Water-Demand Projections for the Broad River Basin, 2022–2070

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1.0 Background

The South Carolina Department of Natural Resources (SCDNR) is legislatively mandated through the South Carolina Water Resources Planning and Coordination Act (§ 49-3-10, et. seq., Code of Laws of South Carolina, 1976) to formulate a water plan for South Carolina. The South Carolina Water Plan[1] was last published in 2004, and SCDNR has initiated a multi-year project to update the plan. As part of this effort, SCDNR convened the South Carolina Planning Process Advisory Committee (PPAC) in 2018 to develop a guidance document for updating the State Water Plan. Work of the PPAC culminated in the publication of the South Carolina State Water Planning Framework[2] (Planning Framework) in October 2019. Under the new Planning Framework, water management plans, or River Basin Plans, will be developed for each of the eight major planning basins in the state. A key component of the river basin planning process is the formation of a River Basin Council (RBC) in each basin responsible for developing their respective basin plan. The RBC is a working group of stakeholders representing diverse water use interests in each basin. The eight River Basin Plans, once completed, will form the foundation of the new State Water Plan.

River Basin Plans will include an evaluation of current and future water availability and will consider water-demand projections over a period of approximately 50 years extending to the year 2070 (Planning Horizon). The Planning Framework describes two water-demand projection scenarios to be reviewed by each RBC: the Moderate Water-Demand Projection Scenario (formerly called the Business-as-Usual Water-Demand Projection Scenario), and the High Water-Demand Projection Scenario. For the purposes of this report, these two projection scenarios will be referred to as the Moderate-Demand Scenario and the High-Demand Scenario. The Moderate-Demand Scenario is based on median rates of water use and moderate growth projections, while the High-Demand Scenario is based on the maximum monthly rates of water use in recent reporting and high growth projections. Potential water shortages over the Planning Horizon will be evaluated by using the water-demand projections as inputs to hydrologic models.

2.0 Methods Summary

The methods used to calculate the projections were devised by SCDNR over the course of several years (2016–2019) within a collaborative framework including partners at the SC Water Resources Center at Clemson University and the US Army Corps of Engineers. The ongoing progress was presented and discussed with stakeholders at meetings of the SC Water Works Association Water Utility Council, SC Farm Bureau Water Committee, SC Chamber of Commerce Environmental Committee, SC Water Quality Association, and the SCDNR PPAC. In fall 2018, stakeholders and experts participated in teleconferences to discuss the proposed methods in

[1] Badr, A. W., Wachob, A., and Gellici, J.A., 2004, South Carolina Water Plan, second edition: South Carolina Department of Natural Resources, 120 p. (https://hydrology.dnr.sc.gov/pdfs/water-plan/SCWaterPlan2.pdf)

[2] South Carolina State Water Planning Framework: South Carolina Department of Natural Resources Staff and the Water Planning Process Advisory Committee, 2019, 95 p. (https://hydrology.dnr.sc.gov/water-planning-framework.html)

more detail. The first complete draft of the methods was distributed in spring 2019, followed by a public comment period. The report, "Projection Methods for Off-stream Water Demand in South Carolina," was published in October 2019 and is available online[3]. Appendix A of this report documents adjustments that have been made to the methods since October 2019.

The methods were applied to each water-use system that withdraws surface water in the Broad basin. Water-use systems are defined by one or more associated permits or registrations for the withdrawal and distribution. Sales of water among water distributors are not currently modeled explicitly. Generally, interconnected water distributors are considered as a single water-use system. Individual water-demand projection reports were distributed to all permitted and registered water users in the basin. These reports presented the specific data and methods used to project water demand for each water-use system, and recipients were requested to respond with any questions, comments, or corrections.

SCDNR has strived to put together the best available input dataset for the water demand projection estimates in the basin. The water withdrawal database maintained by the South Carolina Department of Health and Environmental Control (SCDHEC) is an important dataset used in the projection of future water demand. The database was reviewed for quality control, and adjustments were made as needed. Other available datasets, including geographic and weather information, were researched, reviewed, and further incorporated into a single database. The input data are used to calibrate a quantitative model for the water demand of each water-use system. The model design is intended to balance interpretability and accuracy. Regardless of the input data, there is uncertainty in projection of future water demand. These projections are presented with the understanding that they will be revised and updated as part of an iterative water-planning process. The projection scenarios are intentionally biased towards higher water demand. If this results in water shortages, then further investigation will determine whether the projection scenarios are realistic or whether shortages can be easily mitigated or avoided. On the other hand, if water planning were based on lower projections of water demand, then the possibility of a shortage could be under-estimated and unplanned for, possibly leading to serious problems.

The current estimates of water demand documented in this report are calculated using the reported water withdrawals maintained by SCDHEC. Water-demand projections were completed for the major categories of water use in the Broad basin: Thermoelectric Power, Public Water Supply, and Manufacturing. Most of the water used for Hydroelectric Power generation is returned directly to the river from which it was withdrawn and is therefore omitted from all data analyses described below. Groundwater withdrawals account for less than 1% of the total withdrawal in the Broad basin, are not expected to increase significantly over the next 50 years and were not projected for the basin. Projected water demands described in this report are assumed to be withdrawn from a surface water source. In addition, agricultural irrigation and other categories have a minor water demand in the Broad basin and are projected to remain stable over the Planning Horizon.

[3] Pellett, A., 2019, Projection Methods for Off-Stream Water Demand in South Carolina: South Carolina Department of Natural Resources, 55 p. (https://hydrology.dnr.sc.gov/pdfs/basin-planning/Projection_Methods.pdf)

Driver variables for the three major water use categories in the Broad basin are summarized in Table 1. Water demand for Thermoelectric Power is projected based on information provided by the electric utilities. Public Water Supply is projected according to county-wide population projections developed by the SC Office of Revenue and Fiscal Affairs (SCORFA). Manufacturing water demand is projected according to economic projections developed by the US Energy Information Agency. Projections of the driver variables are available from published sources (See the Projection report[3] for more details). Two scenarios of future conditions are assessed using the calibrated water-demand models. The Moderate-Demand Scenario takes projections of future conditions of the driver variables from the cited sources and assumes other conditions are at moderate (median) levels. The High-Demand Scenario uses elevated projections of driver variables and assumes other variables cause the rate of water demand for each water-use system to be at its maximum level, calculated using monthly data. It is highly unlikely that the High-Demand Scenario would occur for an extended time and for all water users in an entire basin at the same time. These two scenarios are intended to define a range from moderate growth to extreme circumstances with the High-Demand Scenario serving as an upper bound for projected demand.

Table 1. Description for water use driver variables

Water Use Sector	Driver Variable	Driver Variable Data Source
Thermoelectric Power	Electricity demand	Information provided by electric utilities
Public Water Supply	Population	South Carolina Office of Revenue and Fiscal Affairs
Manufacturing	Economic production	Growth rates from the US Energy Information Agency

The following sections of this report summarize current and projected water demand for the Broad basin as a whole and for different categories of water use within the basin. Projection results are presented as a range spanning the Moderate-Demand and High-Demand Scenarios. Appendix B includes tables summarizing the results for the main categories under the two planning scenarios, including annual total demands and peak monthly demands.

3.0 Summary of 2021 Reported Water Withdrawals

Permitted and registered water users in the Broad basin reported total surface water withdrawals of 265.9 billion gallons per year (BGY), for an average of 728.4 million gallons per year (MGD) in 2021 (Table 2). The Broad basin has large water withdrawals for Thermoelectric Power, which tends to overshadow withdrawals from other water use categories. Most of the water withdrawn for Thermoelectric Power is returned to the system and only a small percent of the total withdrawal is consumed. To better illustrate water use distribution for other categories, water withdrawals for Thermoelectric Power are excluded for some of the water use data analysis. After excluding water withdrawals for Thermoelectric Power, the permitted and registered water users in the Broad basin reported total surface water withdrawals of 36.9 BGY, for an average of 101.0 MGD in 2021 (Table 2).

Table 2. 2021 Water withdrawals (MGD) in the Broad basin by source and their percent of total withdrawals

Source	Including Power		Excluding Power	
	Withdrawals	% of Total	Withdrawals	% of Total
Groundwater	0.5	0.1	0.5	0.5
Surface Water	728.4	99.9	101.0	99.5
Total	728.9		101.5	

In 2021, Thermoelectric Power had the largest surface water withdrawal by volume in the Broad basin (627.4 MGD) and accounted for 86% of total surface water withdrawals, while Public Water Supply (97 MGD) and Manufacturing (2.9 MGD) accounted for 13.3% and 0.4% of withdrawals, respectively. The remaining categories had much smaller withdrawals with the Other (Golf Course and Mining combined) category accounting for 0.1% and Agriculture accounting for less than 0.1% of total surface water withdrawals (Table 3). After excluding withdrawals for Thermoelectric Power, Public Water Supply accounted for 96.1% of surface water withdrawals while Manufacturing accounted for 2.9%. The remaining categories had smaller withdrawals with the Other category accounting for 0.7% and Agriculture accounting for 0.3% (Table 4) of total withdrawals.

