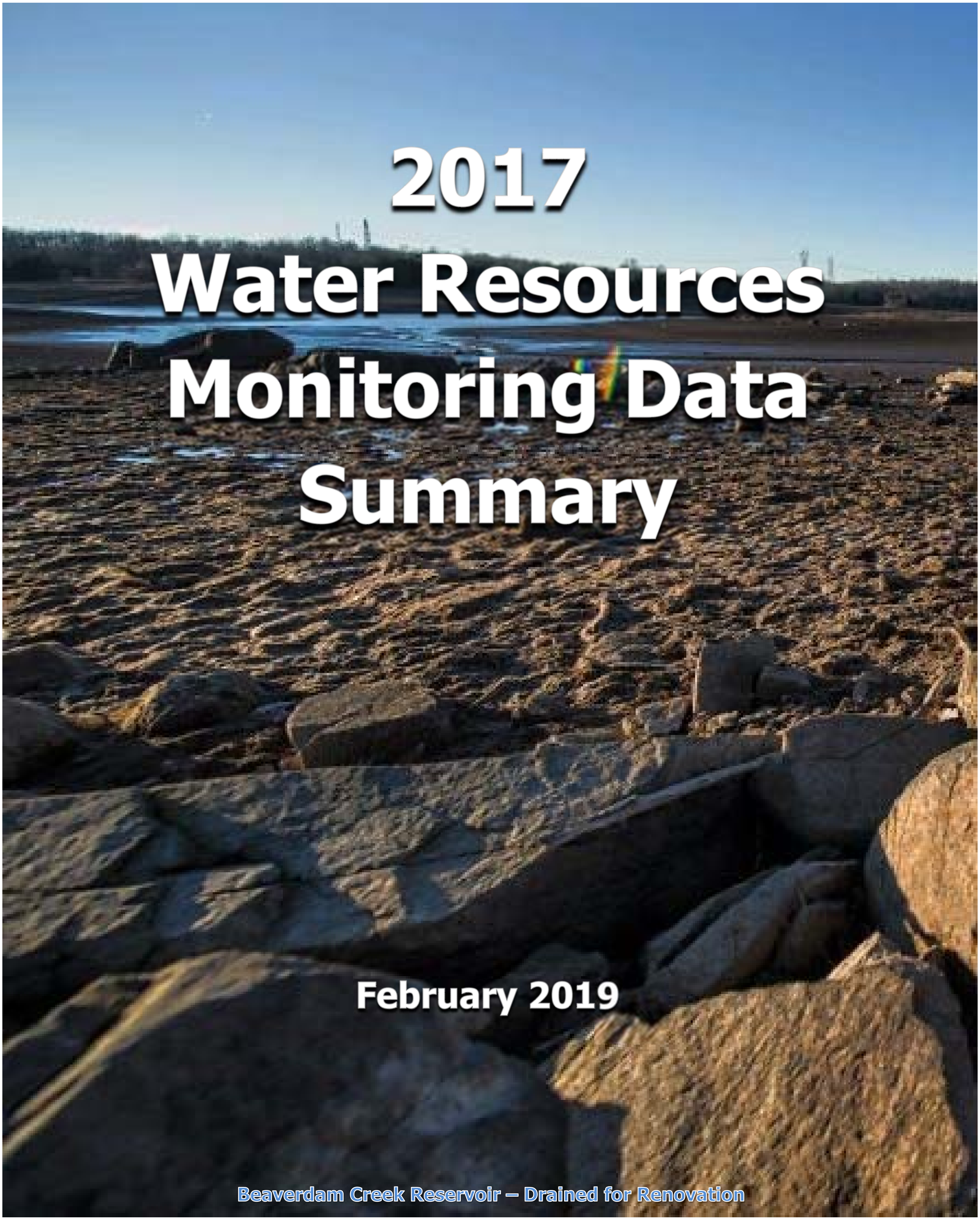
# Loudoun County, Virginia



# 2017 Water Resources Monitoring Data Summary

**February 2019**

Beaverdam Creek Reservoir – Drained for Renovation

# 2017
# Water Resources Monitoring Data Summary

**Loudoun County, Virginia**
**Department of Building and Development**
**Natural Resources Division**
**Floodplain Management Team**

**February 2019**

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| *cfs:* | *cubic feet per second* |
| *DEQ:* | *Virginia Department of Environmental Quality* |
| *EPA:* | *U.S. Environmental Protection Agency* |
| *MCL:* | *maximum contaminant level* |
| *mg/L:* | *milligrams per Liter* |
| *NWS-COOP:* | *National Weather Service Cooperative monitoring station* |
| *OWTS:* | *On-site Wastewater Treatment System* |
| *TDS:* | *Total Dissolved Solids* |
| *uS/cm:* | *microSiemens per centimeter* |
| *USGS:* | *U.S. Geological Survey* |
| *NWS:* | *National Weather Service (Division of National Oceanographic and Atmospheric Administration)* |

## DATA LIMITATIONS

While efforts have been made to insure the accuracy of the data presented in this report, Loudoun County does not assume any liability arising from the use of these data. Reliance on these data is at the risk of the user. The U.S. Geological Survey (USGS) and the National Climatic Data Center (who distribute National Weather Service data) have data quality assurance procedures in which data are considered "Provisional" until they are checked and corrected as needed. Data used in this report are all "Approved".

## HYPERLINKS

The underlined text in this document indicates hyperlinks to additional data and online resources that may be accessed when this document is opened in a program designed to view portable document format (pdf) files. The report can be found at www.loudoun.gov/watermonitoring and follow the link to Data Analysis & Reporting.

## ACKNOWLEDGMENTS

This document was prepared by County staff members David Ward, Kelly Baty and Maggie Auer of the Floodplain Management Team in the Natural Resources Division of the Department of Building and Development.

