5/1940	115	3.7	7.43	5.29	0.03	0.58	1.264	2.51	4.32	110.47	40.0	0.00	110.47	40.0	5/5/1940

Town of Beech Mountain - Buckeye Lake Reservoir Model

	Sugar Grove gaging station	Buckeye Lake drainage area	Proportion		Proposed Withdrawal			Storage full	2' above Lowest Intake Elev.	Zfull		Number of Days Could not Withdraw Water	277	
	92.1	3.0	3.26%		0.40	MGD		110.47	18.5	40		No. Days Suppl. Pumped	0	
	sq. mi.	sq. mi.			1.23	ac-ft/day		acre-feet	feet	feet				
	Autumn Min. Release	varies	cfs		0.62	cfs		Results:	-0.4	Min. Depth of Water Above Low Level		10/22/1951		MG pumped in 1954
	Rest of Year Min. Release	varies	cfs		Pump from Supplemental Source when Stage drops X feet below Spillway:			20.0	Supplemental Pumping Rate:	0.00	MGD	Sup. Pumping (avg over 82 years)- MG/YR	-	0

		Qin		Qe		Qw	Qr		Qin-Qw-Qr-Qe	S	Z				
DATE	Watauga River historical	Buckeye Lake Stream Inflow		Surface Area	Evaporation	Withdrawal (reduced during WSRP activation)	Minimum Release		Net Change in Storage (incl. volume over spillway if any)	Total Storage (end of day, before supplementing)	Depth (from drain valve) prior to Supplementing	Supplement (pump from Watauga River)	Total Storage (after supplementing, if any)	Depth (from drain valve) After Supplementing	
	cfs (day's avg)	cfs (day's avg)	acre-feet	acres	acre-feet	acre-feet	Req'd cfs	acre-feet	acre-feet	acre-feet	feet	acre-feet	acre-feet	feet	
4/1/1940	300	9.8	19.38	5.29		0.98		0.00	18.40	110.47	40.0	0.00	110.47	40.0	4/1/1940
4/2/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/2/1940
4/3/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/3/1940
4/4/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/4/1940
4/5/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/5/1940
4/6/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/6/1940
4/7/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/7/1940
4/8/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/8/1940
4/9/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/9/1940
4/10/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/10/1940
4/11/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/11/1940
4/12/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/12/1940
4/13/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/13/1940
4/14/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/14/1940
4/15/1940	300	9.8	19.38	5.29	0.06	0.98	2.528	5.01	13.32	110.47	40.0	0.00	110.47	40.0	4/15/1940
4/16/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/16/1940
4/17/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/17/1940
4/18/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/18/1940
4/19/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/19/1940
4/20/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/20/1940
4/21/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/21/1940
4/22/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/22/1940
4/23/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/23/1940
4/24/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/24/1940
4/25/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/25/1940
4/26/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/26/1940
4/27/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/27/1940
4/28/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/28/1940
4/29/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/29/1940
4/30/1940	300	9.8	19.38	5.29	0.06	0.98	1.264	2.51	15.83	110.47	40.0	0.00	110.47	40.0	4/30/1940
5/1/1940	155	5.0	10.01	5.29	0.03	0.98	1.264	2.51	6.50	110.47	40.0	0.00	110.47	40.0	5/1/1940
5/2/1940	160	5.2	10.34	5.29	0.03	1.12	1.264	2.51	6.68	110.47	40.0	0.00	110.47	40.0	5/2/1940
5/3/1940	140	4.6	9.05	5.29	0.03	1.12	1.264	2.51	5.39	110.47	40.0	0.00	110.47	40.0	5/3/1940
5/4/1940	130	4.2	8.40	5.29	0.03	1.12	1.264	2.51	4.74	110.47	40.0	0.00	110.47	40.0	5/4/1940
5/5/1940	115	3.7	7.43	5.29	0.03	1.12	1.264	2.51	3.77	110.47	40.0	0.00	110.47	40.0	5/5/1940

Town of Beech Mountain - Buckeye Lake Reservoir Model	
Year	**Days without Water**
1941	0
1942	0
1943	0
1944	20
1945	0
1946	0
1947	0
1948	0
1949	0
1950	0
1951	17
1952	8
1953	36
1954	69
1955	0
1956	0
1957	0
1958	0
1959	0
1960	0
1961	0
1962	0
1963	38
1964	0
1965	0
1966	0
1967	0
1968	0
1969	0
1970	0
1971	0
1972	0
1973	0
1974	0
1975	0
1976	0
1977	0
1978	0
1979	0
1980	0
1981	16
1982	0
1983	0

1984	0
1985	0
1986	0
1987	0
1988	9
1989	0
1990	0
1991	0
1992	0
1993	42
1994	0
1995	0
1996	0
1997	0
1998	8
1999	0
2000	0
2001	0
2002	1
2003	0
2004	0
2005	0
2006	0
2007	0
2008	0
2009	0
2010	13
2011	0
2012	0
2013	0
2014	0
2015	0
2016	0
2017	0
2018	0
2019	0
2020	0
2021	0
2022	0
	277

APPENDIX 9 - Lake Coffey Hydrologic Model Results

Town of Beech Mountain
Lake Coffey Reservoir Model

	Pond Ck. & S3 "East Fork" drainage area	S2 "West Fork" drainage area	S1 & S4 "Lake Coffey" drainage area
	0.72	0.66	0.17
	sq. mi.	sq. mi.	sq. mi.
ByPass (1 = Yes)	0	0	0
InFlow (0 = No)	1	1	1
Avg. Annual Discharge	2.10		cfsm
Min. Release % 15.0%	Min Release Discharge	0.32	cfsm

