A.10 Roanoke River Minor Basin

A.10.1 Watershed Overview

The Roanoke minor basin is located in the south central portion of Virginia. The basin drains the eastern side of the Blue Ridge with water flowing southeast eventually reaching the North Carolina border and the Albemarle Sound. Land use and cover in the basin is largely comprised of forested mountains in the headwaters, agriculture, and impervious cover concentrated within the major urban areas.

The total spatial area of the basin occupies approximately 8269.9 sq. miles, notable water features include Catawba and Tinker Creeks, Carvins Cove, Roanoke River, Smith Mountain Lake, Crystal Spring, Keysville Lake, Kerr Reservoir, and more. All or portions of the localities listed in Table 54 are within the basin, with major population centers located in the headwaters of the basin including the Cities of Salem and Roanoke.

A.10.2 Existing Water Sources

Major surface water sources within the basin include the Roanoke River, Carvins Cove, Smith Mountain Lake, Keysville Reservoir, Kerr Reservoir, Lake Gaston,Crystal Spring, Big Otter River, and more. Groundwater within the basin is primarily withdrawn from bedrock or fractured rock aquifers. The basin relies heavily on surface water sources for supply and is currently the most viable source for most users.

Withdrawals within the basin are used for public water supply, agriculture, irrigation, commercial, and industrial/manufacturing, power generation, commercial, and mining operations.

The location of wells and surface water intakes identified to DEQ within the basin are shown in Figure 212. The map also shows locations of any Instream Flow Incremental Method (IFIM) studies completed in the basin, which are relevant to the discussion of ecological impacts in a later section of this appendix. The greatest density of surface and groundwater withdrawal locations are concentrated within the primary population centers of Salem and Roanoke City. Throughout the rest of the basin surface and groundwater withdrawals are clustered around the City of Bedford, Keysville, Lynchburg, Rocky Mount, and smaller towns throughout the basin. Note that surface and groundwater well locations are scattered throughout the basin for agricultural uses.

Table 54: Population Trend by Locality in Roanoke Basin

Localities	20 Year % Change
Appomattox	9.61
Bedford County	12.05
Botetourt	5.22
Brunswick	-16.56
Campbell	4.62
Charlotte	-7.85
Craig	-3.72
Floyd	8.31
Franklin County	13.14
Halifax	-12.25
Henry	-17.48
Mecklenburg	-8.67
Montgomery	13.10
Pittsylvania	-3.96
Prince Edward	12.54
Roanoke County	5.24
Bedford City	NA
Roanoke City	1.68
Salem	0.19

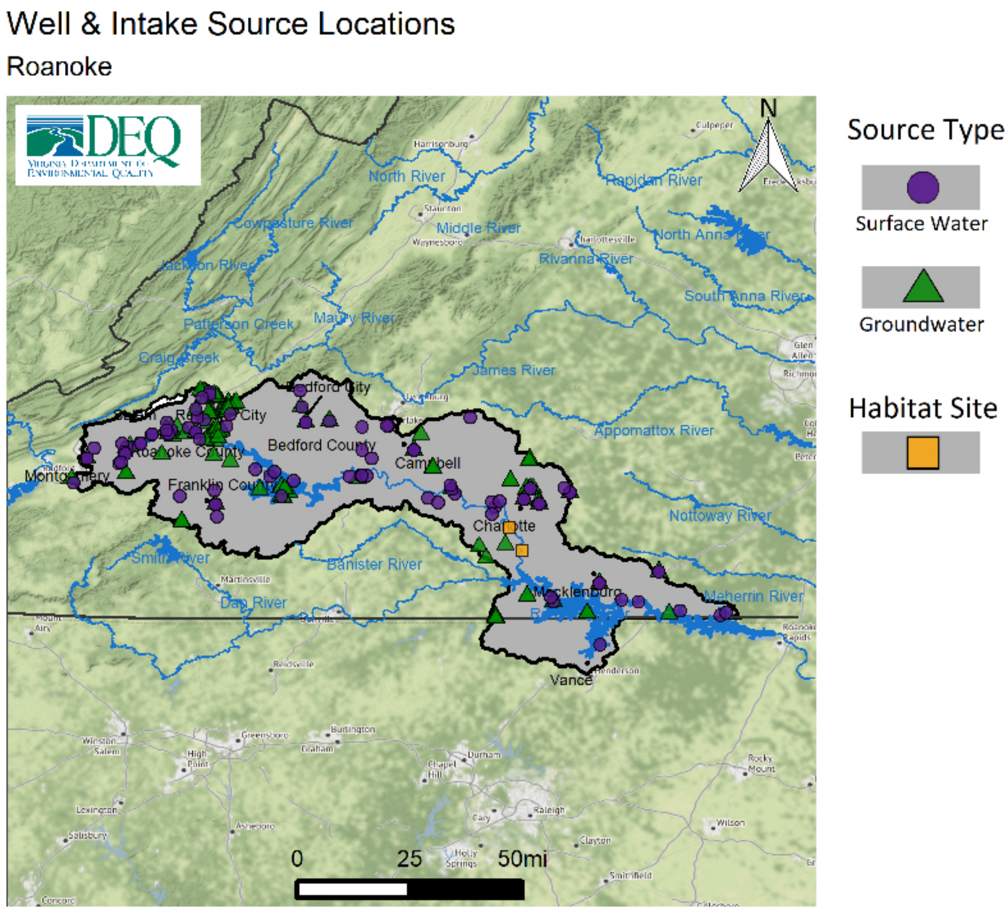

Figure 212: Spatial distribution of groundwater wells and intakes in the Roanoke Minor Basin

A.10.3 Existing Water Use

The following section discusses existing (current) water use within the basin, which is based on existing demand information submitted to DEQ in the water supply plans. Table 55 provides a summary of all demands within the basin including demand associated with power generation. Note that withdrawals related to power generally dwarf other demand categories and can therefore make evaluating trends for other categories more challenging. Most power generation withdrawals are also largely non-consumptive; water is withdrawn for cooling purposes and then discharged back into the source stream with minimal loss. The Roanoke Basin currently has four active power generation facilities including the Altavista Power Station, Clover Power Plant, Mecklenburg Power Station, and the Pittsylvania Power Station. The table also includes the number of sources, groundwater or surface water sources within each category.

Table 55: Summary of Roanoke Minor Basin Water Demand by Source Type and System Type (including Power Generation)

System Type	Source Count	2020 Demand (MGD)	2030 Demand (MGD)	2040 Demand (MGD)	20 Year Percent Change
Surface Water					
Agriculture	30	6.44	6.64	6.83	6.20
CWS	21	76.29	90.38	104.47	36.95
Large SSU	32	16.44	16.12	15.81	-3.88
Small SSU	0	0.00	0.00	0.00	0.00
Total SW	**83**	**99.17**	**113.14**	**127.11**	**28.17**
Groundwater					
Agriculture	7	1.67	1.82	1.98	18.20
CWS	108	4.99	6.04	7.09	41.88
Large SSU	22	0.26	0.32	0.38	47.19
Small SSU	0	12.14	13.49	14.84	22.26
Total GW	**137**	**19.06**	**21.67**	**24.29**	**27.44**
Total (SW + GW)					
Agriculture	37	8.11	8.46	8.81	8.67
CWS	129	81.28	96.42	111.56	37.25
Large SSU	54	16.70	16.45	16.19	-3.08
Small SSU	0	12.14	13.49	14.84	22.26
Minor Basin Total	**220**	**118.23**	**134.82**	**151.40**	**28.06**

The total existing demand from all surface and groundwater sources including power generation is approximately 118.23 MGD, with groundwater supplying approximately 19.06 MGD or 16.1% of total water demands. Surface water demand within the basin totals approximately 99.17 MGD, or 83.9% of current demands. As with most watershed in Virginia, surface water sources account for the majority of current and future water demands, in the Roanoke minor basin withdraws for Community Water Systems is the primary driver of water demands in the basin.