# Loudoun County, VA
# 2017 Water Resources Monitoring Data Summary

## Table of Contents

# INTRODUCTION AND SETTING

This document summarizes data collected during various water resources monitoring activities in and adjacent to Loudoun County, Virginia, by government, private and volunteer organizations during calendar year 2017. Specifically, data characterizing precipitation, streamflow, groundwater levels, and surface water and groundwater quality are presented. The Loudoun County Department of Building and Development collects these data or compiles them from other sources. Efforts originated with the Loudoun County Water Resources Monitoring Program in 2001 as originally funded through a grant from the US Environmental Protection Agency (EPA). Although the grant ended in 2009 the County continues to collect and compile groundwater level and streamflow data. The data are presented and discussed in two sections: water quantity – measurements of precipitation, streamflows, and groundwater levels; and water quality – the chemical and biological characteristics of stream water and groundwater.

Loudoun County has been one of the fastest growing counties in the nation during the past decade. The estimated population of Loudoun County in 2017 is nearing 384,000 and is forecast to reach 494,000 by 2045; an increase of 32 percent.

## General Characteristics of Loudoun County

Loudoun County is located in Northern Virginia approximately 30 miles west of Washington, D.C. The county covers an area of 521 square miles and is bordered on the north by the Potomac River and the west by the Blue Ridge Mountains (Figure 1).

Urban and suburban development is concentrated mostly in the eastern part of the county, generally from the Town of Leesburg to Washington Dulles International Airport and the border with Fairfax County. The western portion of the county is more rural, with crop farms, pastures, vineyards, several small towns, and numerous large-lot residential subdivisions.

Loudoun Water, formerly known as the Loudoun County Sanitation Authority, owns and operates a centralized water and sewer system that serves the developed area of eastern Loudoun as shown in Figure 1. The Town of Leesburg provides treated Potomac River water to residents inside the Town limits, and to several residential areas adjacent to its eastern boundary. Outside of the Leesburg and Loudoun Water central service areas, county residents obtain water primarily from wells. In the rural towns and several of the subdivisions, water may come from communal water systems and sewage is treated in small wastewater treatment plants. The remaining single-family homes and businesses have on-site individual wastewater treatment systems.

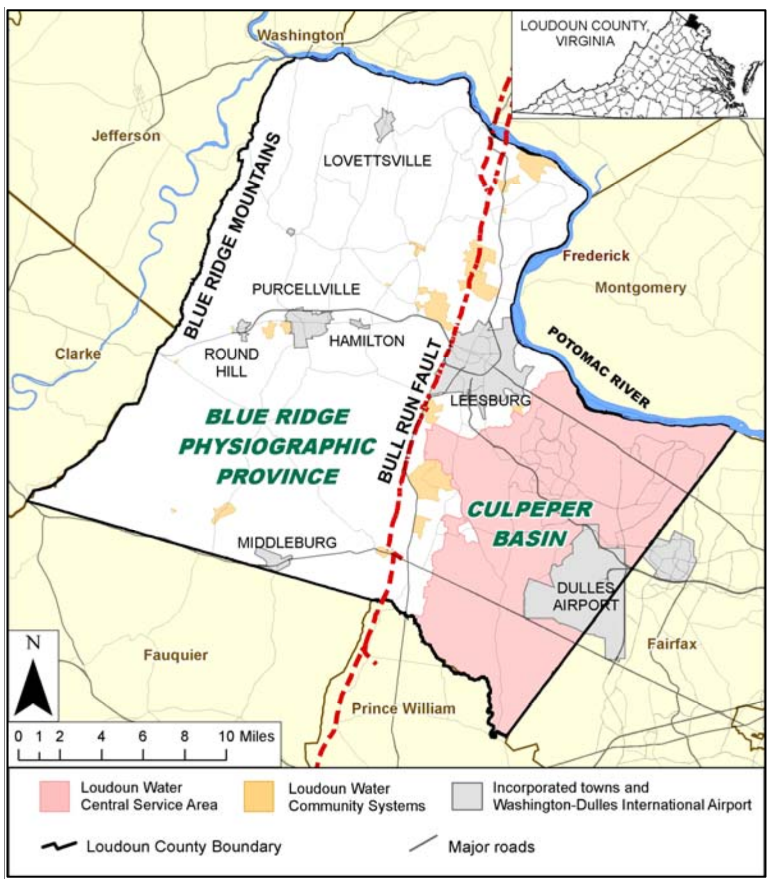



**Figure 1. Major features of Loudoun County, VA.**

## Physiography and Geology

Loudoun County intersects two physiographic provinces which are separated by the Bull Run Fault (Figure 1). The fault separates the Culpeper Basin (a Triassic-age rift basin) of the Piedmont Province on the east from the Blue Ridge Province to the west. The Culpeper Basin is comprised of sedimentary rocks and sedimentary-derived metamorphic rocks, both of which may include intrusions of dense, igneous diabase rock. The north-eastern area of the county, generally from the Town of Leesburg northward, is underlain by limestone conglomerate rock (the Leesburg Member of the Balls Bluff Siltstone) and has the surface features and hydrogeologic characteristics of a karst environment. Western Loudoun is underlain by metamorphic rocks derived from both sedimentary and igneous parent material. Bedrock in the county is covered by regolith (unconsolidated sediments and soils) that is commonly between 20 and 50 feet thick, but ranges from 0 to more than 90 feet thick. Soils are generally less permeable in eastern Loudoun compared to western Loudoun.

## Watersheds

Watersheds are defined by topography and drain all of the surface water in an area to a single location such as a stream or lake. They are often used to delineate areas for monitoring, analyzing, and managing water resources. Watersheds can be defined at many different scales but the watershed scale that is most convenient for county-wide investigations in Loudoun is based on the 17 watershed areas shown in Figure 2. The majority of the county is covered by three major drainage areas that empty into the Potomac River by way of the following stream systems: Goose Creek, Catoctin Creek, and Broad Run.