Withdrawal for WTP	
0.40	MGD
1.23	ac-ft/day
0.62	cfs

Watauga Avg cfsm	Max Pumping to WTP Total (MGD)
1.40	0.40

Storage full	Lowest Intake Elev.	Zfull
151.65	0	40
acre-feet	feet	feet

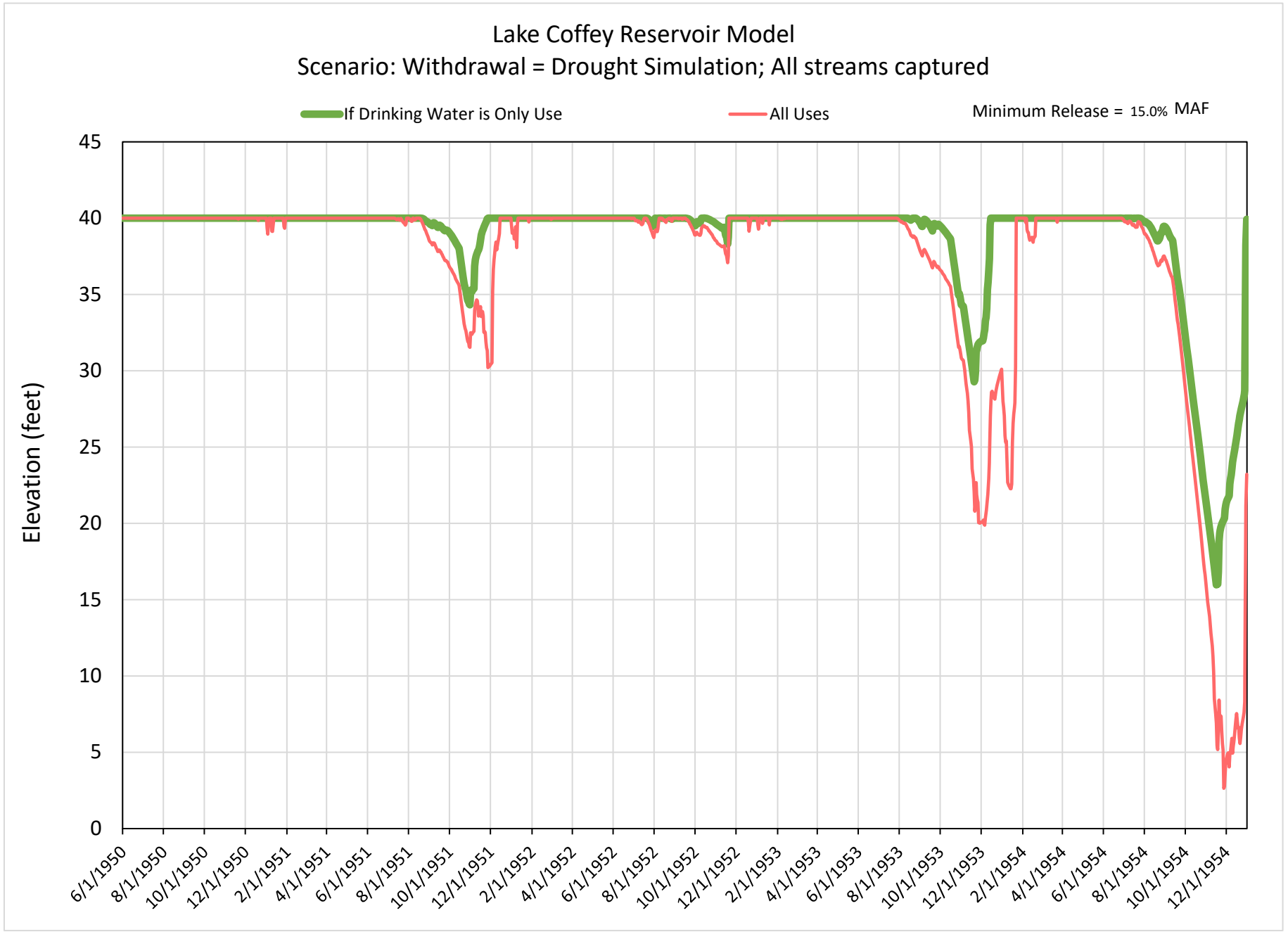
2.6	Min. Depth of Water Above Lowest Intake