Table 3. 2021 Surface water withdrawals (MGD) in the Broad basin by category and their percent of total withdrawals

	Withdrawals	% of Total
Thermoelectric	627.4	86.1
Public Water Supply	97.0	13.3
Manufacturing	2.9	0.4
Agriculture	0.3	< 0.1
Other	0.7	0.1
Total	728.4	

Table 4. 2021 Surface water withdrawals (MGD) in the Broad basin by category and their percent of total withdrawals, excluding Thermoelectric Power

	Withdrawals	% of Total
Public Water Supply	97.0	96.1
Manufacturing	2.9	2.9
Agriculture	0.3	0.3
Other	0.7	0.7
Total	101.0	

4.0 Summary of Projected Water Demands

By the year 2070, total surface withdrawals including Thermoelectric Power are projected to reach 931.7 MGD to 1,112.3 MGD, under the Moderate-Demand and High-Demand Scenarios respectively (Fig. 1; Table 5). Total surface water withdrawals for only Public Water Supply and Manufacturing combined are projected to reach 155.5 to 255.2 MGD, an increase of 55.7% to 155.4% under the Moderate-Demand and High-Demand Scenarios respectively (Fig. 2; Table 5).

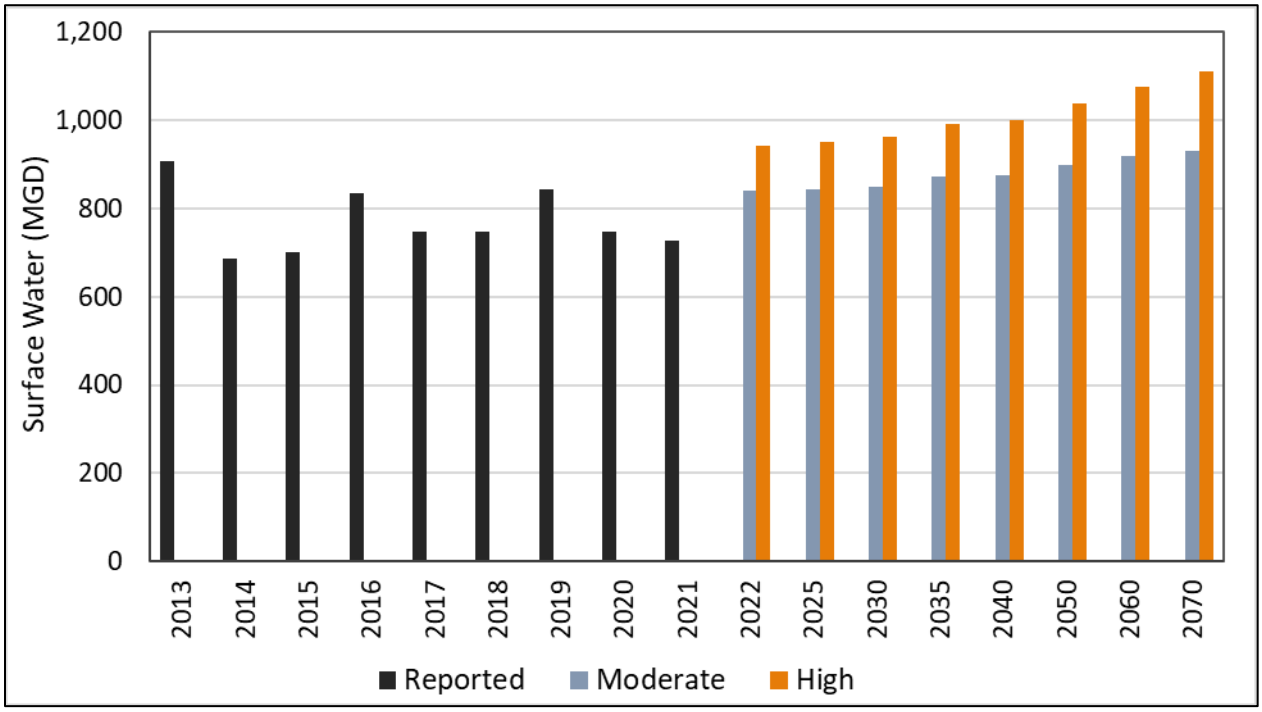

Figure 1. Reported surface water withdrawals (2013-2021) and projections for the Broad basin under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

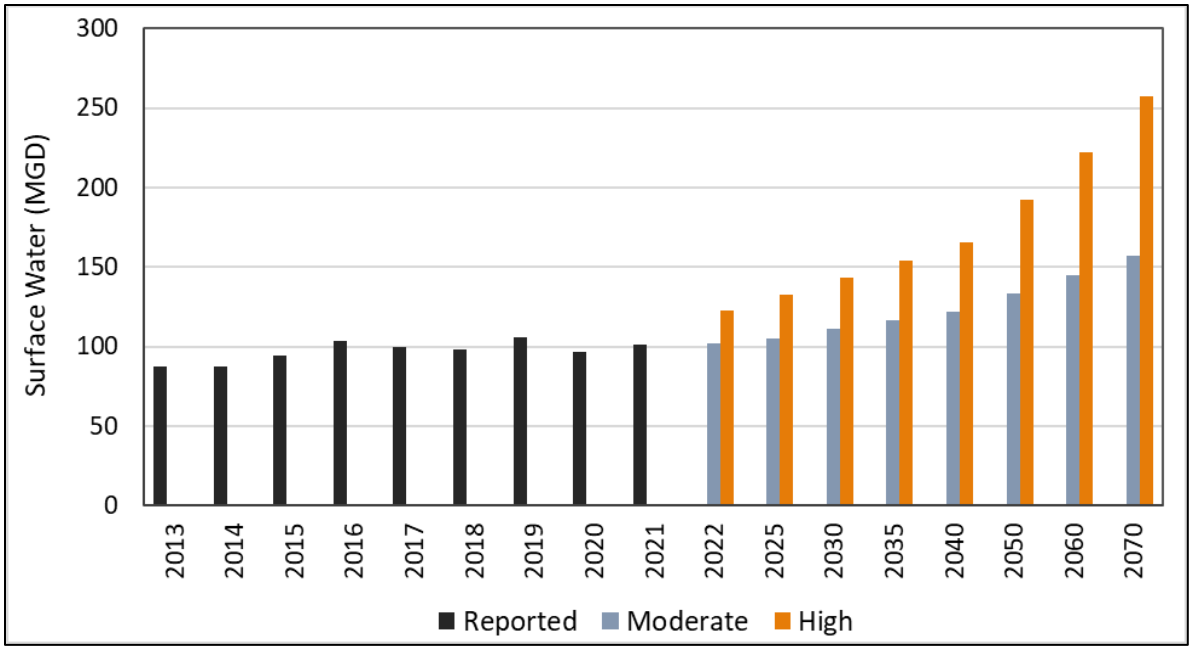

Figure 2. Reported surface water withdrawals (2013-2021) and projections excluding Thermoelectric Power for the Broad basin under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

Out of the three major water use categories in the Broad basin, Public Water Supply is projected to grow at the fastest rate over the Planning Horizon. By 2070 Public Water Supply is projected to increase by 54.4% under the Moderate-Demand Scenario and by 150.6% under the High-Demand Scenario (Table 5). The increase in Public Water Supply demand is driven by the high population growth expected within the basin and neighboring counties (Fig. 6).

Table 5. Comparison of the reported water use and projected surface water demand (MGD) by major water use category for 2040 and 2070 in the Broad basin under the Moderate-Demand and High-Demand Scenarios

		Reported	Moderate Demand		High Demand	
		Withdrawals	Withdrawals	% Diff	Withdrawals	% Diff
2040	Thermoelectric	739.2 (2019)[4]	754.9	2.1	834.7	12.9
	Public Water Supply	97.0 (2021)	116.3	19.9	157.0	61.8
	Manufacturing	2.9 (2021)	4.2	44.8	6.5	124.1
	Total		876.8		1,000.5	
2070	Thermoelectric	739.2 (2019)[4]	774.9	4.8	854.9	15.6
	Public Water Supply	97.0 (2021)	149.8	54.4	243.1	150.6
	Manufacturing	2.9 (2021)	5.7	96.5	12.1	317.2
	Total		931.7		1,112.3	

[4] The VC Summer plant undergoes regular scheduled maintenance roughly every 18 months. Reported withdrawals decrease during the maintenance operations. The methods used to create the Moderate-Demand and High-Demand projections generate results that represent non-maintenance operations (comparable to 2019 withdrawals).