The five largest withdrawals for each source type including power generation are provided in table 56. The largest groundwater withdrawals include public water supply withdrawals within Salem and Roanoke, with over 19% of current groundwater withdrawal demanded by the localities. The largest surface water withdrawals support both public water supply and power generation facilities within and outside of the basin. Lake Gaston is currently a major water supply source that provides water to Virginia Beach via the longest water transfer in Virginia. The second largest surface water withdrawal supports the City of Roanoke and surrounding area. The Clover Power Plant is also a significant source of surface water demand in the basin as the third largest user in the watershed, however the water is primarily used for cooling and is returned to the Roanoke River.

Table 56: Top 5 Users in 2040 by Source Type in the Roanoke Minor Basin (including Power Generation)

Facility Name	**System Type**	**Locality**	**2020 Demand (MGD)**	**2030 Demand (MGD)**	**2040 Demand (MGD)**	**20 Year Percent Change**	**% of Total Surface Water**
Surface Water							
Virginia Beach Service Area	CWS	Virginia Beach	28.84	34.29	39.75	37.83	31.27
Roanoke (City) Service Area	CWS	Roanoke City	18.42	22.39	26.37	43.16	20.75
Clover Power Plant	Large SSU	Halifax	11.53	11.53	11.53	0.00	9.07
Spring Hollow WTP	CWS	Roanoke County	6.08	7.4	8.71	43.26	6.85
Kerr Lake Regional Water	CWS	Vance	6.42	7.14	7.86	22.43	6.18
Total SW			71.29	82.75	94.22	32.16	74.12
Groundwater							**% of Total Groundwater**
Salem WTP	CWS	Salem	1.13	1.46	1.79	58.41	7.37
Roanoke (City) Service Area	CWS	Roanoke City	1.25	1.52	1.78	42.4	7.33
Vinton Service Area	CWS	Roanoke County	1.26	1.44	1.62	28.57	6.67
Charlotte Ct Hse Service Area	CWS	Charlotte	0.07	0.14	0.21	200	0.86
Troutville Service Area	CWS	Botetourt	0.15	0.17	0.19	26.67	0.78
Total GW			3.86	4.73	5.59	44.82	23.01

Table 55 also provides the proportion of each use category that is supplied by either surface water or groundwater. Use categories include Community Water Systems (CWS), Large Self-Supplied users (SSU), Small SSUs, and agriculture. These categories are defined below. Surface water demand is primarily comprised of community water systems (76.29 MGD) and large self-supplied users (16.44 MGD) (including power generation). Groundwater demand is primarily comprised of small self-supplied users (12.14 MGD) and community water system (4.99 MGD) demands. The basin is consistent with much of the state, surface water is the primary source for CWS, or major municipal systems, while groundwater supplies the majority of domestic or residential use.

Community water systems (CWS) consist of public and private waterworks. In the Roanoke Basin, approximately 4.99 MGD of groundwater demand and 76.29 MGD of surface water demand currently supplies CWS. Significant groundwater users within this category include the City of Salem, Roanoke, Town of Vinton, and Troutville. Significant surface water users from this category include the Lake Gaston water transfer to Virginia Beach. Roanoke City's Western Virginia Water Authority withdrawals from Carvins Cove, Crystal Spring, and the Spring Hollow reservoir. The Campbell County Big Otter River intake and several other intakes supporting the Towns of Altavista, Brookneal, Clarksville, and Keysville. Nearly every CWS in the basin withdrawals or purchases surface water to meet public water supply demands.

Large SSUs include any users who withdraw more than 300,000 gallons per month from a well or surface water intake. In the Roanoke Basin, approximately 0.26 MGD of groundwater demand and 16.44 MGD of surface water demand is from large SSUs. Significant groundwater users within this category include the Rustburg Correctional Facility, Hidden Valley Country Club, Blue Hills Golf Course, and the Boxely Blue Ridge Mine. Significant surface water users from the category include the Clover, Mecklenburg, Altavista, and Pittsylvania power stations. Significant surface water withdrawals excluding power generation include the Boxely Mining facilities, and numerous golf courses including the West Lake and Water Front Country Clubs.

Small SSUs include any users who withdraw less than 300,000 gallons per month from a well or surface water intake. Small SSU's generally consist of residential or domestic use for those who lives outside service areas and provide their own water via a private well. In the Roanoke Basin, approximately 12.14 MGD of groundwater demand is from small SSUs. Localities within the basin with the greatest contribution from small SSU's include Bedford, Franklin, and Campbell counties

Agriculture Users (AG) include crop farms, livestock operations, aquaculture and other agricultural facilities. In the Roanoke Basin, approximately 1.67 MGD of groundwater demand and 6.44 MGD of surface water demand is from AG users. Significant groundwater users within this category includes the New Leaf Farm and Yagle Nursery. Primarily groundwater demands in the category are reported as countywide estimates of groundwater use for all AG uses Charlotte, Franklin, and Bedford counties have the largest countywide groundwater demands in the basin. Significant surface water uses in the category include New Leaf Farm, Lavery's Sod Farm, and Bass Farm. Surface water demands in the basin are primarily reported as countywide estimates of use with Franklin, Bedford, and Charlotte counties the largest localities for surface agricultural users.

A.10.4 Projected Population and Water Use

Projected Population: Trends in water use are generally driven by trends in population change or economic development. Increasing population within an area generally means increased connections for community water systems or additional demands from homeowners that construct wells. Increasing population in an area also tends to incentivize both new and expanded industrial and commercial water use. Alternatively, the addition of new economic opportunities such as a large employer may include additional water withdrawals for operational needs. Reviewing short and long term population projections can inform water supply planning efforts.

For reference, Table 54 shows the projected change in population for each locality in the Commonwealth. The Roanoke Basin is expecting significant population growth over the course of the planning period, with the fastest growing localities in the basin including Franklin (13.14%), Bedford (12.05%), Montgomery (13.10%), and Prince Edward Counties (12.54%). Increases in domestic water use (Small SSUs) as well as increasing CWS demands generally align with the expected population growth in the basin.

Projected Water Use: The following section discusses projected water use through 2040 within the Roanoke basin, based on projections provided in local and regional water supply plans. Table 55, included in the existing demand section above, is the basis for information discussed in this section.

Total demand within the basin is projected to increase from 118.23 MGD in 2020 to 151.40 MGD in 2040. Surface water demand is projected to increase by 27.94 MGD, or 28.17%, by 2040. Groundwater demand is projected to increase by 5.23 MGD, or 27.44%, by 2040. Projected increases in demand are primarily driven by expected increases in surface and groundwater withdrawals to meet CWS and Small SSU demands over the planning period.

The largest contributors to this trend in total projected demand include an approximate 37.8% or 10.9 MGD increase in water transfer to the City of Virginia Beach. Additionally, increases in withdrawals from the Western Virginia Water Authority and Salem WTP to supply the greater Roanoke and City of Salem service areas, and projected increases within the greater Smith Mountain area. Increases in water demand are concentrated within the largest public water suppliers in the watershed projecting the greatest increases in demands.