Percent Snow Melt to Creeks
52

Snowmaking 2020-2021 Season

Average GPD	Total (Gallons)
590,737	89,201,260

				Qin		Qe	Qw	Qr					S	Z							
DATE	Watauga River flow (from USGS Sugar Grove gage)	Convert to cfs per sq. mile (92.1 sq. mi.)	ByPass Streams	Inflow Streams		Surface Area	Evaporation	Withdrawal (pump to WTP)	Minimum Release		Qin-Qw-Qr-Qe Net Change in Storage (incl. volume over spillway if any), if no irrigation or snow pumping	Spill from Dam If no Snow & Irrigation Pumping	Total Release from Reservoir If No Snow or Irrigation Pumping	Total Storage (end of day, if no Snow or Irrigation pumping)	Depth After Pumping to WTP (if no snow or irrigation pumping)	Snow making per 2020-2021 Log	Pumping to Ski Slope	Snow Melt	Beech Mtn. Club Irrigation (average)	Total Storage (after snow & irrigation pumping)	Depth After Snow & Irrigation Pumping	Total Release from Reservoir After Snow & Irrigation Pumping
	cfs	cfsm	cfs	cfs	acre-feet	acres	acre-feet	acre-feet	Req'd cfs	acre-feet	acre-feet	cfs	cfs	acre-feet	feet	gallons	acre-feet	acre-feet	acre-feet	acre-feet	feet	cfs
6/1/1950	166.00	1.80	0.0000	2.7937	5.54	5.13	0.08	0.00	0.4883	0.97	4.49	2.26	2.75	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	2.094
6/2/1950	129.00	1.40	0.0000	2.1710	4.31	5.13	0.08	0.00	0.4883	0.97	3.26	1.64	2.13	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	2.130
6/3/1950	125.00	1.36	0.0000	2.1037	4.17	5.13	0.08	0.00	0.4883	0.97	3.12	1.57	2.06	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	2.063
6/4/1950	216.00	2.35	0.0000	3.6352	7.21	5.13	0.08	0.00	0.4883	0.97	6.16	3.11	3.59	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	3.424
6/5/1950	170.00	1.85	0.0000	2.8610	5.67	5.13	0.08	0.00	0.4883	0.97	4.62	2.33	2.82	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	2.820
6/6/1950	131.00	1.42	0.0000	2.2047	4.37	5.13	0.08	0.00	0.4883	0.97	3.32	1.68	2.16	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	2.164
6/7/1950	113.00	1.23	0.0000	1.9017	3.77	5.13	0.08	0.00	0.4883	0.97	2.72	1.37	1.86	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	1.690
6/8/1950	104.00	1.13	0.0000	1.7503	3.47	5.13	0.08	0.00	0.4883	0.97	2.42	1.22	1.71	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.709
6/9/1950	115.00	1.25	0.0000	1.9354	3.84	5.13	0.08	0.00	0.4883	0.97	2.79	1.41	1.89	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.894
6/10/1950	145.00	1.57	0.0000	2.4403	4.84	5.13	0.08	0.00	0.4883	0.97	3.79	1.91	2.40	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	2.229
6/11/1950	181.00	1.97	0.0000	3.0461	6.04	5.13	0.08	0.00	0.4883	0.97	4.99	2.52	3.01	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	3.005
6/12/1950	126.00	1.37	0.0000	2.1205	4.21	5.13	0.08	0.00	0.4883	0.97	3.16	1.59	2.08	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	1.909
6/13/1950	110.00	1.19	0.0000	1.8512	3.67	5.13	0.08	0.00	0.4883	0.97	2.62	1.32	1.81	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.810
6/14/1950	104.00	1.13	0.0000	1.7503	3.47	5.13	0.08	0.00	0.4883	0.97	2.42	1.22	1.71	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	1.539
6/15/1950	95.00	1.03	0.0000	1.5988	3.17	5.13	0.08	0.00	0.4883	0.97	2.12	1.07	1.56	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.558
6/16/1950	91.00	0.99	0.0000	1.5315	3.04	5.13	0.08	0.00	0.4883	0.97	1.99	1.00	1.49	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	1.320
6/17/1950	91.00	0.99	0.0000	1.5315	3.04	5.13	0.08	0.00	0.4883	0.97	1.99	1.00	1.49	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.490
6/18/1950	83.00	0.90	0.0000	1.3969	2.77	5.13	0.08	0.00	0.4883	0.97	1.72	0.87	1.36	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.356
6/19/1950	83.00	0.90	0.0000	1.3969	2.77	5.13	0.08	0.00	0.4883	0.97	1.72	0.87	1.36	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	1.186
6/20/1950	106.00	1.15	0.0000	1.7839	3.54	5.13	0.08	0.00	0.4883	0.97	2.49	1.25	1.74	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.743
6/21/1950	135.00	1.47	0.0000	2.2720	4.51	5.13	0.08	0.00	0.4883	0.97	3.46	1.74	2.23	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	2.061
6/22/1950	180.00	1.95	0.0000	3.0293	6.01	5.13	0.08	0.00	0.4883	0.97	4.96	2.50	2.99	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	2.988
6/23/1950	221.00	2.40	0.0000	3.7193	7.38	5.13	0.08	0.00	0.4883	0.97	6.33	3.19	3.68	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	3.678
6/24/1950	145.00	1.57	0.0000	2.4403	4.84	5.13	0.08	0.00	0.4883	0.97	3.79	1.91	2.40	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	2.229
6/25/1950	115.00	1.25	0.0000	1.9354	3.84	5.13	0.08	0.00	0.4883	0.97	2.79	1.41	1.89	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.894
6/26/1950	108.00	1.17	0.0000	1.8176	3.61	5.13	0.08	0.00	0.4883	0.97	2.56	1.29	1.78	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	1.606
6/27/1950	102.00	1.11	0.0000	1.7166	3.40	5.13	0.08	0.00	0.4883	0.97	2.35	1.19	1.68	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.676
6/28/1950	81.00	0.88	0.0000	1.3632	2.70	5.13	0.08	0.00	0.4883	0.97	1.65	0.83	1.32	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.322
6/29/1950	75.00	0.81	0.0000	1.2622	2.50	5.13	0.08	0.00	0.4883	0.97	1.45	0.73	1.22	151.65	40.0	0	0.00	0.00	0.34	151.65	40.0	1.051
6/30/1950	73.00	0.79	0.0000	1.2286	2.44	5.13	0.08	0.00	0.4883	0.97	1.39	0.70	1.19	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.187
7/1/1950	73.00	0.79	0.0000	1.2286	2.44	5.13	0.08	0.00	0.4883	0.97	1.39	0.70	1.19	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	0.987
7/2/1950	74.00	0.80	0.0000	1.2454	2.47	5.13	0.08	0.00	0.4883	0.97	1.42	0.72	1.20	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.003
7/3/1950	75.00	0.81	0.0000	1.2622	2.50	5.13	0.08	0.00	0.4883	0.97	1.45	0.73	1.22	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.221
7/4/1950	61.00	0.66	0.0000	1.0266	2.04	5.13	0.08	0.00	0.4883	0.97	0.99	0.50	0.99	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	0.785
7/5/1950	94.00	1.02	0.0000	1.5820	3.14	5.13	0.08	0.00	0.4883	0.97	2.09	1.05	1.54	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.340
7/6/1950	226.00	2.45	0.0000	3.8035	7.54	5.13	0.08	0.00	0.4883	0.97	6.49	3.27	3.76	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	3.763
7/7/1950	142.00	1.54	0.0000	2.3898	4.74	5.13	0.08	0.00	0.4883	0.97	3.69	1.86	2.35	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	2.148
7/8/1950	93.00	1.01	0.0000	1.5651	3.10	5.13	0.08	0.00	0.4883	0.97	2.06	1.04	1.52	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.323
7/9/1950	77.00	0.84	0.0000	1.2959	2.57	5.13	0.08	0.00	0.4883	0.97	1.52	0.77	1.26	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.054
7/10/1950	70.00	0.76	0.0000	1.1781	2.34	5.13	0.08	0.00	0.4883	0.97	1.29	0.65	1.14	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.137
7/11/1950	93.00	1.01	0.0000	1.5651	3.10	5.13	0.08	0.00	0.4883	0.97	2.06	1.04	1.52	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.323
7/12/1950	93.00	1.01	0.0000	1.5651	3.10	5.13	0.08	0.00	0.4883	0.97	2.06	1.04	1.52	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.323
7/13/1950	85.00	0.92	0.0000	1.4305	2.84	5.13	0.08	0.00	0.4883	0.97	1.79	0.90	1.39	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.189
7/14/1950	184.00	2.00	0.0000	3.0966	6.14	5.13	0.08	0.00	0.4883	0.97	5.09	2.57	3.06	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	2.855
7/15/1950	160.00	1.74	0.0000	2.6927	5.34	5.13	0.08	0.00	0.4883	0.97	4.29	2.16	2.65	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	2.652
7/16/1950	156.00	1.69	0.0000	2.6254	5.21	5.13	0.08	0.00	0.4883	0.97	4.16	2.10	2.58	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	2.384
7/17/1950	188.00	2.04	0.0000	3.1640	6.28	5.13	0.08	0.00	0.4883	0.97	5.23	2.63	3.12	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	2.922
7/18/1950	126.00	1.37	0.0000	2.1205	4.21	5.13	0.08	0.00	0.4883	0.97	3.16	1.59	2.08	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.879
7/19/1950	104.00	1.13	0.0000	1.7503	3.47	5.13	0.08	0.00	0.4883	0.97	2.42	1.22	1.71	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.508
7/20/1950	87.00	0.94	0.0000	1.4642	2.90	5.13	0.08	0.00	0.4883	0.97	1.85	0.94	1.42	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.423
7/21/1950	91.00	0.99	0.0000	1.5315	3.04	5.13	0.08	0.00	0.4883	0.97	1.99	1.00	1.49	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.290
7/22/1950	81.00	0.88	0.0000	1.3632	2.70	5.13	0.08	0.00	0.4883	0.97	1.65	0.83	1.32	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.121
7/23/1950	79.00	0.86	0.0000	1.3295	2.64	5.13	0.08	0.00	0.4883	0.97	1.59	0.80	1.29	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.088
7/24/1950	95.00	1.03	0.0000	1.5988	3.17	5.13	0.08	0.00	0.4883	0.97	2.12	1.07	1.56	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.357
7/25/1950	77.00	0.84	0.0000	1.2959	2.57	5.13	0.08	0.00	0.4883	0.97	1.52	0.77	1.26	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.255
7/26/1950	81.00	0.88	0.0000	1.3632	2.70	5.13	0.08	0.00	0.4883	0.97	1.65	0.83	1.32	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.121
7/27/1950	222.00	2.41	0.0000	3.7362	7.41	5.13	0.08	0.00	0.4883	0.97	6.36	3.21	3.70	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	3.494
7/28/1950	236.00	2.56	0.0000	3.9718	7.88	5.13	0.08	0.00	0.4883	0.97	6.83	3.44	3.93	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	3.730
7/29/1950	140.00	1.52	0.0000	2.3561	4.67	5.13	0.08	0.00	0.4883	0.97	3.62	1.83	2.32	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	2.315
7/30/1950	113.00	1.23	0.0000	1.9017	3.77	5.13	0.08	0.00	0.4883	0.97	2.72	1.37	1.86	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.660
7/31/1950	99.00	1.07	0.0000	1.6661	3.30	5.13	0.08	0.00	0.4883	0.97	2.26	1.14	1.63	151.65	40.0	0	0.00	0.00	0.40	151.65	40.0	1.424
8/1/1950	104.00	1.13	0.0000	1.7503	3.47	5.13	0.03	0.00	0.4883	0.97	2.48	1.25	1.74	151.65	40.0	0	0.00	0.00	0.43	151.65	40.0	1.521
8/2/1950	95.00	1.03	0.0000	1.5988	3.17	5.13	0.03	0.00	0.4883	0.97	2.18	1.10	1.59	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.586
8/3/1950	87.00	0.94	0.0000	1.4642	2.90	5.13	0.03	0.00	0.4883	0.97	1.91	0.96	1.45	151.65	40.0	0	0.00	0.00	0.43	151.65	40.0	1.235
8/4/1950	83.00	0.90	0.0000	1.3969	2.77	5.13	0.03	0.00	0.4883	0.97	1.78	0.90	1.38	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.384
8/5/1950	75.00	0.81	0.0000	1.2622	2.50	5.13	0.03	0.00	0.4883	0.97	1.51	0.76	1.25	151.65	40.0	0	0.00	0.00	0.43	151.65	40.0	1.033
8/6/1950	70.00	0.76	0.0000	1.1781	2.34	5.13	0.03	0.00	0.4883	0.97	1.34	0.68	1.17	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.165
8/7/1950	66.00	0.72	0.0000	1.1107	2.20	5.13	0.03	0.00	0.4883	0.97	1.21	0.61	1.10	151.65	40.0	0	0.00	0.00	0.43	151.65	40.0	0.881
8/8/1950	64.00	0.69	0.0000	1.0771	2.14	5.13	0.03	0.00	0.4883	0.97	1.14	0.58	1.06	151.65	40.0	0	0.00	0.00	0.00	151.65	40.0	1.064