5.0 Water-Demand Projections by Sector

5.1 Thermoelectric

Thermoelectric power plants use water for steam generation and cooling purposes. All the Thermoelectric water use in the Broad basin is met with surface water. The only Thermoelectric power plant currently in the South Carolina portion of the Broad basin is the V.C. Summer Nuclear Plant owned by Dominion Energy. Water demand at this plant is not projected to change over the Planning Horizon from 2022 to 2070 (Table 7; Fig. 4). Duke Energy, as part of their long-term planning, may construct a new nuclear plant, the William States Lee III Nuclear Station, on Ninety-Nine Islands Reservoir. Water demands for the new plant are included in the water-demand projections (Fig. 3 and Fig. 4), but withdrawals for the plant are not projected to begin until 2035 (Fig. 5).

Table 6. Comparison of the 2019[4] reported Thermoelectric water use and the projected demand (MGD) for 2040 and 2070 under the Moderate-Demand and High-Demand Scenarios

	Reported	Moderate-Demand	% Diff	High-Demand	% Diff
2019	739.2	--	--	--	--
2040	--	754.9	2.1	834.7	12.9
2070	--	774.9	4.8	854.9	15.6

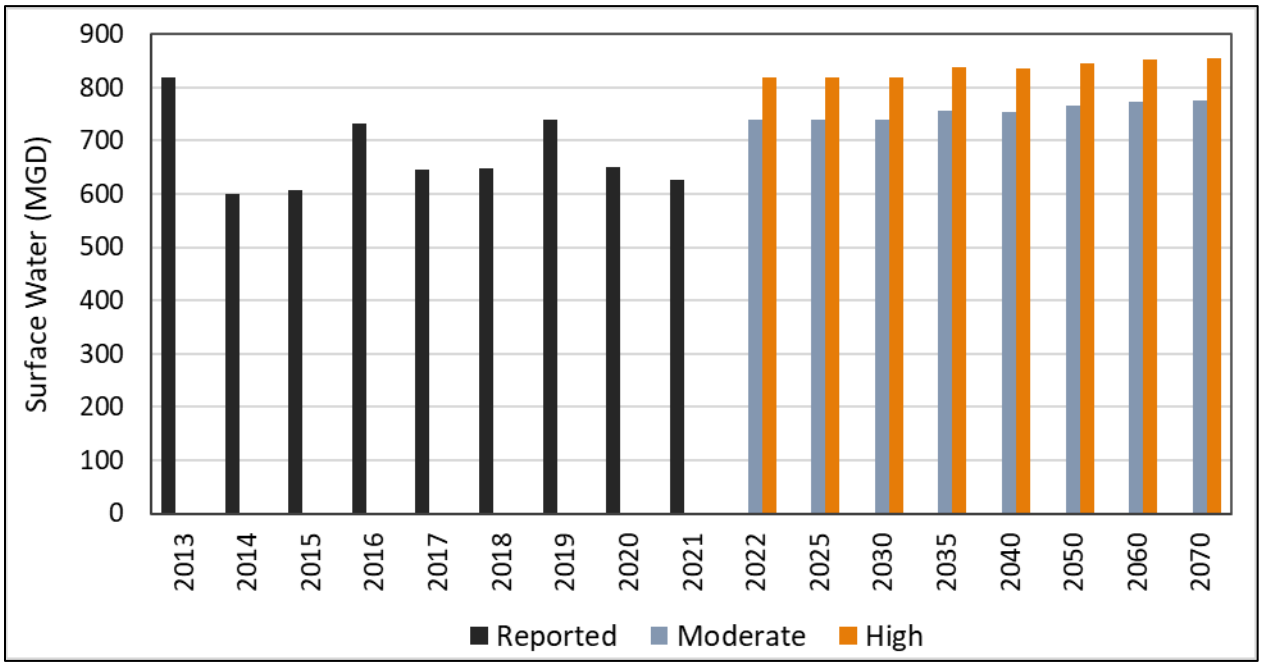

Figure 3. Reported surface water withdrawals (2013-2021) and projections for Thermoelectric Power in the Broad basin under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

Table 7. Comparison of the 2019[4] reported water use and projected demand (MGD) for the V.C. Summer Nuclear Plant under the Moderate Demand and High-Demand Scenarios

	Reported	Moderate-Demand	% Diff	High-Demand	% Diff
2019	739.2	--	--	--	--
2040	--	737.1	-0.3	816.8	10.5
2070	--	739.1	-0.01	819.1	10.8

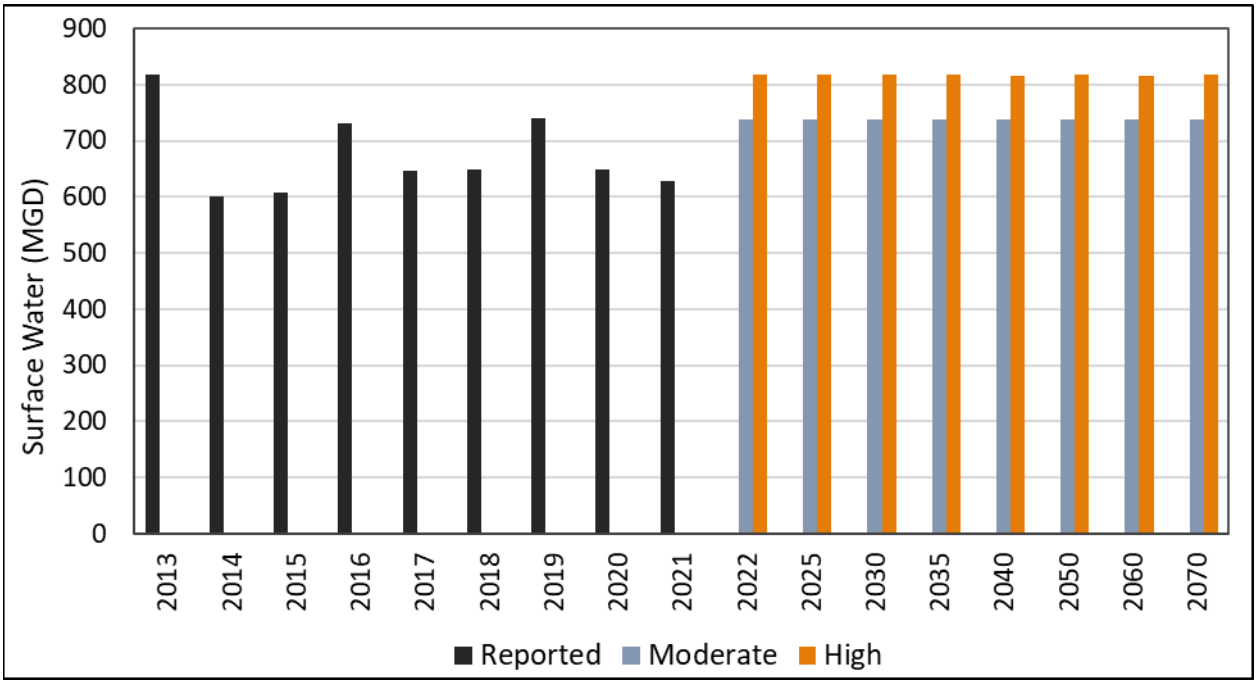

Figure 4. Reported surface water withdrawals (2013-2021) and projections for the V.C. Summer Station operated by Dominion Energy under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