CWS users within the basin are projected to increase in demand by 37.25% by 2040. Within this category, surface water use is projected to increase by 36.95%, while groundwater use is projected to increase by 41.88%. Expected increases in surface water demand is driven primarily from projected demand increases from

Virginia Beach, Roanoke's Western Virginia Water Authority, Salem WTP, and Bedford Smith Mountain Lake intakes. Expected increases in groundwater demand are also expected to primarily occur within the Salem and Roanoke service areas.

Large SSUs within the basin are projected to decrease in demand by approximately 3.08% by 2040. Within this category, surface water use is projected to decrease by 3.88%, while groundwater use is projected to increase by 47.19%. Surface water is the primary source for the category, when compared to surface water demands groundwater demands are minimal. The 47.19% projected increase is a minimal volume of demand compared to the decline in surface water. Declines in surface water demand are the result of the Boxely Lawyer Road mine ending withdrawals from Flat Creek.

Small SSUs within the basin are projected to increase in demand by 22.26% by 2040. Within this category, groundwater is the only known source of supply in the basin. As populations expand in the watershed increases in private well construction will continue to increase demand from groundwater. The greatest demand increases are expected to occur within Bedford, Franklin, and Campbell Counties.

Agriculture Users within the basin are projected to increase in demand by 8.67% by 2040. Within this category, surface water use is projected to increase by 6.20%, while groundwater use is projected to increase by 18.20%. Projected increases within the category are driven by increases in countywide agricultural demands from Charlotte, Bedford, and Franklin counties.

A.10.5 Cumulative Impact Analysis

The following section provides a brief summary of the Cumulative Impact Analysis (CIA) modeling results in the Roanoke Minor Basin. Discussion of these results will primarily be found in the "Goals, Trends, and Strategies" section of this appendix. However a brief overview of the VAHydro model and the scenarios and metrics is provided below.

The VAHydro surface water model simulates streamflow using inputs such as precipitation, climate, land use, and topography, combined with data on all known withdrawals and discharges, and operational rules of major hydrologic features such as reservoirs. Each minor basin is broken into smaller hydrologic subsections, or river segments. The model simulates the water balance on a daily basis for each individual river segment, with each downstream segment being affected by the "cumulative impact" of streamflow changes occurring in upstream segments. The following figures help analyze this cumulative impact within the *Name* Minor Basin (model results summarized by river segment). Note that this section is not intended to document in detail the methods and assumptions for the VAHydro model or for the scenarios and metrics discussed. Detailed documentation of the model and assumptions can be found in Chapter 4 and Appendix B.

The VAHydro surface water model was used to simulate streamflow under a variety of scenarios. Demand scenarios examine how streamflow is impacted under 2030 or 2040 demands as compared to current (2020) demands. Demands were calculated based on current and future demand information submitted through local and regional water supply plans. Climate change scenarios examine how streamflow is impacted when 2040 demands are simulated in conjunction with a range of precipitation and temperature conditions that are expected to occur in the future due to changing climate (Dry, Median, Wet scenarios). Finally, an exempt user scenario examines impacts from users excluded, or exempt, from VWP permit requirements by 9VAC25-210-310 when operating at the maximum demand identified through a review of demand justification values commonly associated with exempt users - including but not limited to VDH Pump Capacity, maximum pre-1989 withdrawal, and maximum intake capacity. The methods and assumptions for each of these scenarios are discussed in detail in Chapter 4 and Appendix B.

For each scenario described above, different metrics can be used to evaluate the simulated streamflow. A metric is a method for measuring or evaluating a given set of data; different metrics can be evaluated to answer different questions. Within this section the following metrics will be discussed: the lowest 30 day flow (L30), the lowest 90 day flow (L90), 7Q10, and overall change in flow. The L30 describes the lowest consecutive 30 day average daily streamflow over the simulation period. This metric is a representation of a short-term, or acute drought, and is a good metric for evaluating impacts to direct withdrawals without storage. Similarly the lowest 90 day flow represents the lowest consecutive 90 day average daily streamflow over the simulation period. This would represent a prolonged drought and is often used to evaluate impacts to reservoirs. The 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years. 7Q10 is generally used in the evaluations of in-stream beneficial uses such as waste assimilative capacity. Overall change in flow describes the net loss of water from the riverine system as a result of off-stream use not otherwise returned through point source discharges, or losses due to evapotranspiration. This metric is useful for evaluating impacts to aquatic life and is discussed in more detail in Chapter 4.

Demand Scenarios: 2020 demand or current demand, 2030 demand, and 2040 demand scenarios were simulated. The following series of figures compares the 2030 and 2040 demand scenarios to the current demand scenario. The change in flow depicted on each map is the change expected when comparing two scenarios - in this case future demands compared to current demands. Each page includes two figures comparing either the 2030 or 2040 demand scenario to current demand using the l30, l90, and 7Q10 metrics. This allows for comparisons of simulated impacts between the 2030 and 2040 demand scenarios. The scenarios and metrics are identified in the paragraph below and in the figure captions.

Figures 213 and 214 compare the lowest 30 day flow simulated with the current demand scenario with the lowest 30 day flow simulated in the 2030 and 2040 demand scenarios respectively. Figures 215 and 216 compare the lowest 90 day low flow simulated with the current demand scenario with the lowest 90 day flow simulated in the 2030 and 2040 demand scenarios respectively. Figures 217 and 218 compare the 7Q10 simulated with the current demand scenario with the 7Q10 simulated in the 2030 and 2040 demand scenarios respectively.

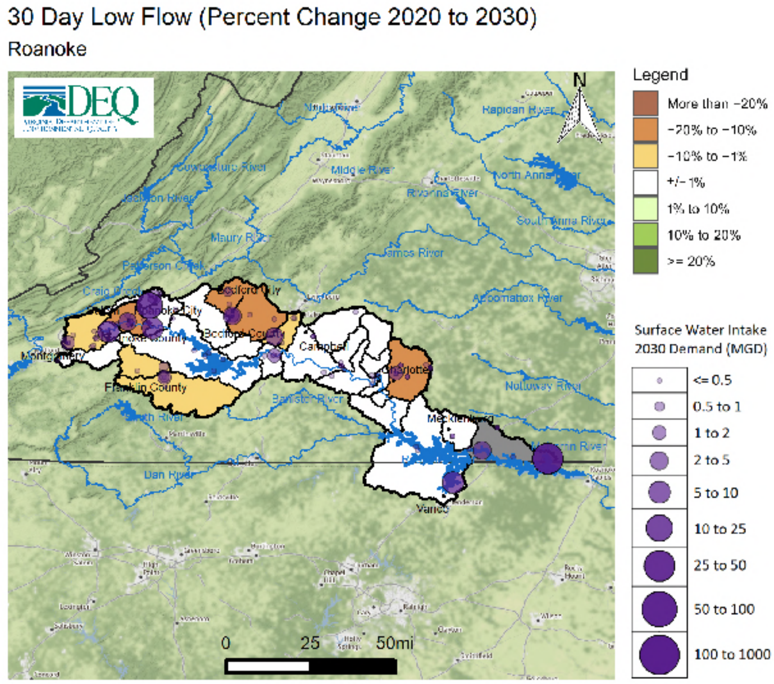

Figure 213: Change in 30 day low flow between 2020 and 2030 demand scenarios within the Roanoke Basin