APPENDIX 10

FEMA Benefit-Cost Analysis Toolkit Results – ASR Model Method

FEMA Benefit-Cost Calculator

V.6.0 (Build 20220831.1934 | Release Notes)

Benefit-Cost Analysis

Project Name: Town of Beech Mountain Water Supply (ASR Method)

Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)
1	Aquifer Storage and Recovery @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604		Drought	$ 146,873,424	$ 14,788,823	9.93
TOTAL (SELECTED)				**$ 146,873,424**	**$ 14,788,823**	**9.93**
TOTAL				**$ 146,873,424**	**$ 14,788,823**	**9.93**

Property Configuration

Property Title:	Aquifer Storage and Recovery @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604
Property Location:	28604, Watauga, North Carolina
Property Coordinates:	36.2033544, -81.8763473
Hazard Type:	Drought
Mitigation Action Type:	Aquifer Storage and Recovery
Property Type:	Utilities
Analysis Method Type:	Modeled Damages

Cost Estimation

Aquifer Storage and Recovery @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Project Useful Life (years):	50
Project Cost:	$14,000,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$57,158

Comments

-

Project Useful Life:

Appendix D of BCA Reference Guide ("Major Infrastructure" and "Major Utility Mitigation - water")

-

Mitigation Project Cost:

see attached Probable Cost Opinion dated 9-12-2022

-

Annual Maintenance Cost:

see attached breakdown

Hazard Probability Parameters - Drought

Aquifer Storage and Recovery @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Recurrence Interval (years)	Water Demand (mgd)	Pre-Mitigation System Supply Yield (mgd)	Pre-Mitigation Duration of Impact (days)	Post-Mitigation System Supply Yield (mgd)	Post-Mitigation Duration of Impact (days)
1	0.4	0.21	58	0.4	0

Comments

•

Hazard Parameters:

The current and only water source, Buckeye Lake, is out of compliance with minimum release requirements every year (refer to Department of Army and NCDWR permits attached). The Town's water demand has been met only by retaining all water that does not go over the spillway. As shown on the attached stream gauge records, the water supply was insufficient for 26 days in 2020 and 90 days in 2021, i.e., the required downstream flow of 2.53 cfs in the winter and 1.26 cfs in all other seasons, was not met. The Town has been reporting stream gauge flows since January 2020. But even before that, plant operators attest that the flow over the spillway decreases to near zero or to zero every summer. Furthermore, the 2017 Hazard Mitigation Plan Update states that the region has experienced drought in 16 of the previous 17 years (Table 5.4). Therefore, a recurrence interval of 1 is used, and impact days per occurrence is 58 (the average of 26 days in 2020 and 90 days in 2021). Current annual average demand/withdrawal of 0.47 MGD, as per 2020 Local Water Supply Plan (LWSP). Some of this demand represents system leakage that can be reduced by replacing aging infrastructure. Therefore, a demand of 0.40 MGD was used for purposes of this BCA. Pre-mitigation yield is estimated to be 0.21 MGD, based on the water balance model for the Buckeye Lake reservoir. That model uses the nearest stream gauge with enough data to capture historical droughts (Watauga River at Sugar Grove, Site #03479000).