The eastern and southern borders of the county share watersheds with the neighboring Virginia counties of Fairfax, Prince William, and Fauquier. The upper reaches of Broad Run and Sugarland Run watersheds lie to the east in Fairfax County and Goose Creek originates to the southwest in Fauquier County, but all three streams/watersheds drain into Loudoun County and ultimately the Potomac River.

The southeastern region of Loudoun includes the headwaters of Bull Run and Cub Run. These streams drain out of Loudoun County to the south and are tributaries to the Occoquan River which eventually discharges into the Potomac River.

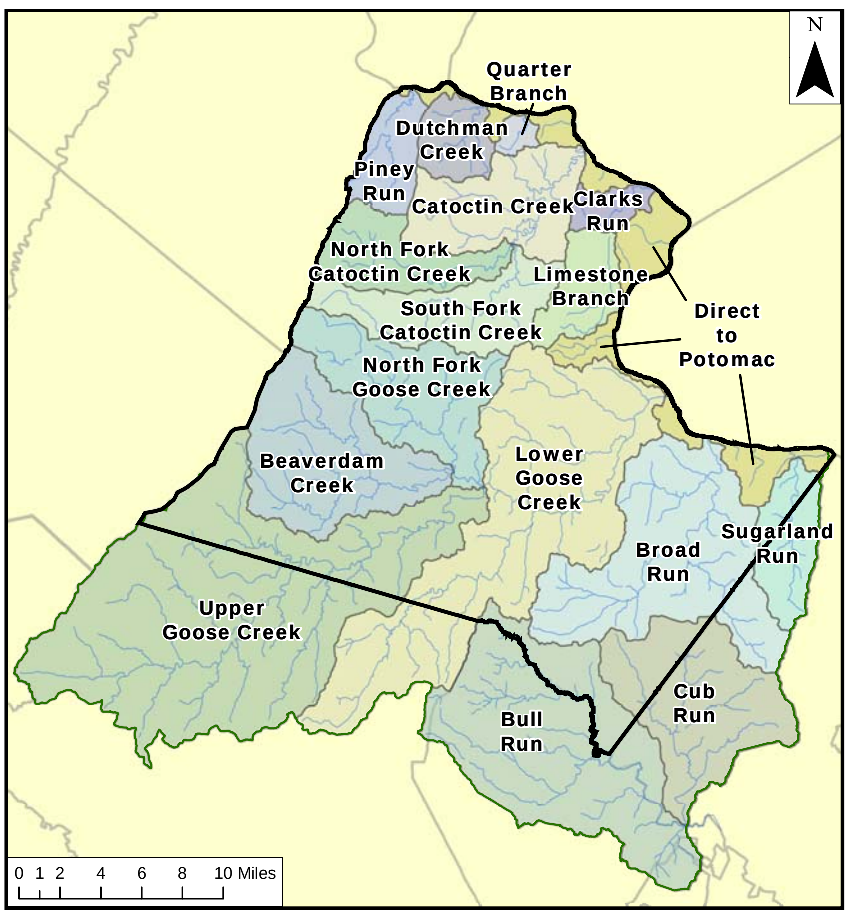



**Figure 2. Watersheds and streams in and adjacent to Loudoun County, VA.**

# WATER QUANTITY

This section presents information on the quantity of water resources with data on precipitation, streamflows, and groundwater levels in Loudoun County during calendar year 2017.

## Precipitation

Total annual precipitation in 2017, was 35.3 inches, which is 4 inches below the normal. The (mean) annual precipitation for the full period of record between 1964 and 2017 at the Dulles Airport monitoring station was 39.3 inches. Precipitation data are obtained from seven monitoring sites in the county (Figure 3). Four precipitation stations are part of the National Weather Service's (NWS) cooperative monitoring network and two rain gages are operated by the U.S. Geological Survey (USGS). The NWS sites have relatively long periods of record with one having nearly continuous data since 1930 (Table 1). The two USGS rain gages have mostly continuous data records beginning in 2004 and 2005 and provide data at 5-minute intervals.

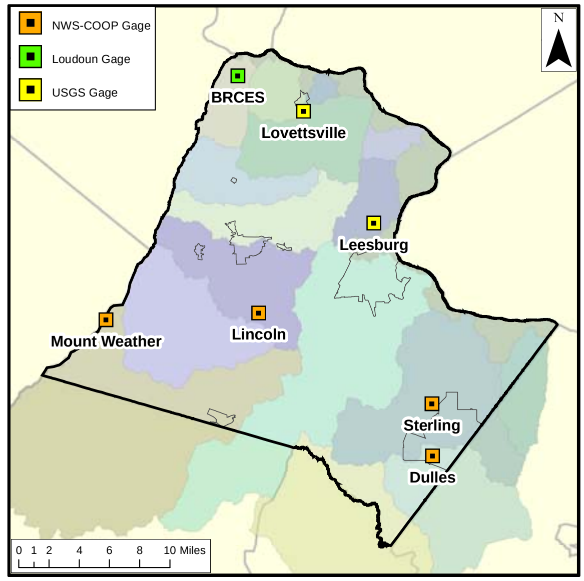



**Figure 3. Precipitation monitoring sites.**

Data from the long-term records indicate that annual precipitation has ranged from a minimum of 20.4 inches (at the Lincoln station in 1930) to maximum of 76.1 inches (at the Limestone Branch station in 2003). For purposes of identifying "normal" (mean) conditions and for comparison to current conditions, the standard practice is to group climatic data into periods of 30 consecutive years with the most recent year of the group ending in "0". For the 30-year period of 1981 through 2010, the annual median precipitation at the Dulles Airport was 40.6 inches and for the period of record 39.1 inches.