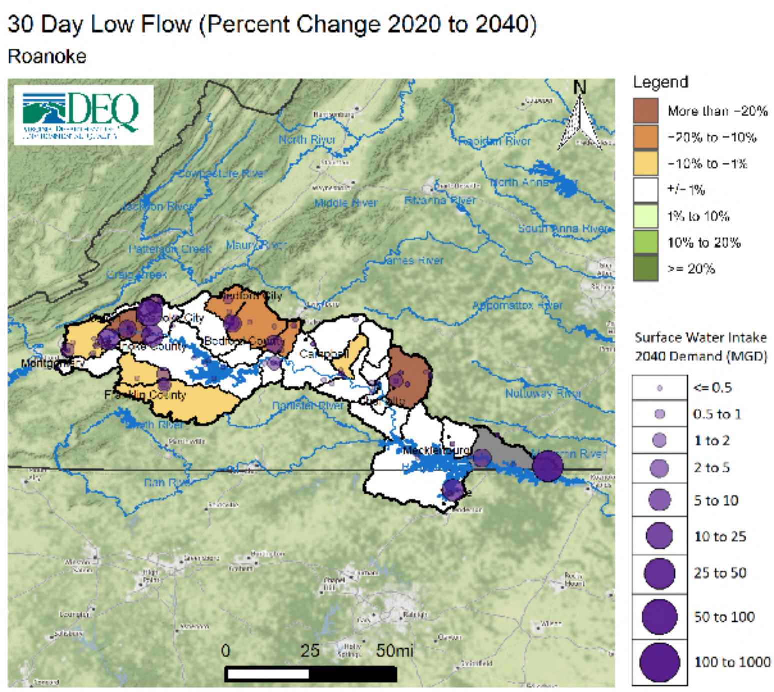

Figure 214: Change in 30 day low flow between 2020 and 2040 demand scenarios within the Roanoke Basin

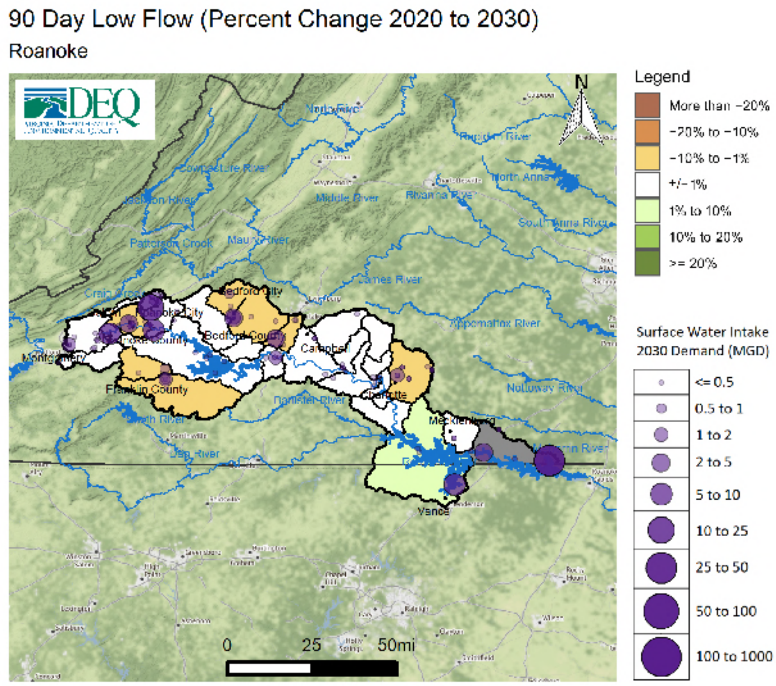

Figure 215: Change in 90 day low flow between 2020 and 2030 demand scenarios within the Roanoke Basin

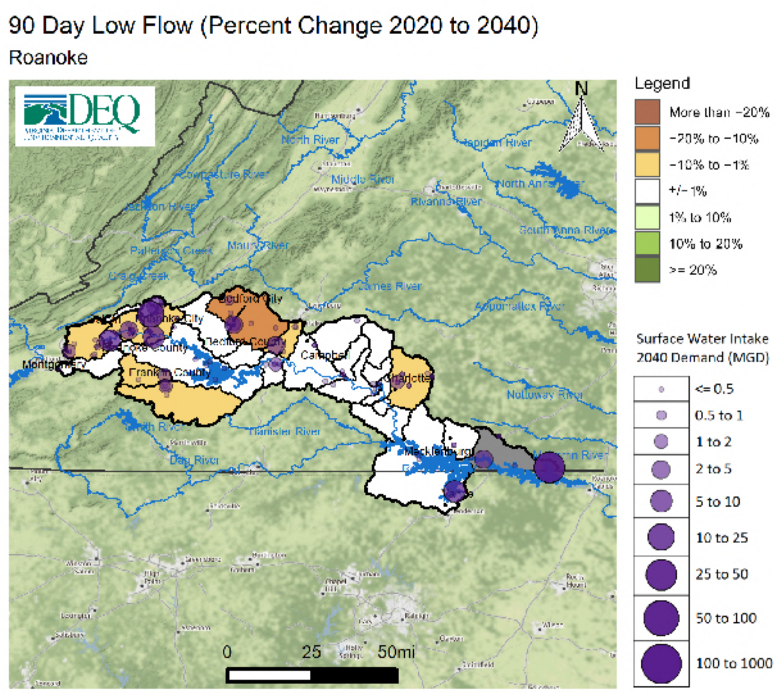

Figure 216: Change in 90 day low flow between 2020 and 2040 demand scenarios within the Roanoke Basin

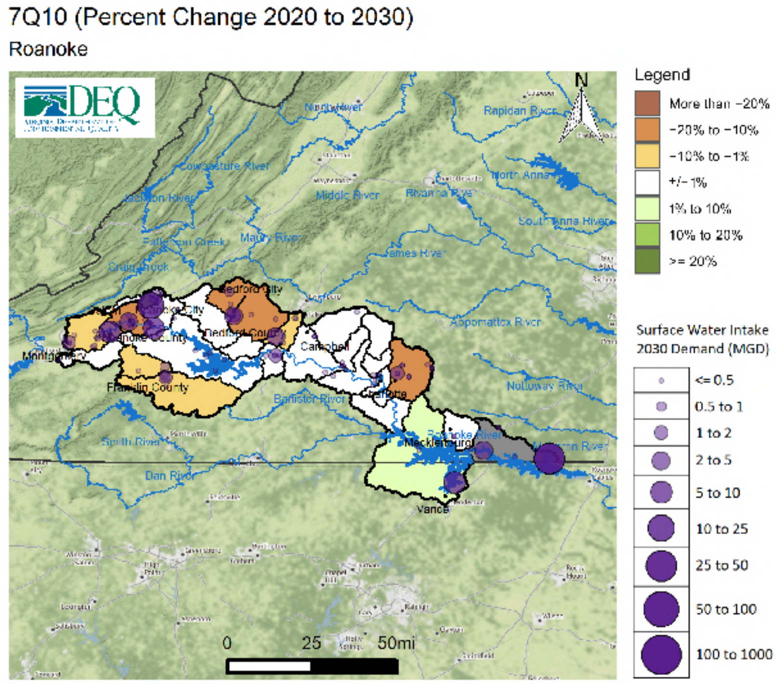

Figure 217: Change in 7Q10 between 2020 and 2030 demand scenarios within the Roanoke Basin