Population Impact and Demand
Aquifer Storage and Recovery @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Population Served:	3679

Comments

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Population Served:

Seasonal population taken from the 2021 Local Water Supply Plan, page 4, and adjusted to approximate the average number of persons using the water system per month. This is calculated by setting the peak water use month as representing a month that housing units are fully occupied, then estimating the other months as having an occupancy that varies proportionately with the residential water consumption. A table showing this calculation is attached.

Damage Results
Aquifer Storage and Recovery @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Recurrence Interval (years)	Damages Before Mitigation ($)	Annual Damages Before Mitigation ($)	Damages After Mitigation ($)	Annual Damages After Mitigation ($)
1	10642427.25	10642426.18575716	0	0

Benefits-Costs Summary

Aquifer Storage and Recovery @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Total Standard Mitigation Benefits:	$146,873,424
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$146,873,424
Total Mitigation Project Cost:	$14,788,823
Benefit Cost Ratio - Standard:	9.93
Benefit Cost Ratio - Standard + Social:	9.93

APPENDIX 11

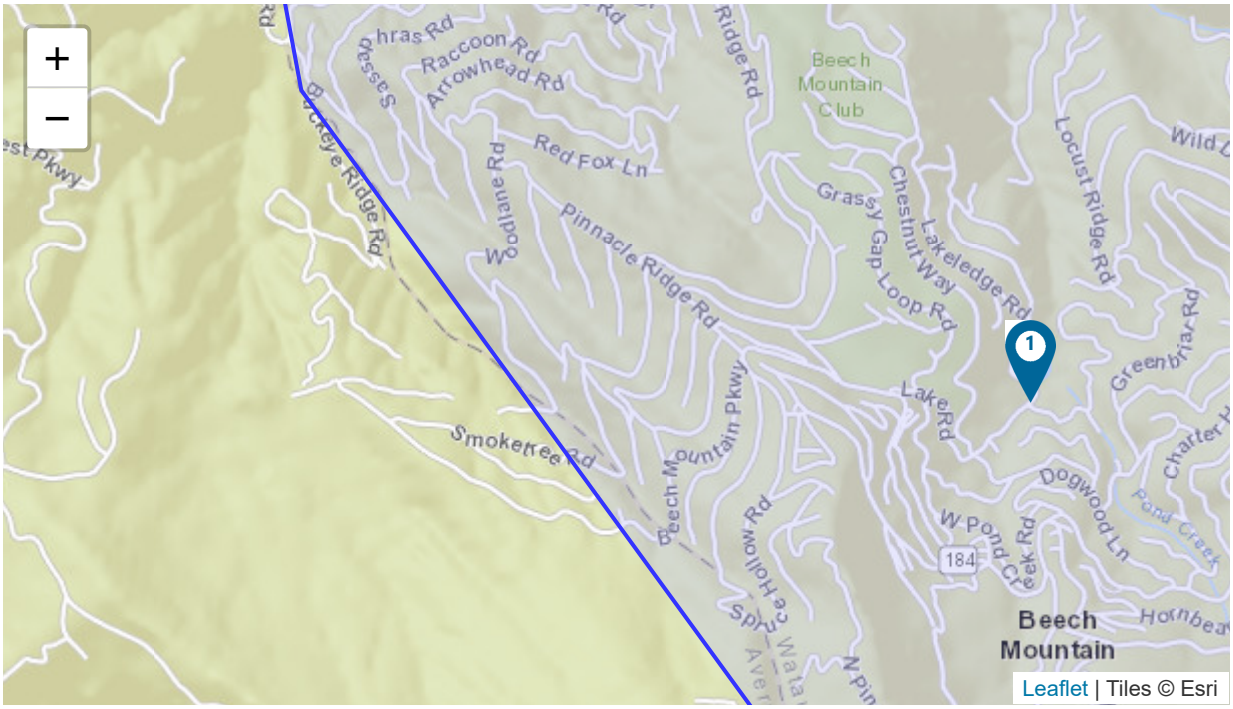
FEMA Benefit-Cost Analysis Toolkit Results – Historical Damages Method

FEMA Benefit-Cost Calculator

V.6.0 (Build 20220831.1934 | Release Notes)

Benefit-Cost Analysis

Project Name: Town of Beech Mountain Water Supply (Historical Damages Method)



Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)
1	Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604		DFA - Uncategorized	$ 20,837,747	$ 14,788,823	1.41
TOTAL (SELECTED)				**$ 20,837,747**	**$ 14,788,823**	**1.41**
TOTAL				**$ 20,837,747**	**$ 14,788,823**	**1.41**

Property Configuration

Property Title:	Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604
Property Location:	28604, Watauga, North Carolina
Property Coordinates:	36.2033544, -81.8763473
Hazard Type:	Uncategorized
Mitigation Action Type:	Other
Property Type:	Utilities
Analysis Method Type:	Historical Damages

Cost Estimation
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Project Useful Life (years):	50
Project Cost:	$14,000,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$57,158

Comments

-

Project Useful Life:

Appendix D of BCA Reference Guide ("Major Infrastructure" and "Major Utility Mitigation - water")

-

Mitigation Project Cost:

see attached Probable Cost Opinion dated 9-12-2022

-

Annual Maintenance Cost:

see attached breakdown

Damage Analysis Parameters - Damage Frequency Assessment
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Year of Analysis was Conducted:	2022
Year Property was Built:	1940
Analysis Duration:	83 Use Default:Yes

Comments

Analysis Year:
as of September 2022

Year Built:
Year that stream gauge records at Watauga River Sugar Grove USGS station begin, which are the records used to estimate professional expected damages.