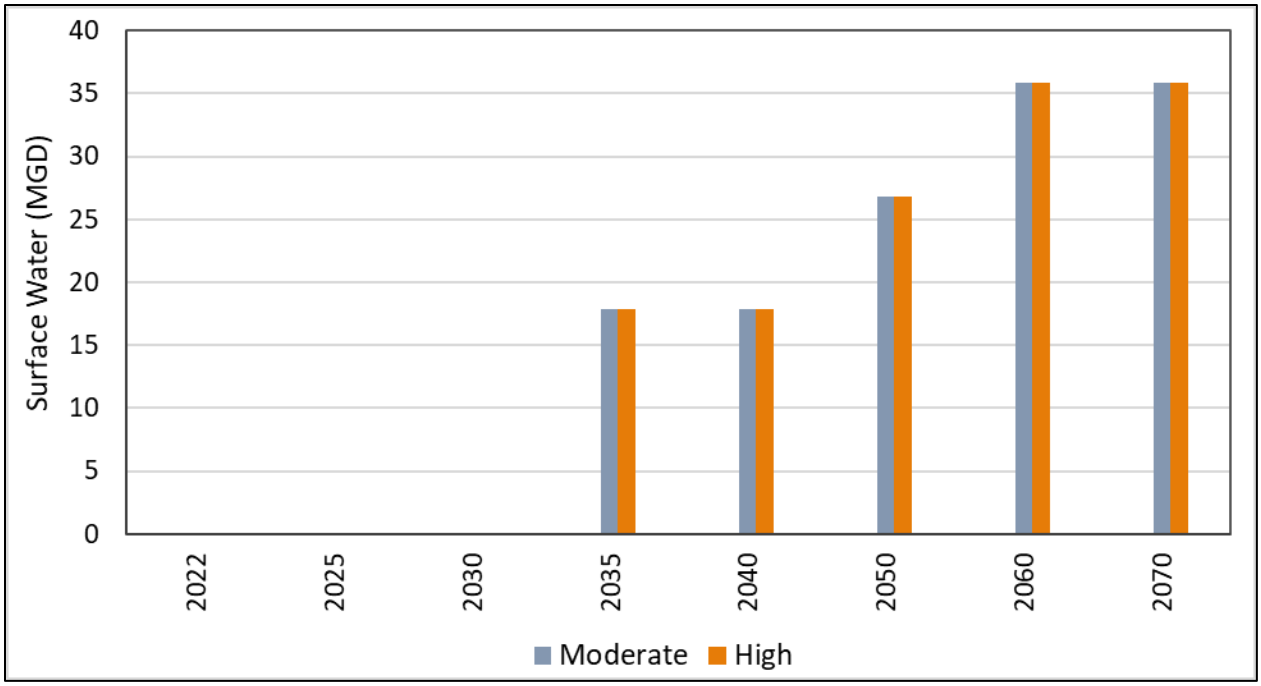

Figure 5 Projected surface water withdrawals for the proposed William States Lee III Nuclear Station operated by Duke Energy under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070.

5.2 Public Water Supply

Public Water Supply distributors provide water for residential, commercial, and some industrial uses in South Carolina. Projections of water demand are based on county population projections from SCORFA. Many public water supply systems are interconnected so that water demand in a system can be met with water supplied from another system. The projected water demand shown here is summarized based on the water user objects in the SWAM model.

For the Moderate-Demand Scenario, the SCORFA projections are extended linearly. If the SC ORFA projections indicate a decline in population, then the extension to 2070 is flatlined at 2035 levels. For the High-Demand Scenario, populations are projected to grow exponentially. If the SCORFA projected growth, then the exponential growth rate was increased by 10%. If the SCORFA projection for a county was less than the state average, then the high scenario population projection is set at the state average plus 10% (Fig. 6; Table 8).

Surface water demand for Public Water Supply is projected to reach 116.3 MGD by 2040 and 149.8 MGD by 2070 under the Moderate Demand Scenario. For the High Demand Scenario, projected demand is estimated to reach 157.0 MGD by 2040 and 243.1 MGD by 2070. (Table 9; Fig. 7). By 2070 water demand is projected to increase by 54.4% and 150.5% for the Moderate-Demand and High-Demand Scenarios, respectively, as compared to 2021 reported water use (Table 9).

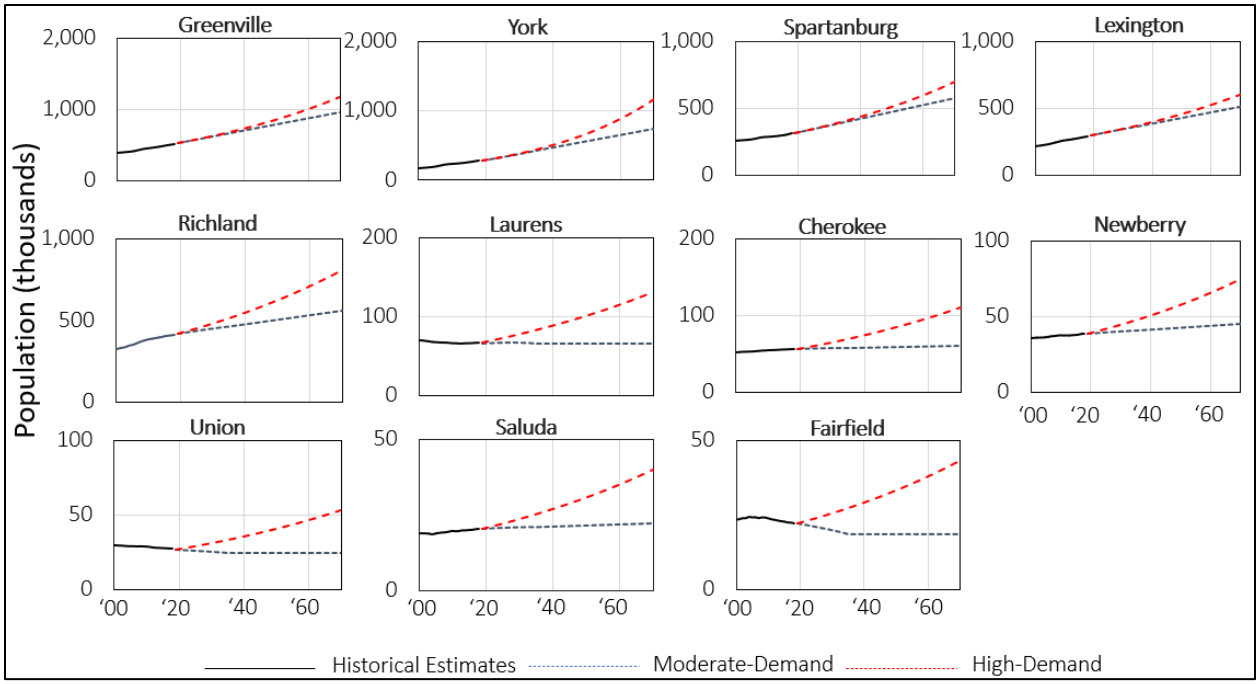

Figure 6. Historical population estimates (2000-2021) and projections through 2070 for counties included in the Broad basin. Population projections are adapted from SCORFA.

Table 8. County population estimates for 2020 and projected population (in thousands) through 2070 under the Moderate-Demand and High-Demand Scenarios for each county included in the Broad Basin

	County	**2020**	**2025**	**2030**	**2035**	**2040**	**2050**	**2060**	**2070**
Moderate Demand	Greenville	530.9	573.1	616.1	659.3	701.9	787.4	872.9	958.3
	York	289.6	329.9	374.4	423.1	467.2	555.4	643.7	731.9
	Spartanburg	323.5	348.1	373.5	399.4	424.6	475.1	525.5	575.9
	Richland	420.8	436.4	451.0	463.5	477.8	506.5	535.1	563.7
	Lexington	303.6	324.9	345.6	365.6	386.3	427.6	469.1	510.5
	Laurens	67.1	67.4	67.4	67.0	67.0	67.0	67.0	67.0
	Cherokee	57.4	57.9	58.3	58.3	58.7	59.4	60.1	60.8
	Newberry	38.8	39.6	40.3	40.8	41.5	42.9	44.2	45.6
	Union	27.1	26.4	25.6	24.7	24.7	24.7	24.7	24.7
	Saluda	20.7	20.9	21.0	21.1	21.3	21.6	21.9	22.2
	Fairfield	22.0	21.0	19.9	18.6	18.6	18.6	18.6	18.6
High Demand	Greenville	530.9	575.1	622.9	674.6	730.7	857.2	1005.6	1179.7
	York	289.8	333.2	383.0	440.3	506.2	669.0	884.2	1168.5
	Spartanburg	323.7	349.8	377.9	408.5	441.4	515.4	601.8	702.8
	Richland	423.2	451.7	482.0	514.5	549.1	625.5	712.4	811.5
	Lexington	303.5	325.0	348.1	372.9	399.4	458.3	525.8	603.2
	Laurens	67.9	72.5	77.4	82.6	88.2	100.4	114.4	130.3
	Cherokee	57.9	61.8	66.0	70.5	75.2	86.7	97.6	111.1
	Newberry	39.2	41.8	44.6	47.6	50.8	57.9	65.9	75.2
	Union	27.6	29.5	31.5	33.6	35.8	40.8	46.5	52.9
	Saluda	20.9	22.3	23.7	25.4	27.1	30.8	35.1	40.0
	Fairfield	22.5	24.0	25.6	27.4	29.2	33.3	37.9	43.2