**Table 1. Precipitation monitoring stations and data.**

| Precipitation Monitoring Station Name | Start of Record[1] | Station Operated by [2, 3] | Annual Statistics (Inches) for Period of Record[4] | | | 2017 Total (Inches)[3] | Days missing in 2017 |
|---|---|---|---|---|---|---|---|
| | | | Minimum | Median | Maximum | | |
| Blue Ridge Center[5] | 2011 | Loudoun County | 31.7 | 40.7 | 50.5 | Unknown | Unknown |
| Dulles Airport | 1964 | NWS-COOP | 27.0 | 39.2 | 65.7 | 35.3 | 0 |
| Limestone Branch | 2004 | USGS | 28.0 | 38.3 | 76.1 | 37.9 | 0 |
| Lincoln | 1930 | NWS-COOP | 20.4 | 41.2 | 63.5 | 24.8 | 108 |
| Lovettsville | 2005 | USGS | 27.6 | 36.2 | 61.3 | 34.6 | 0 |
| Mt. Weather[6] | 1949 | NWS-COOP | 24.8 | 40.7 | 64.1 | 44.4 | 66 |
| Sterling RCS | 1978 | NWS-COOP | 30.3 | 42.9 | 67.7 | 46.3 | 0 |

[1] First full year that generally continuous data collection began.
[2] National Weather Service Cooperative weather station; U.S. Geological Survey; Loudoun County Government
[3] NWS-COOP stations record liquid & frozen precipitation; USGS & Loudoun stations record rainfall only.
[4] Annual precipitation statistics based on site's period of available record through 2016 (see footnote 1).
[5] Only four complete years of data (2011-2014) exists for this station. Data from 2015 and 2016 are suspect.
[6] Period of record ended October 31, 2017

Figure 4 presents annual precipitation data from the Dulles Airport from 1981 through 2017. Annual precipitation has alternated above and below the 30-year median for the last several years so that there has not been a prolonged, multi-year deficit or surplus of precipitation.

*In 2017 there were over 700,000 precipitation records collected at the seven stations.*

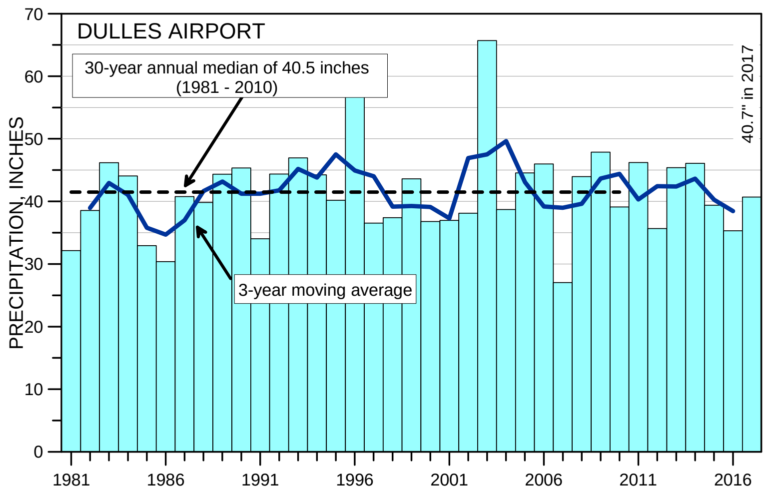



**Figure 4. Annual precipitation at Dulles Airport from 1981 through 2017.**

Figure 5 shows 2017 monthly precipitation at the Dulles Airport in relation to monthly data for the 30-year period from 1981 through 2010. The data indicate that precipitation during May and July 2017 were above normal, whereas February, June and December were below normal.

*On April 6, 2017 there was a confirmed tornado between Herndon and Sterling with estimated peak wind speed of 70 MPH. Dozens of trees were uprooted or snapped.*

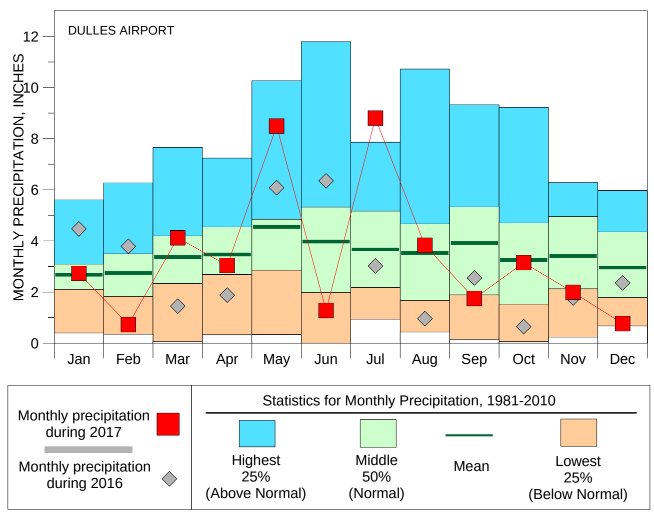



**Figure 5. Monthly precipitation at Dulles Airport.**

A graph of daily precipitation at the Dulles station is shown in Figure 6. There were five days when the precipitation exceeded 1.5 inches. Over the entire year, there were 252 days with no recorded precipitation at the Dulles station.