Utilities Properties
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Type of Service:	Potable Water
Number of Customers Served:	3,679
Value of Unit of Service ($/person/day):	$114 Use Default:Yes
Total Value of Service Per Day ($/day):	$419,406

Comments

Type of Service:
The project will address source water supply deficiency in times of drought, for the Town's public water system.

Number of Customers Served:
Seasonal population taken from the 2021 Local Water Supply Plan, page 4, and adjusted to approximate the average number of persons using the water system per month. This is calculated by setting the peak water use month as representing a month that housing units are fully occupied, then estimating the other months as having an occupancy that varies proportionately with the residential water consumption. A table showing this calculation is attached.

Historical Damages Before Mitigation

Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

		POTABLE WATER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL		
Damage Year	Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)	Current Dollars?	Inflated Damages ($)
1940	0	20	0	0	0	0	0	8,388,120	Yes	8,388,120
1951	0	17	0	0	0	0	0	7,129,902	Yes	7,129,902
1952	0	8	0	0	0	0	0	3,355,248	Yes	3,355,248
1953	0	36	0	0	0	0	0	15,098,616	Yes	15,098,616
1954	0	69	0	0	0	0	0	28,939,014	Yes	28,939,014
1963	0	38	0	0	0	0	0	15,937,428	Yes	15,937,428
1981	0	16	0	0	0	0	0	6,710,496	Yes	6,710,496
1988	0	9	0	0	0	0	0	3,774,654	Yes	3,774,654
1993	0	42	0	0	0	0	0	17,615,052	Yes	17,615,052
1998	0	8	0	0	0	0	0	3,355,248	Yes	3,355,248
2002	0	1	0	0	0	0	0	419,406	Yes	419,406
2010	0	13	0	0	0	0	0	5,452,278	Yes	5,452,278

Comments

-

Damages Before Mitigation:

The current and only water source, Buckeye Lake, is out of compliance with minimum release requirements every year (refer to Department of Army and NCDWR permits attached). The Town's water demand has been met only by retaining all water that does not go over the spillway. As shown on the attached stream gauge records, the water supply was insufficient for 26 days in 2020 and 90 days in 2021, i.e., the required downstream flow of 2.53 cfs in the winter and 1.26 cfs in all other seasons, was not met. The Town has been reporting stream gauge flows since January 2020. But even before that, plant operators attest that the flow over the spillway decreases to near zero or to zero every summer. Therefore, a recurrence interval of 1 could be used. However, as a more conservative approach to estimating damages associated with drought, a water balance calculation was performed that mimics the function of the Buckeye Lake reservoir. The water flow into the reservoir is modeled as being proportional, on a drainage area basis, to the nearest USGS stream gauge with a long history of flow data. The model then estimates flows out of the reservoir due to evaporation, minimum downstream release, and drinking water withdrawals. The model includes reductions in water outflows during times of drought, based on water restrictions placed on the customers and based on reductions in the required minimum release. (The current permit allows reducing the minimum release during droughts). The model results then show which days over the USGS stream gauge history the water supply would have failed to meet the drinking water demand. Using the BCA Toolkit calculator, the estimated historical damages are converted to annualized damages.

Annualized Damages Before Mitigation
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
7	419,406	21,183
8	3,355,248	62,183
9.3	3,774,654	55,749
10.5	5,452,278	112,475
13	6,917,021	132,533
16.8	8,388,120	288,416
28.8	16,121,832	492,852
84	28,939,014	344,509
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	73,367,573	1,509,900

Expected Damages After Mitigation
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

	POTABLE WATER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Comments

-

Damages After Mitigation:

After mitigation by the completion of the new Lake Coffey reservoir, annual dry weather conditions will no longer impact the water system. This is demonstrated by a water model of the new Lake Coffey reservoir showing that its storage can meet the water system's demand on the days that the Buckeye Lake reservoir cannot.

Annualized Damages After Mitigation
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Benefits-Costs Summary

Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Total Standard Mitigation Benefits:	$20,837,747
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$20,837,747
Total Mitigation Project Cost:	$14,788,823
Benefit Cost Ratio - Standard:	1.41
Benefit Cost Ratio - Standard + Social:	1.41

APPENDIX 12

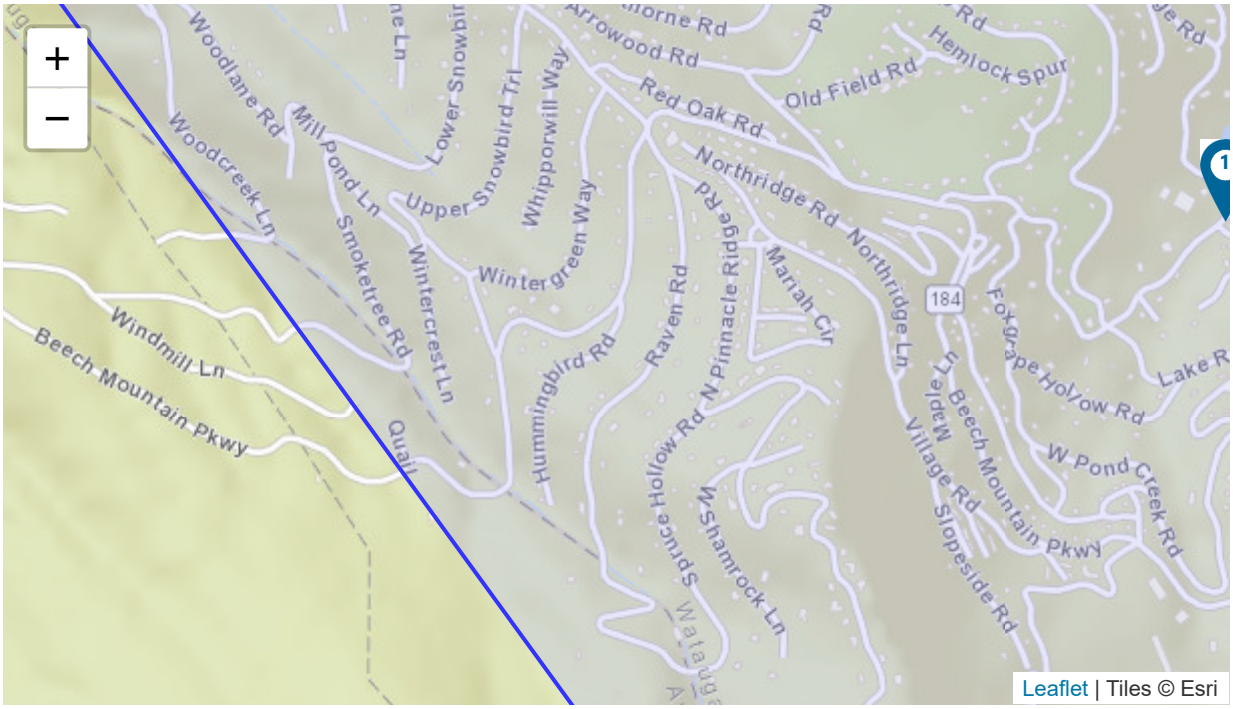
FEMA Benefit-Cost Analysis Toolkit Results – Professional Expected Damages Method