Table 9. Comparison of the 2021 reported Public Water Supply use and the projected demand (MGD) for 2040 and 2070 under the Moderate-Demand and High-Demand Scenarios

	Reported	Moderate-Demand	% Diff	High-Demand	% Diff
2021	97.0	--	--	--	--
2040	--	116.3	19.9	157.0	61.9
2070	--	149.8	54.4	243.1	150.5

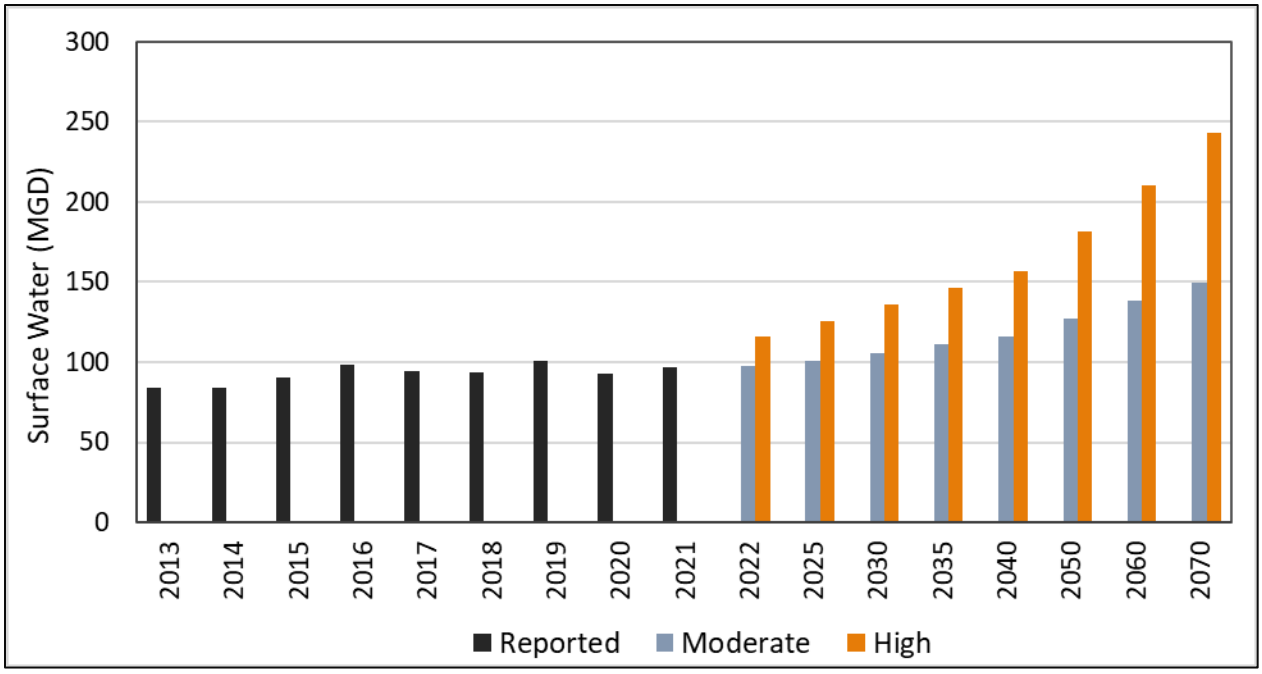

Figure 7. Reported surface water withdrawals (2013-2021) and projections for Public Water Supply in the Broad basin under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

The three largest Public Water Supply systems in the Broad basin (based on recent 5-year average of annual surface water withdrawals) are Columbia Water, Spartanburg Water System, and the Greer Commission of Public Works (CPW). Water demand for each of these systems are presented separately below.

Columbia Water currently withdraws approximately half of its total demand from the Broad River basin and the other half from the Saluda River basin. Water use projections presented here assume that Columbia Water will continue to provide approximately half of its withdrawals from the Broad River basin over the Planning Horizon. By 2040 water demand for Columbia Water in the Broad basin is projected to increase by 14.2% and 40.8% for the Moderate-Demand and High-Demand Scenarios, respectively, as compared to the 2021 reported water use. By 2070 water demand is projected to increase by 34.9% and 108.0% for the Moderate-Demand and High-Demand Scenarios, respectively (Table 10; Fig. 8).

Table 10. Comparison of Columbia Water's 2021 reported use and projected demand (MGD) for 2040 and 2070 under the Moderate-Demand and High-Demand Scenarios

	Reported	Moderate-Demand	% Diff	High-Demand	% Diff
2021	31.3	--	--	--	--
2040	--	35.7	14.2	44.1	40.8
2070	--	42.2	34.9	65.1	108.0

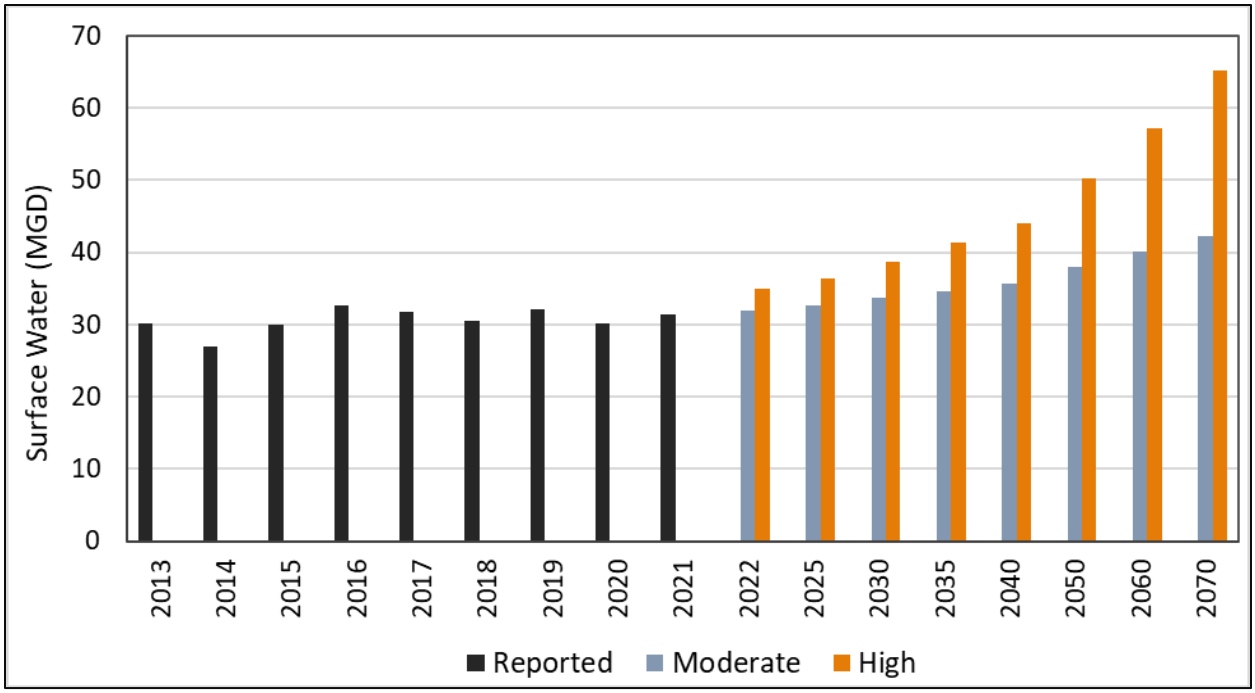

Figure 8. Reported surface water withdrawals (2013-2021) and projections for Columbia Water under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

Spartanburg Water System has two surface water intakes in the Broad basin: Spartanburg Municipal Reservoir #1, downstream of Lake Bowen on the South Pacolet River, is the primary source; another intake is located on Lake Blalock on the Pacolet River. By 2040 water demand is projected to increase by 35.8% and 57.3% for the Moderate-Demand and High-Demand Scenarios, respectively, as compared to the 2021 reported water use. By 2070 water demand is projected to increase by 84.0% and 149.8% for Moderate-Demand and High-Demand Scenarios, respectively (Table 11; Fig. 9).