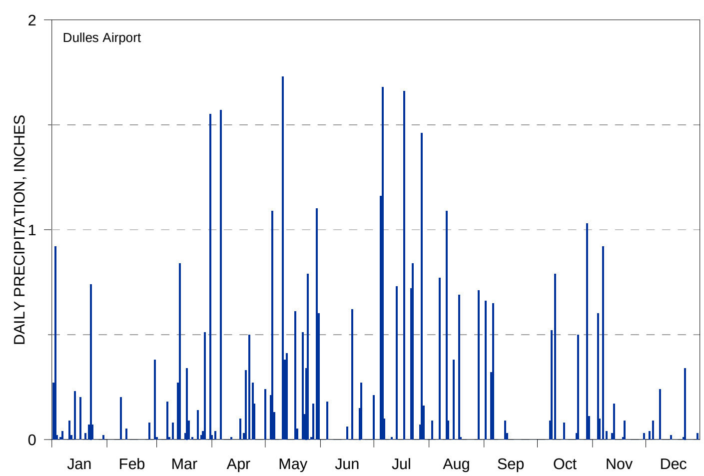



**Figure 6. Daily precipitation at Dulles Airport in 2017.**

## Snowfall

Of the total precipitation at the Dulles station during 2017-2018 season, frozen precipitation totaled 11.9 inches, which was below the normal annual total of 20.1 inches of frozen precipitation and well below the 75.1 inches in winter season 2009-2010. Note that frozen precipitation contributes to the total (liquid) reported precipitation, however, at a reduced ratio based on the characteristics of the frozen precipitation. For example, heavy snow may be a 3 to 1 ratio (3 in of snow = 1 in of water) while dry, powdery snow may be 50 to 1 or more. The total snow depths are aggregated from daily values recorded at three weather stations operated by the National Weather Services as shown in Figure 7. The average total of the three stations for each season is also shown.

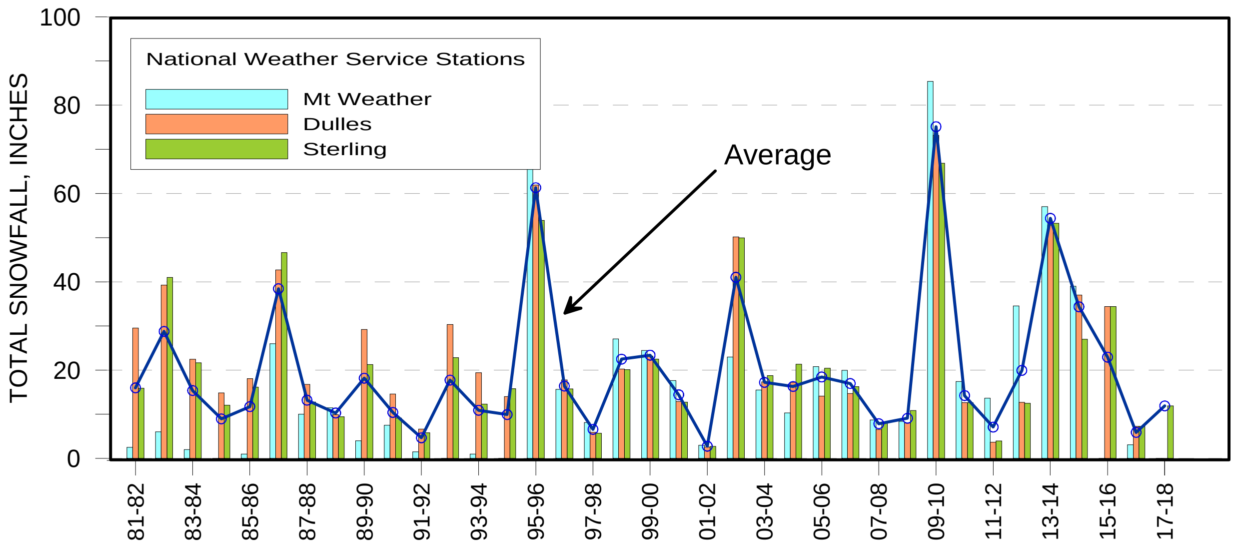



**Figure 7. Seasonal snowfall totals.**

## Streamflow

Perennial streams flow all or most of the year. In the past, the USGS has estimated that Loudoun County has approximately 507 miles of perennial streams while more recent investigations using additional data and standardized methodologies have indicated that the county may have over 1,500 miles of perennial streams. Knowing how much water flows in the larger perennial streams and how it varies over both short and long time periods is useful in the assessment of floodplains, flood control, stormwater structures, and environmental conditions. There are 10 stream gages that measure and record water stage (level) in Loudoun County streams (Figure 8). Measured water levels at each gaging station are reported via telemetry to the USGS, correlated to historical site-specific stream discharges (flows), and the data posted in near real-time with updates normally every 15 minutes. The data are available at the USGS web site for Loudoun County. Three additional stream gages are located along the county's perimeter: at Harpers Ferry and Point of Rocks on the Potomac River (both with real-time data on an internet web page) and on Bull Run near Route 705.

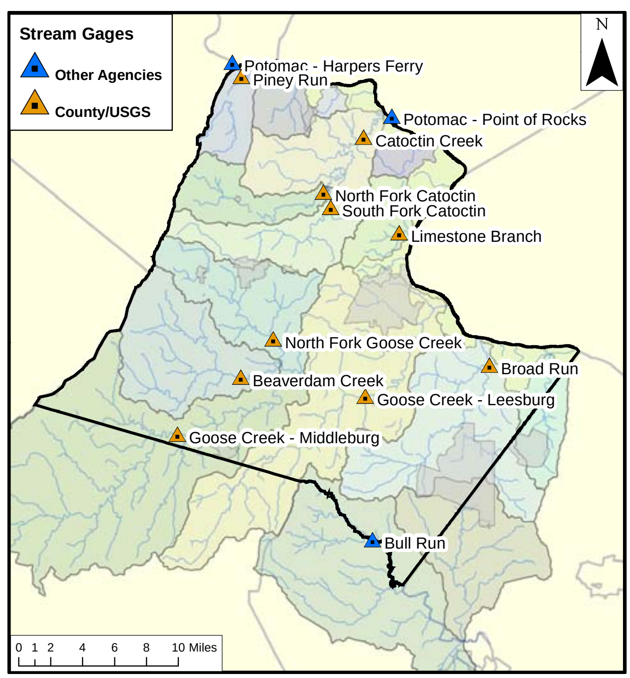



**Figure 8. Locations of stream gaging stations.**

The USGS regularly inspects the gaging stations to check the monitoring equipment and measure stream channel cross sections, water levels, and streamflow velocities in order to maintain calibration and data accuracy. However, data are considered provisional until passing the USGS's full quality control process.