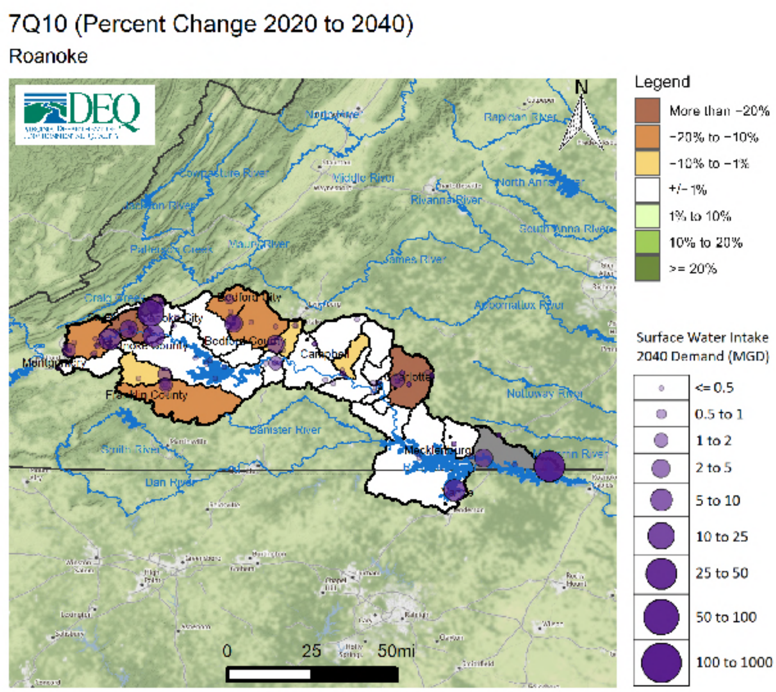

Figure 218: Change in 7Q10 between 2020 and 2040 demand scenarios within the Roanoke Basin

The figures above show a comparison between two scenarios. An additional way to evaluate impacts to streamflow is to examine the total reduction in streamflow resulting from all withdrawals within a river segment, as well as losses due to evapotranspiration, while taking into consideration any discharges back to the source. To use a common industry term, the overall change in flow metric evaluates "consumptive use", or the amount of water removed from the river that is not returned through discharges. This can help describe potential impacts to downstream withdrawals, while also providing a basis for evaluating impacts to aquatic life. In general, total reductions in streamflow can result in a reduction in aquatic biodiversity [91]. The relation between streamflow and aquatic biodiversity is discussed in more detail in the "Analysis of Ecological Impacts" section below and in Chapter 5. Figure 219 shows the overall change in streamflow for the 2030 Demand Scenario, while figure 220 shows the overall change in streamflow for 2040 Demand Scenario.

[91] Rapp, J.L., R. Burgholzer, J. Kleiner, D. Scott, and E. Passero. 2020. "Application of a New Species-Richness Based Flow EcologyFramework for Assessing Flow Reduction Effects on Aquatic Communities." Journal of the American Water Resources Association 1–14.https://doi.org/10.1111/1752-1688.12877.

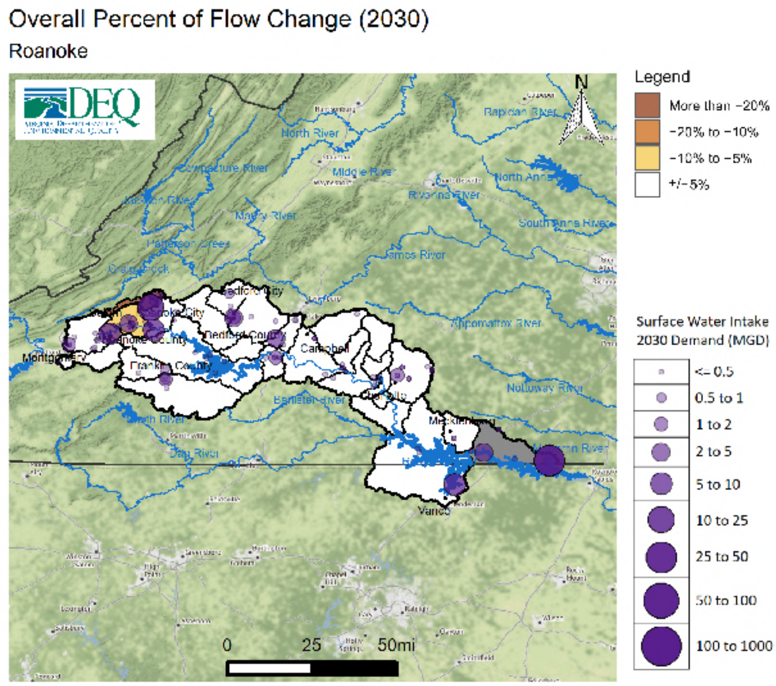

Figure 219: Overall change in flow in percent for 2030 demand scenario within the Roanoke Basin

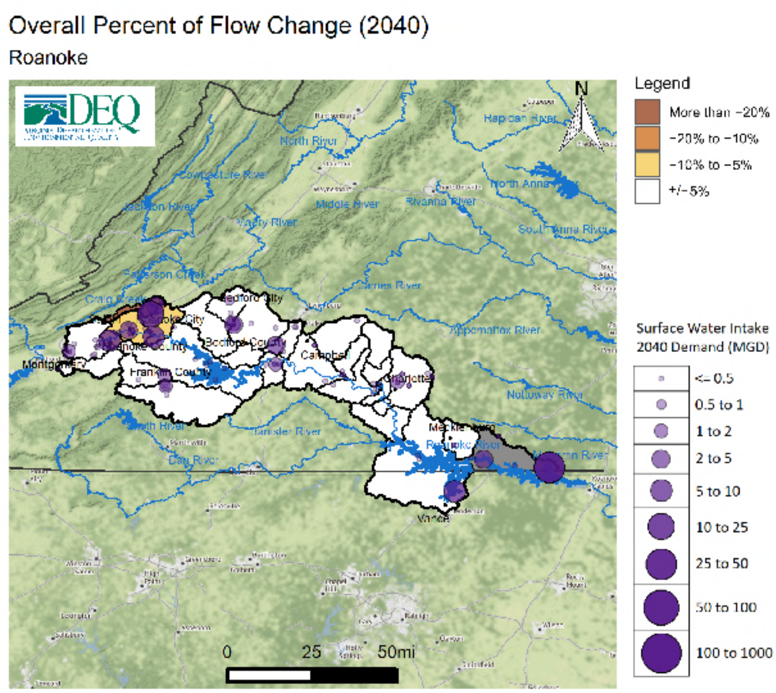

Figure 220: Overall change in flow in percent for 2040 demand scenario within the Roanoke Basin

Climate Scenarios:Three scenarios that simulate impacts to streamflow in response to changes in temperature and climate were completed for areas in the state where climate data was available, which includes the portions of the Commonwealth located in the Chesapeake Bay drainage. Details on the methods and assumptions employed for these scenarios can be found in Appendix B. In short, the three scenarios can be described as dry, median, and wet scenarios. Virginia is expected to experience a range of precipitation and temperature changes that may vary spatially and from year to year. The potential for both more severe and prolonged droughts as well as for higher intensity and more frequent rain events must be considered. These three scenarios are not intended as predictions of future climate conditions, but as representations of several possibilities that climate change models indicate could occur. Should they occur, these results provide an evaluation of how streamflows may be impacted. Their purpose is to build upon existing climate modeling to provide a foundation for state and local government, as well as other stakeholders, to better evaluate what practical water resource challenges may be associated with the range of climate conditions Virginia could experience. Note that this Basin is located outside of the Chesapeake Bay drainage and therefore climate scenarios were not completed at this time. DEQ is working to expand these climate scenarios to cover the entire state for future planning efforts.