Table 11. Comparison of Spartanburg Water System's 2021 reported use and projected demand (MGD) for 2040 and 2070 under the Moderate-Demand and High-Demand Scenarios

	Reported	Moderate-Demand	% Diff	High-Demand (MGD)	% Diff
2021	24.9	--	--	--	--
2040	--	33.8	35.8	39.1	57.3
2070	--	45.7	84.0	62.1	149.8

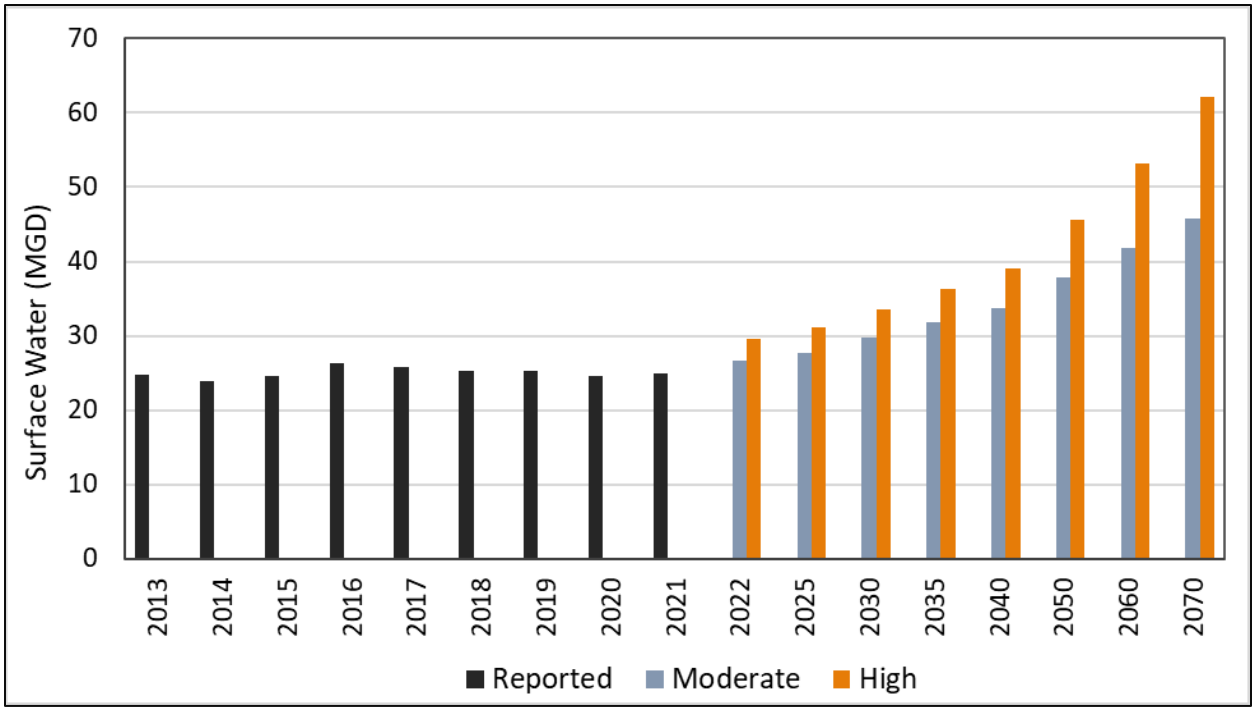

Figure 9. Reported surface water withdrawals (2013-2021) and projections for Spartanburg Water System under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

The Greer CPW system has a single surface water intake on Lake Cunningham in the South Tyger River subbasin. By 2040 water demand is projected to increase by 21.2% and 41.5% for Moderate-Demand and High-Demand Scenarios, respectively. By 2070 water demand is projected to increase by 64.5% and 124.9% for the Moderate-Demand and High-Demand Scenarios, respectively (Table 12; Fig. 10).

Table 12. Comparison of Greer CPW's 2021 reported use and projected demand (MGD) for 2040 and 2070 under the Moderate-Demand and High-Demand Scenarios

	Reported	Moderate-Demand	% Diff	High-Demand	% Diff
2021	9.9	--	--	--	--
2040	--	12.1	21.2	14.1	41.5
2070	--	16.4	64.5	22.4	124.9

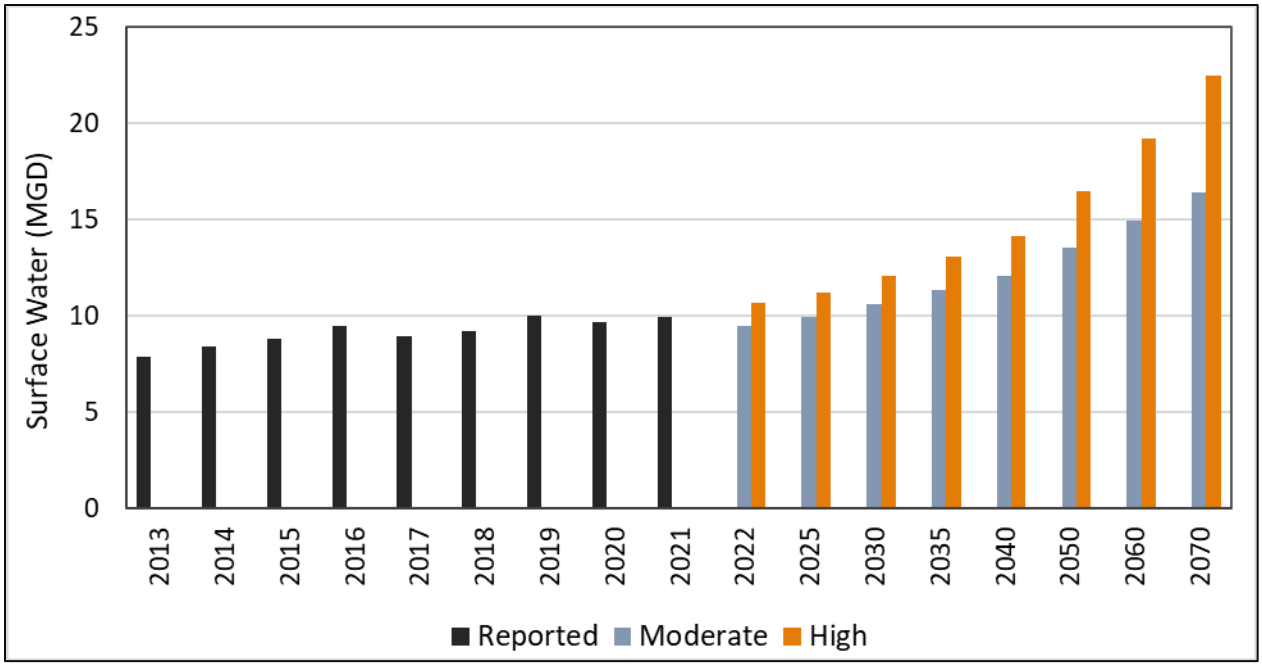

Figure 10. Reported surface water withdrawals (2013-2021) and projections for Greer CPW under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

5.3 Manufacturing

Water demand for manufacturing is projected to grow according to economic growth rates provided by the US Energy Information Agency for each economic subsector[3]. Surface water demand for Manufacturing in the Broad basin is projected to reach 4.2 MGD by 2040 and 5.7 MGD by 2070 under the Moderate-Demand Scenario. For the High-Demand Scenario, projected demand is expected to reach 6.5 MGD by 2040 and 12.1 MGD by 2070 (Table 13; Fig. 11). By 2040 water demand for Manufacturing is projected to increase by 44.4% and 122.2% for the Moderate-Demand and High-Demand Scenarios, respectively, as compared to the 2021 reported water use. By 2070 water demand is projected to increase by 94.8% and 315.6% for the Moderate-Demand and High-Demand Scenarios, respectively (Table 13; Fig. 11).