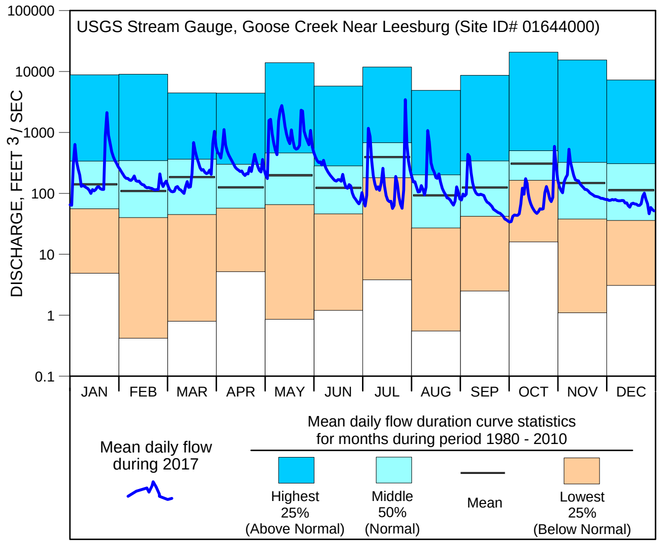



**Figure 9. Stream discharge hydrograph for Goose Creek during 2017 compared to data from 1981-2010.**

Figure 9 illustrates mean daily flow rates in Goose Creek near Leesburg during 2017 and compares it to monthly flow statistics at the same site for the period 1981 through 2010. These data indicate that streamflows were above normal for the first five months, then dropped to below normal in July and October. Spikes in streamflow are generally correlated with rainfall at Dulles Airport (Figure 6). These two monitoring sites are approximately 5 miles apart, but the upper reaches of the watershed are over 30 miles from the Dulles precipitation station. If a storm event is localized in the upper area of the watershed, it can result in a relatively high stream discharge even though reported precipitation at the Dulles site is relatively low. The highest peak stream discharge recorded in 2017 at this station occurred on July 29. Goose Creek is the County's largest stream, with its headwaters in Fauquier County, flowing across Loudoun County, and discharging to the Potomac River.

Table 2 lists the 10 gaging stations in the county along with selected data statistics. The peak flow rates for 2017 occurred on July 29 at eight of the stream gages and on May 13 for Goose Creek Middleburg and on February 4 at Catoctin Creek.

**Table 2. Stream gaging stations and basic statistics.**

| Stream Gage Site Name | Start of Record | Drainage Area[1] (sq. miles) | 2016 Avg[2] (cfs) | Previous Historic Avg[3] (cfs) | 2017 Min[4] (cfs) | Previous Historic Min[5] (cfs) | 2017 Peak[6] (cfs) | Previous Historic Peak[7] (cfs) | 2017 Non-flowing[8] (days) | Average Annual Historic Non-flowing[9] (days) |
|---|---|---|---|---|---|---|---|---|---|---|
| Beaverdam Creek | Jul 2001 | 47.2 | 40.0 | 50.4 | 4.1 | 0.0 | 804 | 5,000 | 0 | 20.0 |
| Broad Run | Oct 2001 | 76.1 | 95.0 | 126.3 | 12.7 | 1.3 | 1,420 | 10,300 | 0 | 0 |
| Catoctin Creek - Taylorstown | Oct 1970 | 89.5 | 63.0 | 102.9 | 5.6 | 0.1 | 2,070 | 6,770 | 0 | 1.5 |
| Goose Creek - Leesburg | Jul 1909 | 332.0 | 263.0 | 349.6 | 33.7 | 1.1 | 3,450 | 20,800 | 0 | 0 |
| Goose Creek - Middleburg | Oct 1965 | 122.0 | 96.1 | 134.7 | 11.8 | 0.0 | 996 | 14,000 | 0 | 4.3 |
| Limestone Branch | Aug 2001 | 7.9 | 5.1 | 8.8 | 1.2 | 0.4 | 142 | 976 | 0 | 0 |
| North Fork Catoctin Creek | Jul 2001 | 23.1 | 18.0 | 24.3 | 2.3 | 0.0 | 472 | 1,190 | 0 | 7.9 |
| North Fork Goose Creek | Jul 2001 | 38.1 | 30.0 | 46.0 | 5.9 | 0.2 | 584 | 3,040 | 0 | 0 |
| Piney Run | Oct 2001 | 13.5 | 11.0 | 14.2 | 1.7 | 0.0 | 177 | 488 | 0 | 2.1 |
| South Fork Catoctin Creek | Jul 2001 | 31.6 | 23.9 | 36.1 | 0.6 | 0.0 | 601 | 1,920 | 0 | 3.2 |

[1] Drainage area above the stream gage (square miles)

[2] Average daily flow rate during 2017

[3] Average daily flow rate for the period 2002–2016

[4] Lowest 7-day average flow rate during 2017. Note: Broad Run flow augmented by wastewater discharge up to 11 MGD starting in 2008.