Exempt User Scenario: The exempt user scenario simulates the maximum potential withdrawal claim for users excluded from Virginia Water Protection permitting requirements per 9VAC25-210-310, in combination with the permitted withdrawal limits for those users that are permitted. A more detailed discussion of the data and assumptions used in this scenario can be found in Appendix B. Note that this scenario uses current climate conditions. Figure 221 depicts the percent change in the Lowest 30 Day Flow between the exempt user scenario and current (2020) demand. Figure 222 depicts the percent change in the Lowest 90 Day Flow between the exempt user scenario and current (2020) demand. Figure 223 depicts the percent change in the 7Q10 between the exempt user scenario and current (2020) demand. Finally, figure 224 depicts the overall change in flow in percent (consumptive use) for the exempt user scenario.

Notes on Exempt user scenario. The Tinker Creek intake is used to refill the Carvins Cove reservoir, and therefore it's demands are determined by refill needs in Carvins Cove. Because the Carvins Cove refill considers the flowby in Tinker Creek, demand never exceeds available flow in the normal operation (non-exempt) scenarios. It does, however, have a separate intake and accompanying estimated maximum exempt demand amount, though this is only used to limit the maximum pumping rate from Tinker Creek in the exempt demand scenario.

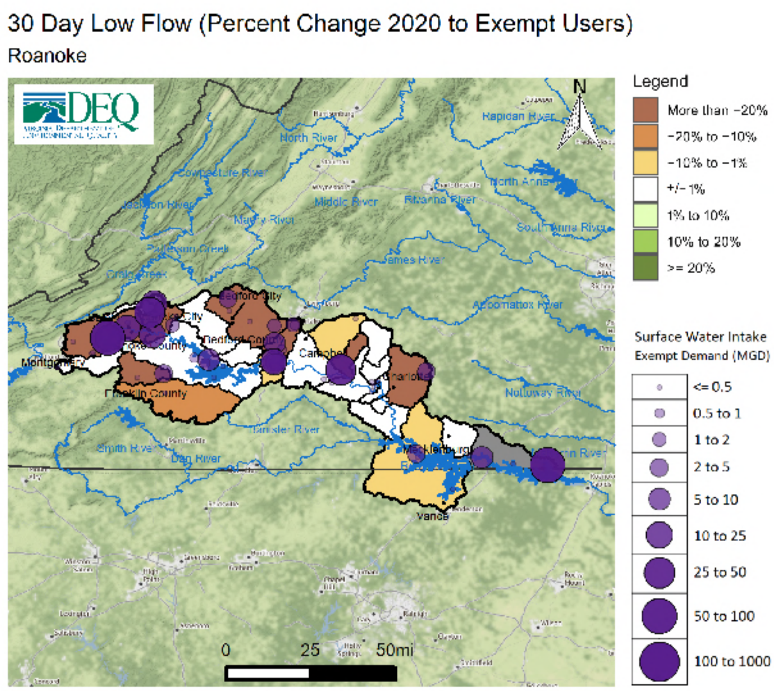

Figure 221: Change in 30 day low flow between current demand scenario and exempt User scenario within the Roanoke Basin

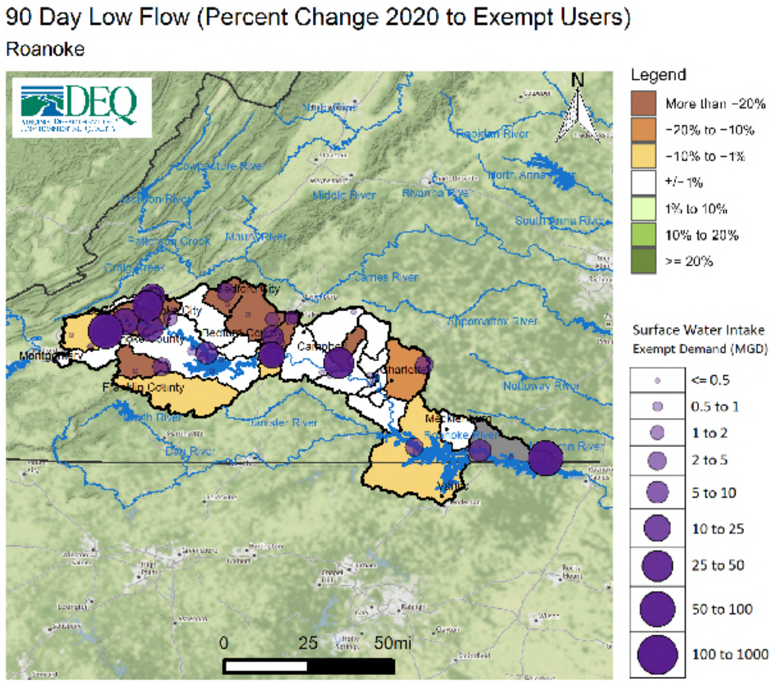

Figure 222: Change in 90 day low flow between current demand scenario and exempt User scenario within the Roanoke Basin

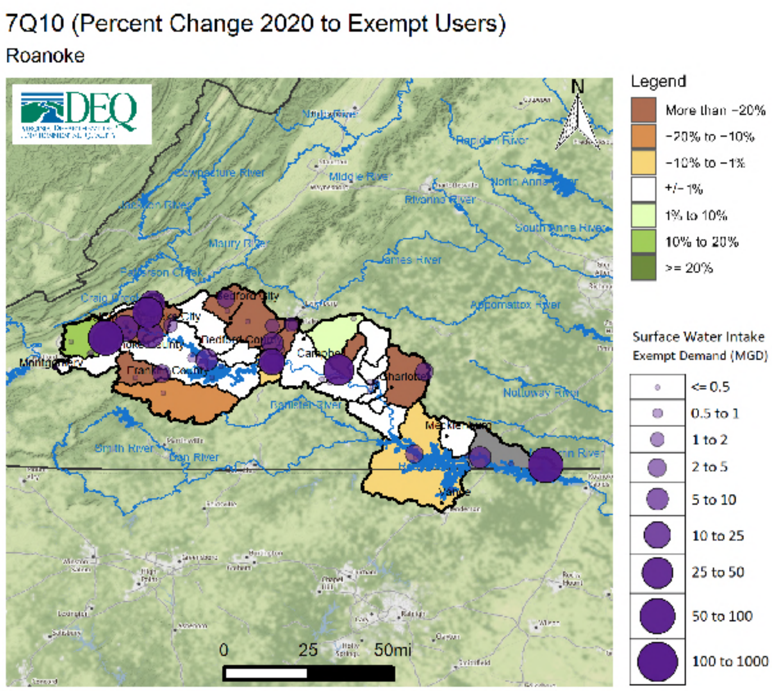

Figure 223: Change in 7Q10 between current demand scenario and exempt User scenario within the Roanoke Basin