FEMA Benefit-Cost Calculator

V.6.0 (Build 20220831.1934 | Release Notes)

Benefit-Cost Analysis

Project Name: Town of Beech Mountain Water Supply (Professional Expected Damages Method)



Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)
1	Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604		DFA - Uncategorized	$ 20,837,747	$ 14,788,823	1.41
TOTAL (SELECTED)				**$ 20,837,747**	**$ 14,788,823**	**1.41**
TOTAL				**$ 20,837,747**	**$ 14,788,823**	**1.41**

Property Configuration

Property Title:	Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604
Property Location:	28604, Watauga, North Carolina
Property Coordinates:	36.2033544, -81.8763473
Hazard Type:	Uncategorized
Mitigation Action Type:	Other
Property Type:	Utilities
Analysis Method Type:	Professional Expected Damages

Cost Estimation
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Project Useful Life (years):	50
Project Cost:	$14,000,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$57,158

Comments

-

Project Useful Life:

Appendix D of BCA Reference Guide ("Major Infrastructure" and "Major Utility Mitigation - water")

-

Mitigation Project Cost:

see attached Probable Cost Opinion dated 9-12-2022

-

Annual Maintenance Cost:

see attached breakdown

Damage Analysis Parameters - Damage Frequency Assessment
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Year of Analysis was Conducted:	2022
Year Property was Built:	1984
Analysis Duration:	39 Use Default:Yes

Comments

•

Analysis Year:

as of September 2022

•

Year Built:

Year that Buckeye Lake reservoir was built.

Utilities Properties

Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Type of Service:	Potable Water
Number of Customers Served:	3,679
Value of Unit of Service ($/person/day):	$114 Use Default:Yes
Total Value of Service Per Day ($/day):	$419,406

Comments

•

Type of Service:

The project will address source water supply deficiency in times of drought, for the Town's public water system.

•

Number of Customers Served:

Seasonal population taken from the 2021 Local Water Supply Plan, page 4, and adjusted to approximate the average number of persons using the water system per month. This is calculated by setting the peak water use month as representing a month that housing units are fully occupied, then estimating the other months as having an occupancy that varies proportionately with the residential water consumption. A table showing this calculation is attached.

Professional Expected Damages Before Mitigation

Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

	POTABLE WATER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
1	0	1,509,900	0	0	0	0	1,509,900

Comments

•

Damages Before Mitigation:

Refer to notes in the BCA Toolkit report "Town of Beech Mountain Water Supply (Historical Damages Method)". Annualized damages were estimated using the historical damages based on the water balance modelling.

Annualized Damages Before Mitigation
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
1	1,509,900	1,509,900
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,509,900	1,509,900

Professional Expected Damages After Mitigation
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

	POTABLE WATER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Comments

•

Damages After Mitigation:

After mitigation by the completion of the new Lake Coffey reservoir, annual dry weather conditions will no longer impact the water system. This is demonstrated by a water model of the new Lake Coffey reservoir showing that its storage can meet the water system's demand on the days that the Buckeye Lake reservoir cannot.

Annualized Damages After Mitigation
Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

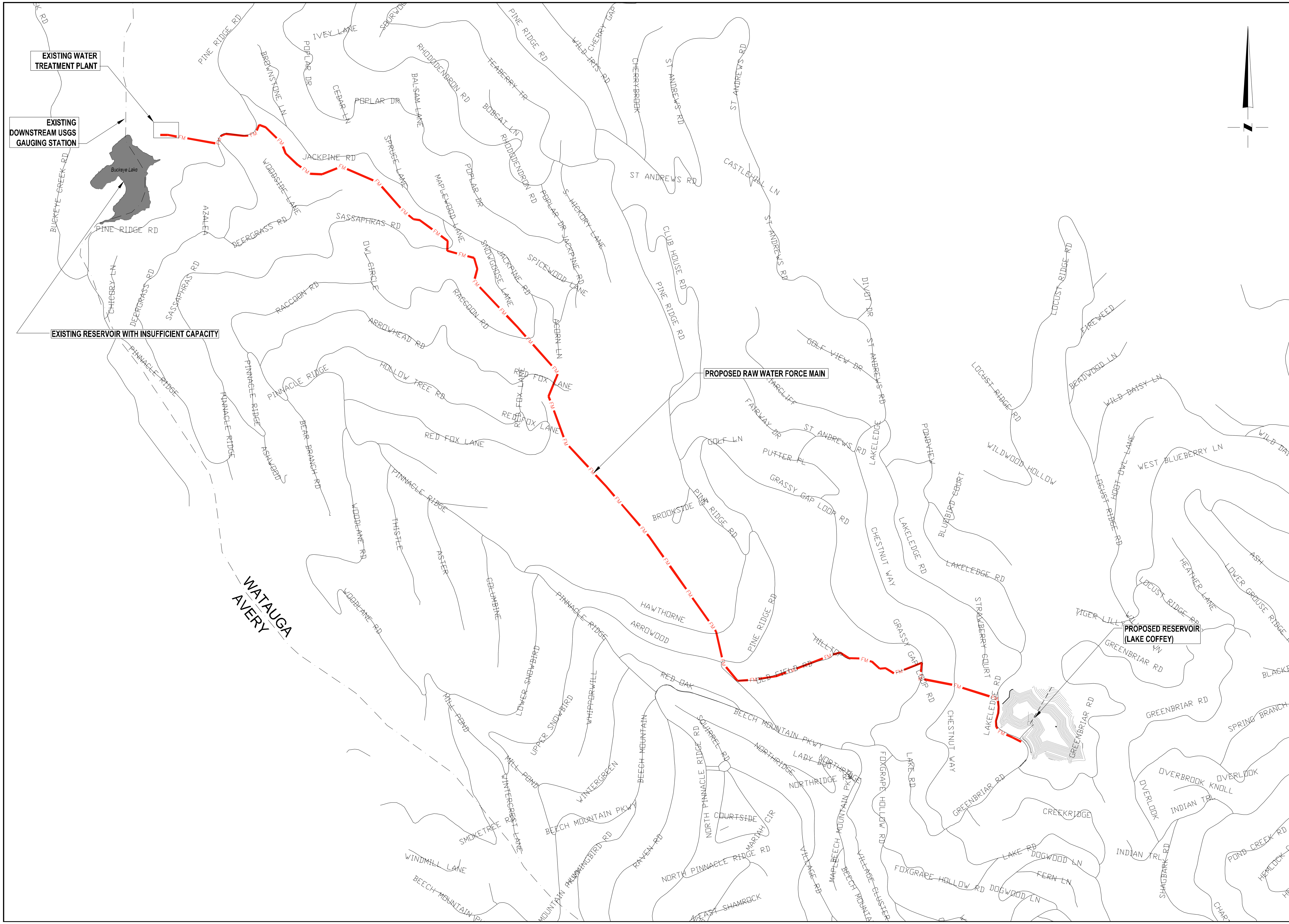
Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Benefits-Costs Summary