[5] The lowest 7-day average flow rate for the period 2002–2016

[6] Peak daily flow rate during 2017

[7] Peak daily flow rate for the period 2002–2016

[8] Maximum number of consecutive days with very low flow (below 0.2 cfs) during 2017

[9] Maximum number of consecutive days per year with less than 0.2 cfs flow during the period 2002–2016

## Groundwater Levels and Wells

There are more than 19,000 active individual water supply wells throughout Loudoun County. Groundwater is the primary source of drinking water for the majority of residents in western Loudoun. Groundwater levels during 2017 were recorded at 14 of 16 dedicated monitoring wells at the sites shown in Figure 10. Sixteen of these wells are operated by staff from the Department of Building and Development and three are operated by the USGS. Groundwater level data have been collected from the three USGS wells since the late 1960s or early 1970s. Most of the County-monitored wells were established as monitoring sites within the past decade, with one well dating back to 2002. Table 3 lists the monitoring wells, basic information about each well, and groundwater level data for both 2017 and the well's historic record.

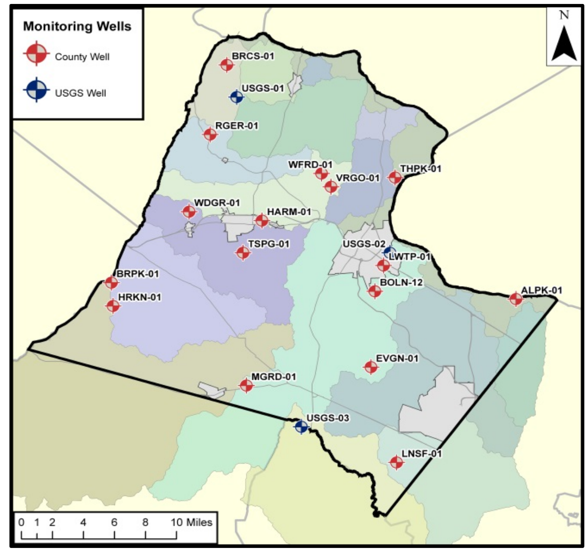



**Figure 10. Locations of groundwater monitoring wells.**

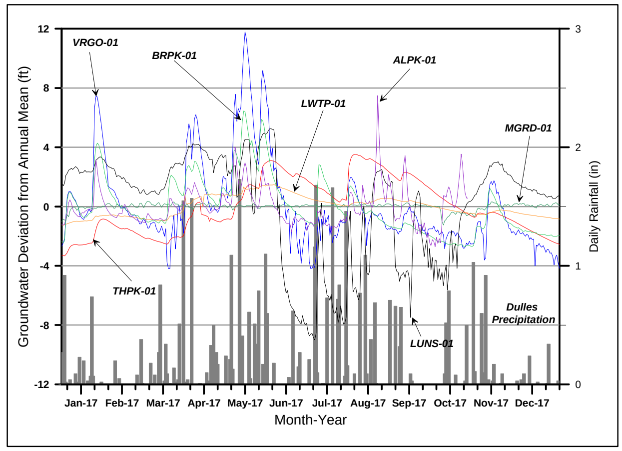
**Table 3. Monitoring wells and groundwater level data for 2017.**

| Well Site ID (see map for location) | Monitoring Organization | Well Depth (feet) | Rock Type | Period of Record | Groundwater Level (feet)[1, 2] | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Historic High | 2017 High | Historic Low | 2017 Low |
| *USGS-01* | USGS | 516 | Meta-conglomerate/ metasiltstone | 8/1969 - Present | 1015.9 | 1011.4 | 1000.3 | 1001.6 |
| *USGS-02* | USGS | 535 | Fluvial, deltaic sandstone | 10/1977 - Present | 364.6 | 363.5 | 342.0 | 344.7 |
| *USGS-03* | USGS | 165 | Siltstone/sandstone | 11/1968 - Present | 416.5 | 415.8 | 409.9 | 410.8 |
| BOLN-12 | Loudoun | 515 | Fluvial, deltaic sandstone | 12/2006 - 12/30/2016 | 340.3 | NA | 333.2 | NA |
| BRCS-01 | Loudoun | 320 | Igneous intrusive | 12/2007 - Present | 548.6 | 545.2 | 537.5 | 542.6 |
| HARM-01 | Loudoun | 945 | Plutonic igneous intrusive | 2/2005 - 4/12/2017 | 501.1 | 497.2 | 463.6 | 493.0 |
| MGRD-01 | Loudoun | 400 | Plutonic igneous intrusive | 12/2007 - Present | 483.1 | 477.9 | 470.6 | 476.3 |
| RGER-01 | Loudoun | 700 | Igneous intrusive | 2/2005 - Present | 646.9 | NA | 620.2 | NA |
| TSPG-01 | Loudoun | 360 | Plutonic igneous intrusive | 2/2005 - Present | 434.7 | NA | 419.9 | NA |
| WDGR-01 | Loudoun | 940 | Mafic igneous intrusive | 3/2005 - Present | 618.4 | 609.8 | 602.2 | 605.2 |
| WFRD-01 | Loudoun | 400 | Plutonic igneous intrusive | 11/2002 - 9/27/2016 | 421.9 | NA | 400.1 | NA |
| BRPK-01 | Loudoun | 680 | Igneous intrusive | 7/2009 - Present | 1668.5 | 1664.6 | 1649.3 | 1655.4 |
| THPK-01 | Loudoun | 360 | Limestone conglomerate | 7/2009 - Present | 222.3 | 196.6 | 188.3 | 189.8 |
| ALPK-01 | Loudoun | 240 | Alluvium/metasiltstone | 7/2009 - Present | 187.1 | 180.9 | 152.3 | 175.1 |
| HRKN-01 | Loudoun | 600 | Plutonic igneous intrusive | 3/2009 - Present | 645.4 | 641.6 | 632.0 | 636.5 |
| VRGO-01 | Loudoun | 300 | Igneous intrusive | 3/2009 - Present | 529.9 | 522.1 | 504.5 | 506.1 |
| EVGN-01 | Loudoun | 320 | Diabase | 3/2009 - Present | 321.8 | 320.5 | 312.9 | 316.7 |
| LNSF-01 | Loudoun | 322 | Hornfels | 8/2013 - Present | 286.9 | 285.5 | 269.0 | 271.2 |
| LWTP-01 | Loudoun | 250 | Metasiltstone | 3/2009 - Present | 246.0 | 241.7 | 203.0 | 238.9 |

[1] Elevation above mean sea level. [2] Historic data highs and lows are during the period of record through 2016.