Table 13. Comparison of the 2021 reported Manufacturing use and the projected demand (MGD) for 2040 and 2070 under the Moderate-Demand and High-Demand Scenarios

	Reported	Moderate-Demand	% Change	High-Demand	% Change
2021	2.9	--	--	--	--
2040	--	4.2	44.4	6.5	122.2
2070	--	5.7	94.8	12.1	315.6

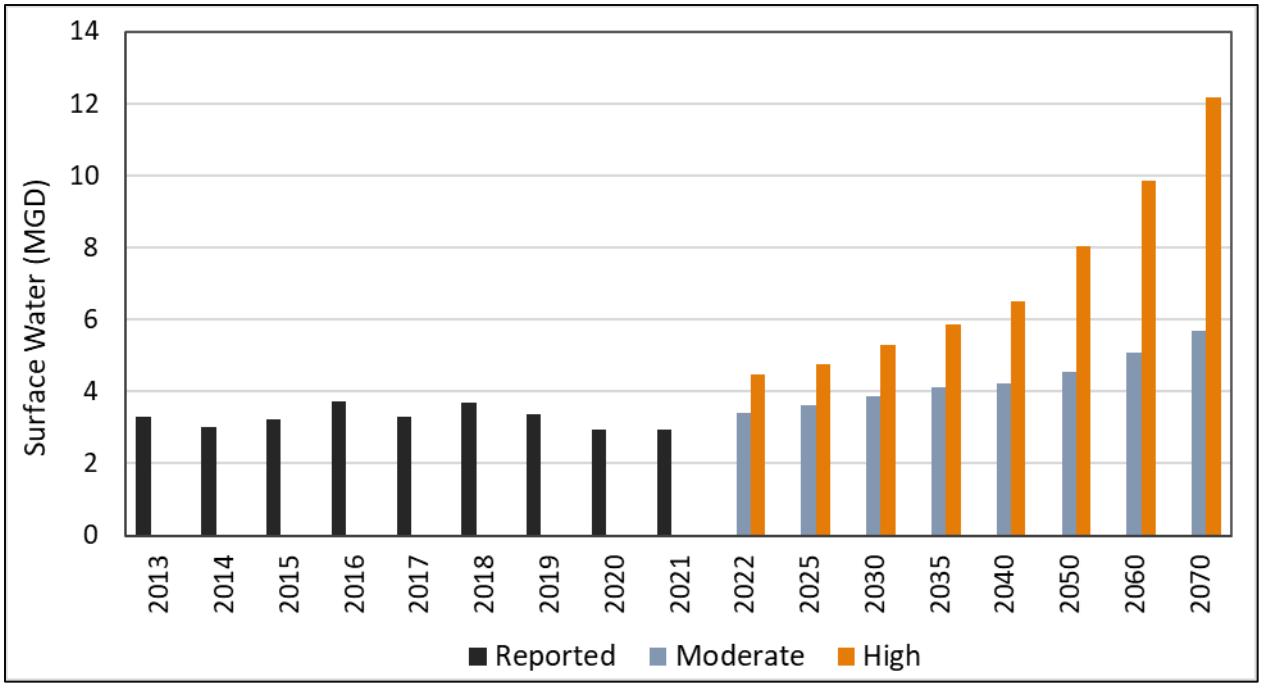

Figure 11. Reported surface water withdrawals (2013-2021) and projections for Manufacturing in the Broad basin under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

The three largest users from the Manufacturing category in the Broad basin (based on recent five-year average of annual withdrawals) are Milliken and Company (Magnolia Plant), Carlisle Finishing Company, and Chemtrade Performance Chemicals (US LLP Leeds Plant). Water demand projections for each of these systems are presented separately below.

Milliken and Company withdrawals are directly from the Broad River. By 2040 water demand is projected to increase by 23.7% and 69.7% for Moderate-Demand and High-Demand Scenarios, respectively, as compared to the 2021 reported water use. By 2070 water demand is projected to increase by 73.9% and 217.5% for the Moderate-Demand and High-Demand Scenarios, respectively (Table 14; Fig. 12).

Table 14. Comparison of the Milliken and Company's 2021 reported use and projected demand (MGD) for 2040 and 2070 under the Moderate-Demand and High-Demand Scenarios

	Reported	Moderate-Demand	% Change	High-Demand	% Change
2021	2.8	--	--	--	--
2040	--	3.5	23.7	4.7	69.7
2070	--	4.9	73.9	8.9	217.5

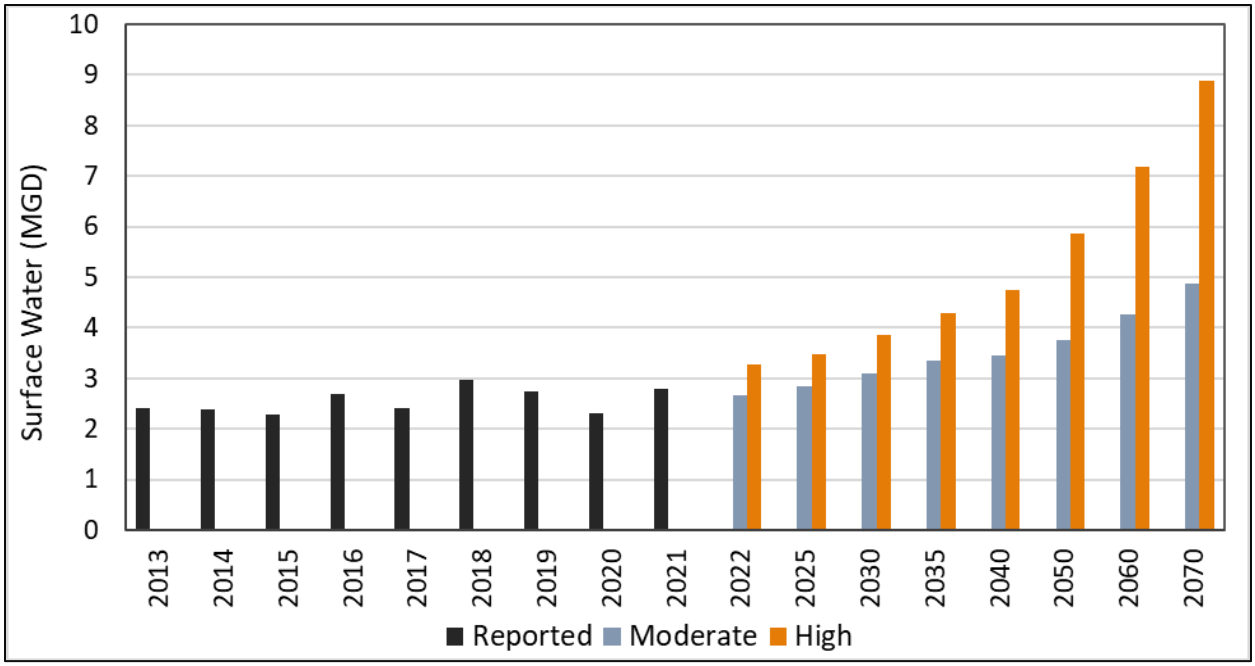

Figure 12. Reported surface water withdrawals (2013-2021) and projections for Milliken and Company under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

The Carlisle Finishing Company withdraws directly from the Broad River. The company had no reported withdrawals in 2021, and the projected values are compared to 2020 reported withdrawals. By 2040 water demand is projected to increase by 15.8% and 150.7% for the Moderate-Demand and High-Demand respectively, as compared to the 2020 reported water use. By 2070 water demand is projected to increase by 23.3% and 368.9% for the Moderate-Demand and High-Demand Scenarios, respectively (Table 15; Fig. 13).

Table 15. Comparison of the Carlisle Finishing Company's 2020 reported use and projected demand (MGD) for 2040 and 2070 under the Moderate-Demand and High-Demand Scenarios

	Reported	Moderate-Demand	% Change	High-Demand	% Change
2020	0.5	--	--	--	--
2040	--	0.6	15.8	1.3	150.7
2070	--	0.7	23.3	2.5	368.9

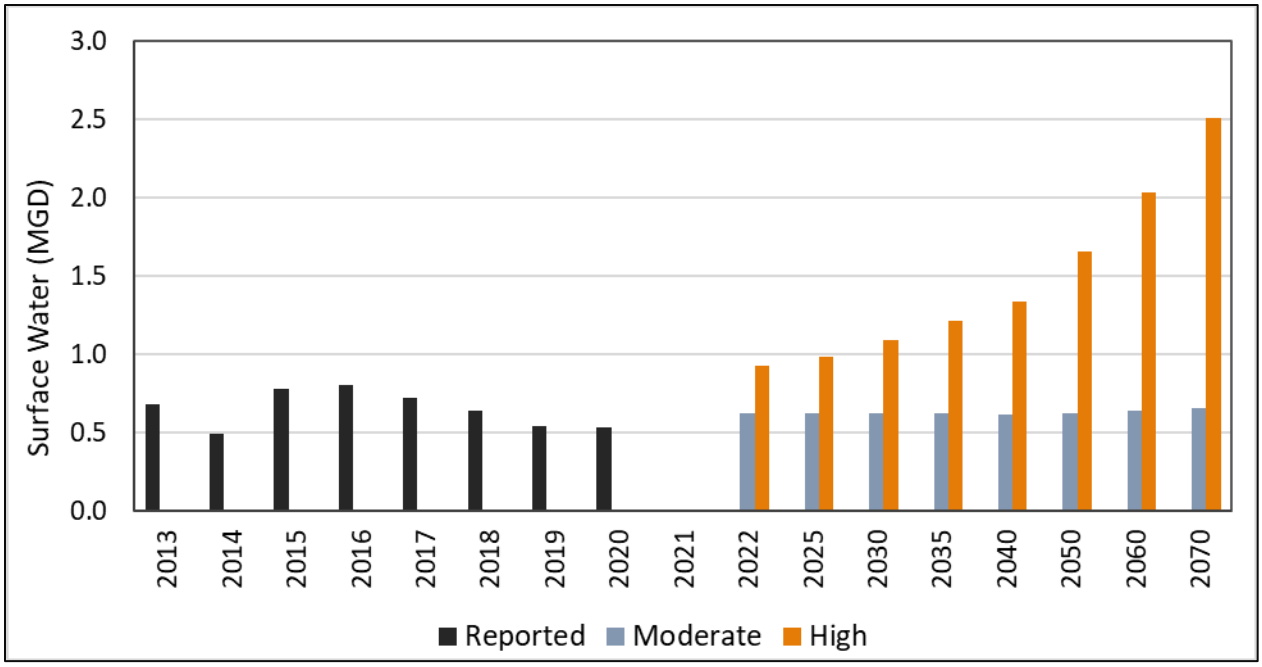

Figure 13. Reported surface water withdrawals (2013-2021) and projections for Carlisle Finishing Company under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