Other @ 112 Lakeledge Rd, Banner Elk, North Carolina, 28604

Total Standard Mitigation Benefits:	$20,837,747
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$20,837,747
Total Mitigation Project Cost:	$14,788,823
Benefit Cost Ratio - Standard:	1.41
Benefit Cost Ratio - Standard + Social:	1.41

APPENDIX 13 - Preliminary Drawings



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Fax (828) 433-5662
NC License No. P-0210
www.west-consultants.com

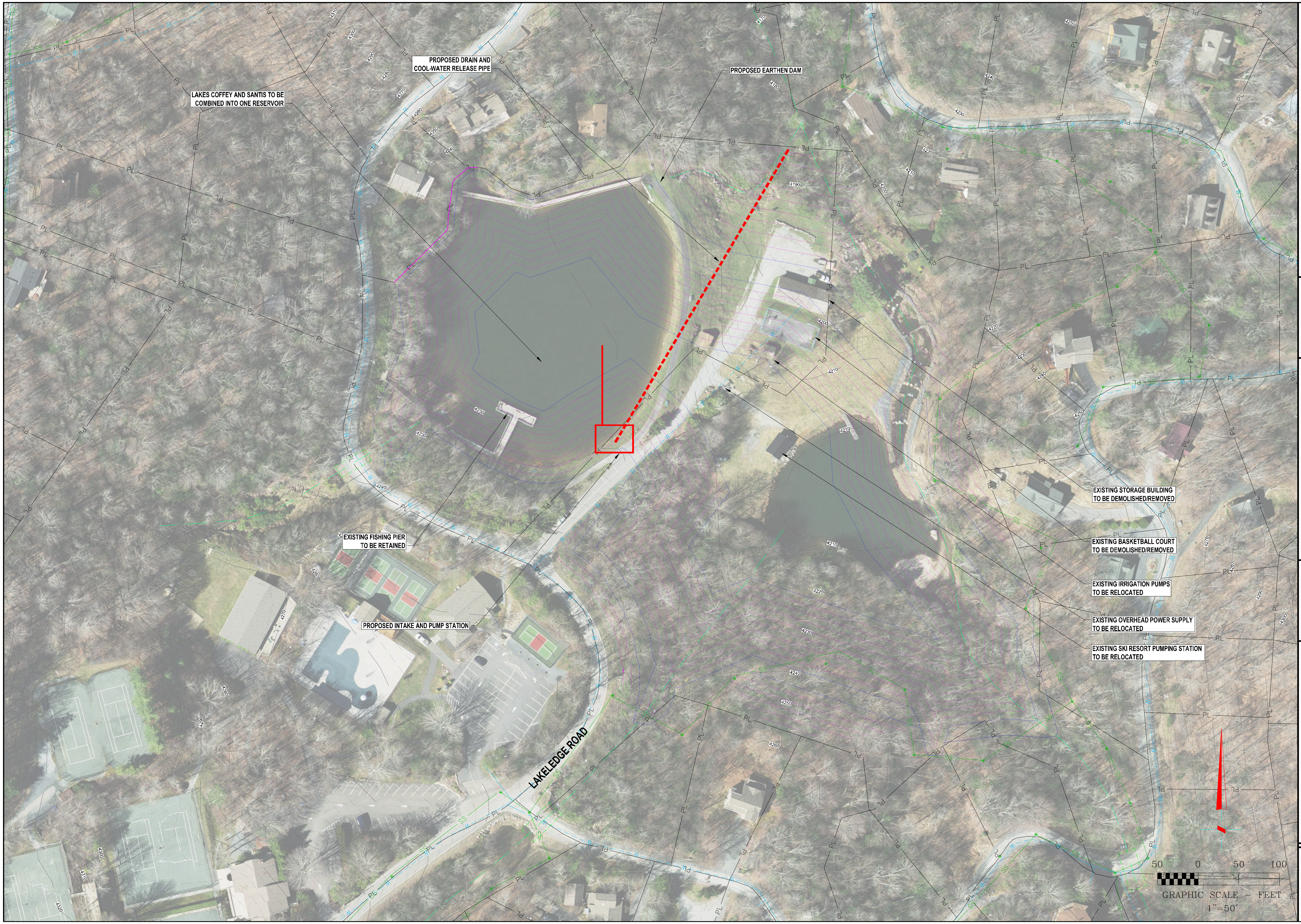
PRELIMINARY

PROPOSED FORCE MAIN ROUTE

PROJECT NO.: 21.183
SCALE: 1"=400'
DATE: 9/12/2022
DRAWN BY: BML
REVISION:

TOWN OF BEECH MOUNTAIN
DROUGHT MITIGATION PROJECT
WATAUGA COUNTY, NORTH CAROLINA

SHEET 1 OF 2



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Fax (828) 433-5662
NC License No. P-0210
www.west-consultants.com

PRELIMINARY

RESERVIOR CONCEPT

PROJECT NO.: 21.183
SCALE: 1"=50'
DATE: 9/12/2022
DRAWN BY: BML
REVISION:

TOWN OF BEECH MOUNTAIN
DROUGHT MITIGATION PROJECT
WATAUGA COUNTY, NORTH CAROLINA

SHEET

2 OF 2