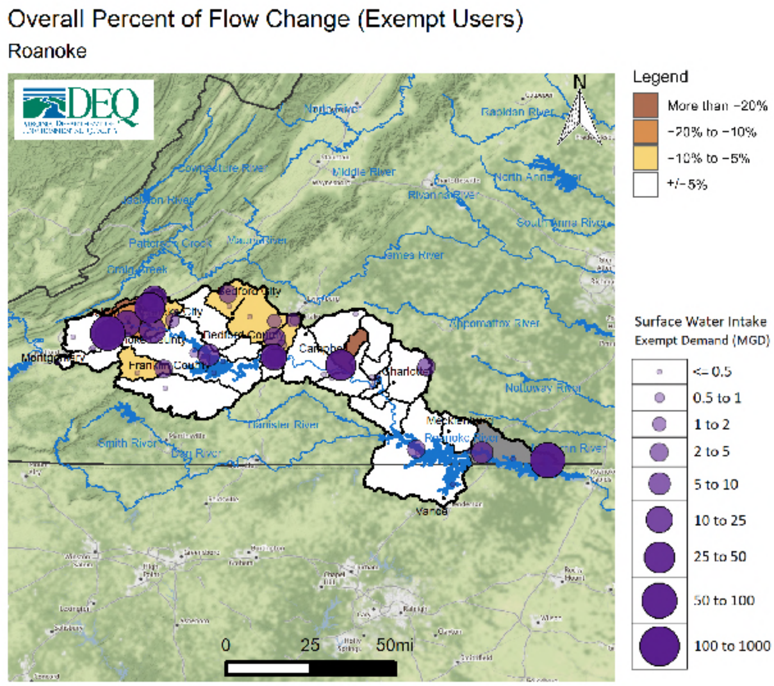

Figure 224: Overall change in flow in percent for exempt user scenario within the Roanoke Basin

Potential Unmet Demand: Potential unmet demand was evaluated for all facilities within the basin for each scenario. Potential unmet demand is the portion of surface water demand for a specific facility that is limited by available streamflow as simulated in a given model scenario, including any known operational limits such as flow-by requirements. This unmet demand, if realized, could be managed through water conservation, through alternative sources, operational changes, or from available storage. Absent of these or other options, this portion of demand could remain unmet. As with all scenarios, demand requirements were determined using demand projections provided in the water supply plans. In the case of the exempt user scenario, the highest demand amount among the data sets described in the exempt user scenario documentation in B was used for users exempt from VWP permitting requirements.

This metric is useful for evaluating where the results seen in the above figures may result in challenges in meeting future demands under a variety of conditions including increasing demands in the basin, changing climate, or withdrawals from users exempt from permitting requirements. Table 57 provides for each facility the highest average daily potential unmet demand over a 30 day period over the course of the simulation for the following scenarios: 2020 demand, 2030 demand, 2040 demand, dry climate, and exempt User. Only facilities showing potential unmet demand in at least one scenario appear on this table. The dry climate scenario is selected among the climate scenarios as the dry scenario represents the potential for increased drought intensity and frequency, and therefore poses the greatest challenge for water supply. Additional information on the potential unmet demand metric can be found in B.

Table 57: Change in Highest 30 Day Potential Unmet Demand (MGD) in Roanoke Minor Basin

Facility	2020 Demand	2030 Demand	2040 Demand	Dry Climate	Exempt User
Brookneal WTP	0.00	0.00	0.00	-	38.16
Roanoke (City) Service Area	0.00	0.00	0.00	-	27.12
Salem WTP	0.00	0.04	0.26	-	13.61
Central System Service Area	0.93	1.06	1.19	-	5.19
Bedford Central WTP	0.00	0.02	0.04	-	3.67
Brookneal WTP	0.00	0.00	0.00	-	2.85
Roanoke Facilities	0.00	0.00	0.00	-	2.75
Blackwater River WTP	0.00	0.00	0.02	-	2.49
Salem Glenvar WTP 2	0.00	0.00	0.00	-	1.77
Lawyers Road Plant	0.16	0.16	0.16	-	1.58
Keysville WTP	0.00	0.00	0.01	-	1.07
Roanoke City Service Area	0.00	0.00	0.00	-	0.90
London Downs Golf Course	0.00	0.00	0.00	-	0.41
Catawba WTP	0.00	0.00	0.00	-	0.19
Altavista Service Area	0.00	0.00	0.00	-	0.18
Laverys Sod Farm	0.00	0.00	0.00	-	0.12
Glenvar Plant	0.00	0.00	0.00	-	0.12
Blacksburg Country Club	0.00	0.00	0.00	-	0.11
New Leaf Farms, Inc.	0.00	0.00	0.00	-	0.01
Drakes Branch Plant	0.00	0.00	0.00	-	0.01

* Climate scenarios were not completed in areas located outside of the Chesapeake Bay Basin

Note: Potential unmet demand is the portion of surface water demand for a specific facility that is limited by available streamflow as simulated in a given model scenario, including any known operational limits such as flow-by requirements. This unmet demand, if realized, could be managed through water conservation, alternative sources, operational changes, or from available storage.

A.10.6 Spatial Overview of Groundwater Demands

The cumulative impact analysis figures above provide an overview of surface water demands in the basin but did not include groundwater demands. Figure 225 identifies the location and size of projected groundwater demands in the basin for 2040 based on information provided by localities in water supply plans.