Chemtrade Performance Chemicals has two surface water intakes in the Broad River basin. In 2021, approximately 61% of the system's demand was met from an intake on the Broad River, while the remaining demand was met from an intake on Mineral Creek. By 2040 water demand is projected to increase by 11.0% and 218.5% for the Moderate-Demand and High-Demand Scenarios, respectively, as compared to the 2021 reported water use. By 2070 water demand is projected to increase by 35.3% and 495.8% for the Moderate-Demand and High-Demand Scenarios, respectively (Table 16; Fig. 14).

Table 16. Comparison of the Chemtrade Performance Chemicals' 2021 reported use and projected demand (MGD) for 2040 and 2070 under the Moderate-Demand and High-Demand Scenarios

	Reported	Moderate-Demand	% Change	High-Demand	% Change
2021	0.1	--	--	--	--
2040	--	0.1	11.0	0.4	218.5
2070	--	0.2	35.3	0.8	495.8

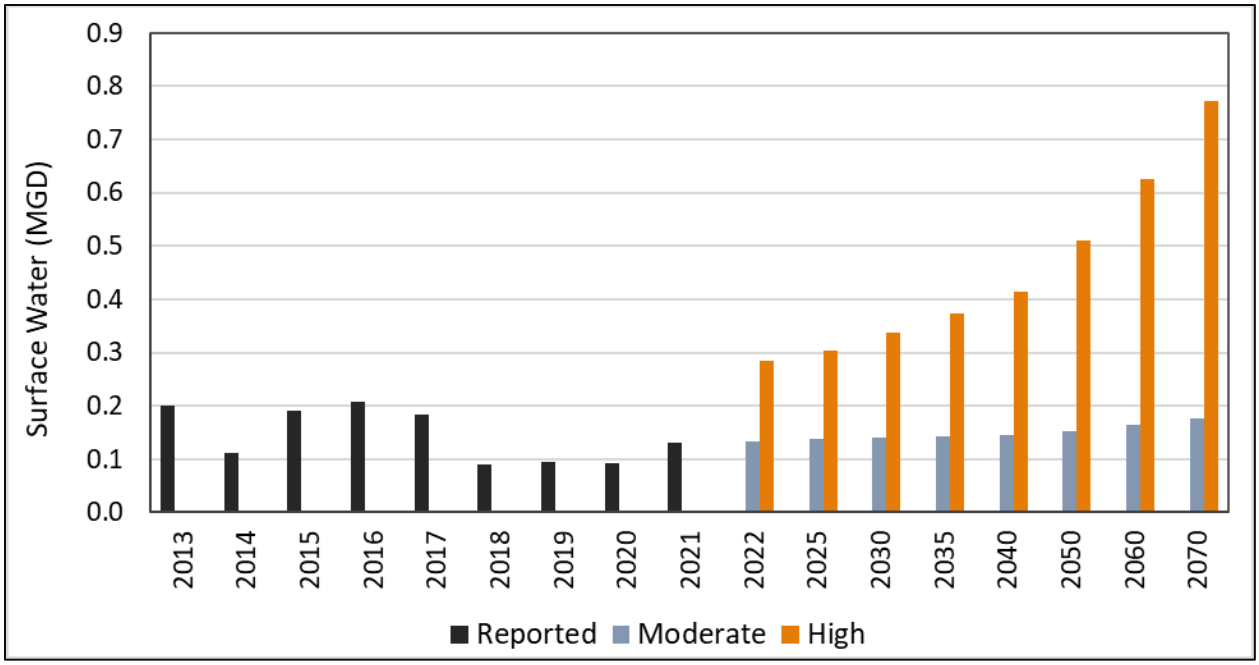

Figure 14. Reported surface water withdrawals (2013-2021) and projections for Chemtrade Performance Chemicals under the Moderate-Demand and High-Demand Scenarios from 2022 to 2070 (MGD).

Appendix A. Updates to the Water-Demand Projection Methods

While drafting the water-demand projections for the Broad basin, SCDNR made the following adjustments to the methods outlined in the report "Projection Methods for Off-stream Water Demand in South Carolina":

1. **Population Projections.** For the High-Demand Scenario, population had been depicted as diverging from the Moderate-Demand Scenario beginning in 2013 (Figure 3.2 p17). Now, High-Demand population projections begin diverging from Moderate-Demand in 2020. Figure 6 (above in this report) illustrates the updated population projections.

2. **Weather Impacts.** The High-Demand Scenario had originally included an estimate of the impact of weather on water demand. The impacts of weather on water demand vary widely among different water users, even among water users of the same category. Also, the effects of weather can easily be overshadowed by other dynamics, such as expanding operations. The statistical methods applied did not provide reliable estimates of weather impacts on water demand, and so the weather impact variable is not used to calculate the water-demand projection results.

3. **Peaker Generators**. The methodology report includes the following statement in Section 2.3.2 on page 12: "Increases in summer and winter demands are assigned preferentially to peaker generators." Because there are no major thermoelectric peaker generators in the Broad basin, no such preferential assignment of peak summer and winter demands has been implemented.

4. **High-Impact Factor**. The High-Demand Scenario is based on elevated projections of driver variables and high-impact factors which increase the rate of water demand. The high-impact factors were calibrated using a multiplicative model:

   *Water Demand = Driver * Rate * Seasonality * High Impact Factor*

   The high-impact factors were calculated by comparing the Moderate-Demand model calibration results with reported water withdrawals over the baseline period. The deviation of the model from the reported values was calculated as modelled value divided by reported value, for each month. The high-impact factor is calculated for each month as the maximum deviation for that month over the baseline period.

Appendix B. Broad Basin Surface Water-Demand Projections for Major Sectors

Table B1. Water-demand projections (annual totals, in MGD) under the Moderate-Demand Scenario for Thermoelectric Power, Public Water Supply, and Manufacturing

Year	Thermoelectric	Public Water Supply	Manufacturing
2025	739.1	100.5	3.6
2030	739.1	105.7	3.9
2035	757.0	110.8	4.1
2040	754.9	116.3	4.2
2050	765.9	127.5	4.5
2060	772.9	138.6	5.1
2070	774.9	149.8	5.7

Table B2. Water-demand projections (annual totals, in MGD) under the High-Demand Scenario for Thermoelectric Power, Public Water Supply, and Manufacturing

Year	Thermoelectric	Public Water Supply	Manufacturing
2025	819.1	125.8	4.8
2030	819.1	135.6	5.3
2035	836.9	145.9	5.9
2040	834.7	157.0	6.5
2050	845.9	181.9	8.0
2060	852.6	210.2	9.9
2070	854.9	243.1	12.2

Table B3. Peak monthly water demand projections (MGD) for Public Water Supply and Manufacturing. Peak monthly demands for Thermoelectric Power are not shown since projected monthly values are uniform throughout each projection year.

	Public Water Supply		Manufacturing	
	Moderate Demand July	High Demand July	Moderate Demand August	High Demand August
2022	116.1	136.9	3.7	5.2
2025	120.5	149.0	3.9	5.6
2030	127.0	160.5	4.1	6.2
2035	133.3	172.8	4.4	6.9
2040	139.9	186.0	4.5	7.6
2050	153.2	215.2	4.9	9.4
2060	166.5	248.8	5.5	11.5
2070	179.8	287.4	6.1	14.2