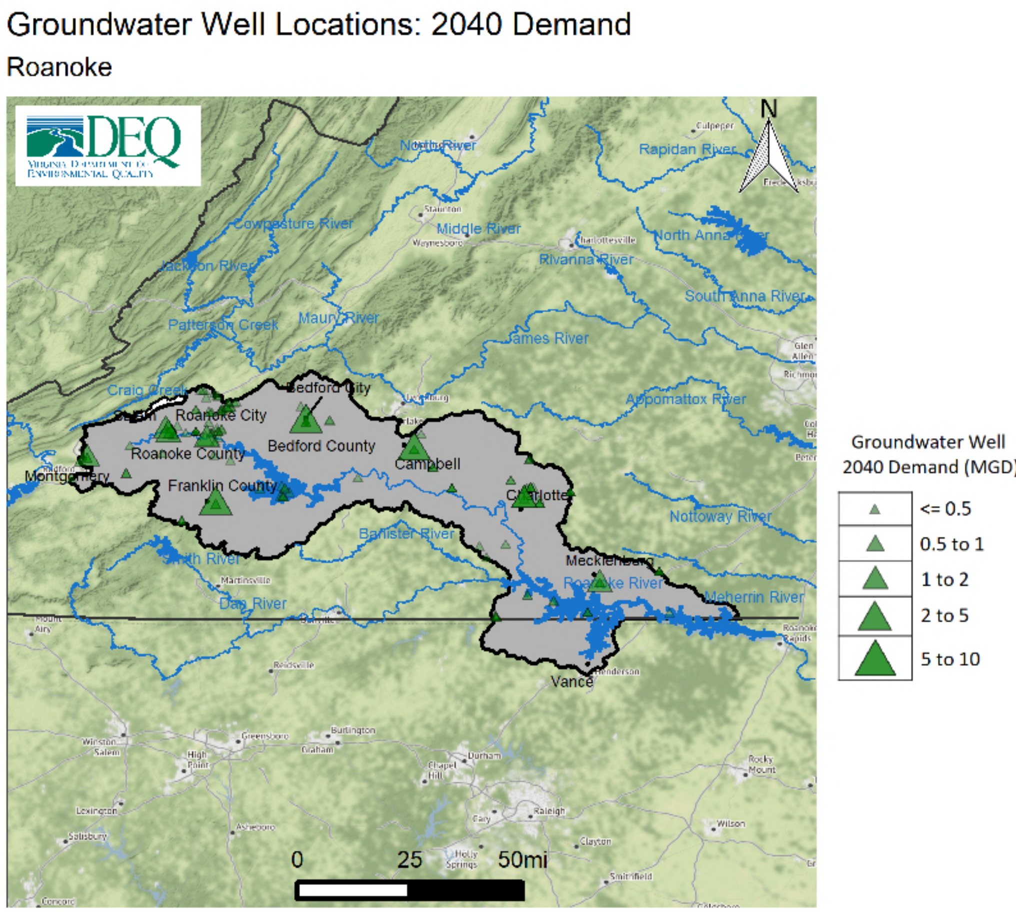

Figure 225: Projected 2040 Groundwater Demands in the Roanoke Minor Basin

A.10.7 Trends and Goals

The Code of Virginia mandates that the State Water Control Board should consider as principle that "adequate and safe supplies shall be preserved and protected for human consumption, while conserving maximum supplies for other beneficial uses" [92]. This principle is the key driver of the challenges in water resource management, which is that all beneficial uses must be adequately considered when evaluating impacts to surface water resources. The State Water Control Board is tasked with insuring that water supply quantity needs are met at all times while also protecting Virginia's natural resources, and furthermore, ensuring equitable allocation during a time of shortage [93]. While evaluating and planning for the long-term sustainability of water supply for Virginia is the primary goal for the State Plan, evaluating and limiting impacts to in-stream beneficial uses such as aquatic habitat life is also part of DEQ's responsibility.

The primary purpose of this section is to identify where the most significant challenges to long-term sustainability of water supply and other beneficial uses are indicated based on the CIA and information collated from local water supply plans within this basin. Goals for future planning and areas for additional data collection or analysis are also suggested where appropriate.

The CIAs were completed using the best available data and methods known to DEQ. This discussion focuses on the evaluation of trends - in other words the prevailing tendency or inclination. This means evaluating whether streamflow is simulated to increase or decrease in a given scenario, and by how much. A relative trend indicating reductions of greater than or equal to 10% in streamflow, whether driven by demand increases, changing climate conditions, or exempt user demands was considered a threshold for potential impacts to beneficial uses. The following summarize the key trends or goals for this basin:

- **Demand Scenarios:** Surface water demands in the Roanoke Minor Basin are projected to increase approximately 28% through 2040, and impacts from increasing demands are expected to result in significant water resource management challenges. Impacts from increasing surface water withdrawals simulated reductions of 10% or were occurred within the basin for the short-term drought (L30)long-term drought (L90), and 7Q10 metrics. Short term drought or L30 was simulated with 10% or greater reduction in four river segments during the 2040 scenario. With the greatest reductions occurring in the Roanoke River near Salem, the Roanoke River near Saxe , Upper Big Otter River near Evington, and the Lower Big Otter River. Reductions are largely driven by increasing demands in the cities of Salem and Roanoke, Bedford County, Campbell County, and by effects of widespread agricultural users in the basin. For long term drought or L90, only one river segment shows 10% or greater percent change in L90. The Upper Big Otter River near Evington, and is driven by the Campbell County Big Otter River intake supplying increases in demands within the service area. The Roanoke River near Saxe segment shows the greatest reduction driven by withdrawals from agricultural irrigation, livestock, and withdrawals from the Keysville Reservoir. The Roanoke River near Salem and the Upper Big Otter near Evington were simulated with greater than 15% reductions in 7Q10. Increasing demands from municipal sources of supply including the Roanoke and Blackwater Rivers in combination with expected increases in agricultural and large self-supplied users in the basin contribute to simulated reductions. Increasing agricultural and irrigation demands in the North and South Fork of Roanoke River in Montgomery County also showed impacts of greater than 10% reduction in the headwaters of the basin. Overall Percent of Flow Change (consumptive use) is simulated to exceed 20% in Carvins Cove, with 76% consumptive use with 2040 demands. Increased demands from Salem and Roanoke will continue to stress Carvins Cove as the primary water source in the headwaters of the basin. The Roanoke River near Roanoke is simulated with under 10% consumptive use, the segment is adjacent and downstream of Carvins Cove. In combination with demands from the City of Roanoke overall percent of flow reduction of 10% continue downstream of Carvins continues until reaching the upper portion of Smith Mountain Lake impoundment. Potential unmet demands were simulated for the Campbell County Central System, City of Salem, and Bedford WTP. Potential unmet demands and impacts simulated for the City of Salem may be mitigated by the pending surface water withdrawal

[92] § 62.1-44.36 of the Code of Virginia
[93] 9VAC25-390-20.1

permit VWP 98-1992 for an intake located in the Roanoke River. Significant reductions in streamflow from consumptive withdrawals should be investigated to mitigate impacts to aquatic life and all other beneficial uses. Projected demands indicate the potential for impacts to future water supply availability and in-stream beneficial uses within the basin. Eight facilities show potential unmet demand in the 2040 demand scenario including large public water suppliers in Salem, Altavista, Bedford, and Campbell Counties.

- **Climate Scenario:** Although climate scenarios were not completed in this basin, statewide climate modeling trends indicate a wide range of impacts to streamflow are possible. Systematic evaluation of alternatives including conjunctive use systems, as well as increased interconnection, conservation, and storage are effective tools in managing this uncertainty. Existing resources may not be sufficient to meet current or increasing demands for some public water suppliers in the basin based on 2040 demands, future planning should consider the potential for droughts that are more significant than the drought of record.

- **Exempt User Scenario:** The exempt user scenario models the cumulative claims from all users exempt from VWP permitting requirements. Reductions in streamflow of more than 10% during short term (L30), long term droughts (L90), 7q10, and overall change in flow occurred when compared to current demands. Seven river segments were simulated with 10% or greater reduction in L30 in the basin, the most significant reductions in L30 are simulated in the Roanoke River near Salem with greater than 70% reductions. Simulated reductions in the Roanoke River near Salem are driven primarily from withdrawals from the Roanoke River by the City of Salem and the Koppers Industries Inc. Glenvar Plant. Additional drivers reducing short term drought flows (L30) by 10% or more include Withdrawals from the Roanoke River to fill Spring Hollow Reservoir, Phelps Creek Reservoir to support the Town of Brookneal, Crystal Spring Reservoir, Town of Rocky Mount Blackwater River intake, and the Burlington Industries Roanoke River intake contributing among others to simulated reductions. L90 simulations show a 10% or greater reduction in long term drought flow in eight river segments. The greatest reductions were simulated within the Lower Falling River, Roanoke River near Salem, and Blackwater River. Exempt claims from the City of Salem & Roanoke, Town of Brookneal, and Koppers Industries Glenvar Plant contribute to significant simulated reductions in long term drought flow. These results indicate that the cumulative exempt claims in the basin exceed the water budget in multiple river segments. The exempt user scenario suggests that the cumulative effect of all surface water claims in this basin would impact the ability of public water supplies facilities to meet demands. With reductions in overall flow of more than 20% in some river segments, the exempt user scenario also suggests a high probability of impacts to aquatic life. While it is not expected that all facilities within this basin will operate at the claimed amounts, the analysis indicates insufficient streamflow to support these claims without impacts to downstream water supply and other beneficial uses. Preserving water supply and other beneficial uses will require managing these demands with respect to their cumulative impacts and in the context of the available resources in the basin. Overall, the most pressing issue in the Roanoke River Basin appears to be the potential impact of exempt use surface water claims and the potential impacts of the highest claims on a number of metrics including potential unmet future demand for public water supplies.