In 2016, ground surface elevation were revised to 1-meter DEM derived from 2012 LiDAR.

Figure 11 shows hydrographs for selected monitoring wells that are representative of groundwater levels in the county for calendar year 2017. Short-term natural increases in groundwater levels occur because of recharge from precipitation. In the absence of additional recharge from precipitation and outside influences such as nearby pumping, groundwater levels normally exhibit a steady, slow decline over time after rain events. Groundwater levels are typically highest in late spring/early summer and lowest in late fall/early winter. Assuming normal precipitation patterns, this is due to greater recharge to the groundwater system during cooler winter/spring weather when evapotranspiration is low, thereby allowing more water to infiltrate downward to the water table.




Record period from Jan. 2017 through Dec. 2017
Source: Loudoun County Dept. of Bldg. & Dev.

**Figure 11. Groundwater levels from selected County monitoring wells.**

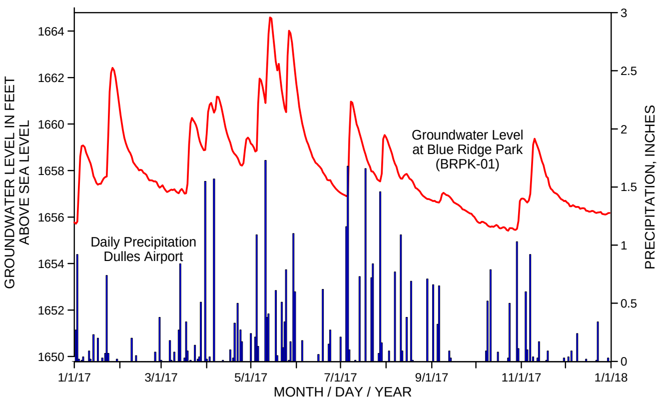



**Figure 12. Groundwater hydrograph and daily rainfall in 2017.**

Figure 12 shows a hydrograph from the monitoring well at Blue Ridge Park and daily rainfall from the Dulles rain gage. Both data sets are during 2017 and show the response of groundwater levels to precipitation events. Note that during late summer, when conditions are generally dryer and evapotranspiration is highest, response to even significant rain events will produce only subtle increases in groundwater level.

During 2017, 156 new water supply wells were constructed. Figure 13 presents the number of wells drilled each year since 1980. The installation of new wells is primarily driven by the pace of residential construction and, occasionally, zoning changes affecting residential development potential. As occurred during the previous ten years, the number of new wells drilled in 2017 remained relatively low. The median total depth of wells installed in 2017 was 440 feet with the depths ranging from 160 to 1,060 feet. The median estimated yield (based on air-lift pumping) was 10.0 gallons per minute with yields ranging from 0.15 to 191 gallons per minute.

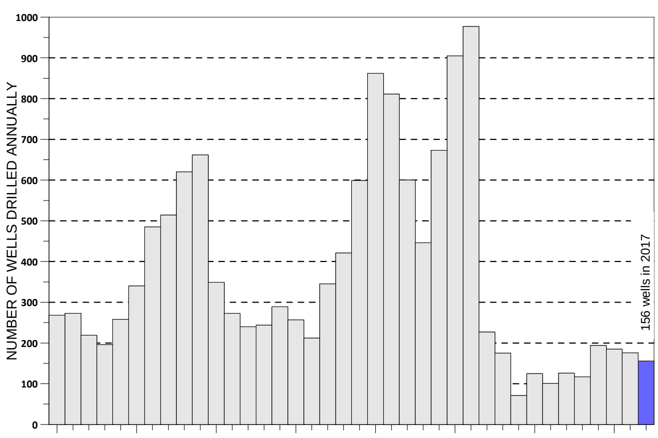



**Figure 13. Number of wells constructed in Loudoun County between 1980 and 2017.**

*The median depth of wells drilled in Loudoun County has increased from 150 feet during 1960 to 1970 to 420 feet since 2000. The increase has been possible because of advances in drilling technology, allowing wells to be drilled cheaper, quicker and deeper to provide increased water storage.*

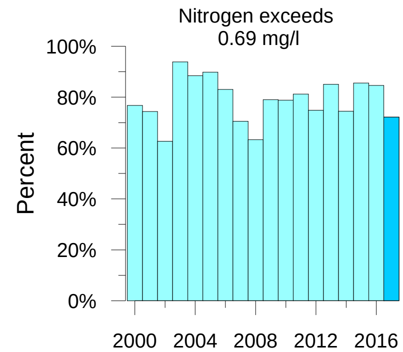
## WATER QUALITY

The quality of surface water in Loudoun County was quantified in 2017 using several metrics including chemical, microbiological, and benthic macroinvertebrates. Groundwater quality was assessed through chemical and bacteria analyses conducted on well water samples. Monitoring results from each of these data types are discussed below.

### Surface Water Chemistry

Chemical sampling and analysis of surface water in 2017 was primarily conducted by the Virginia Department of Environmental Quality (DEQ) as part of their state-wide surface water quality sampling program.

In 2017, DEQ collected samples from 19 sites and conducted 86 and 72 analyses of nitrogen and phosphorous respectively from the watersheds of Loudoun County (some watershed boundaries extend beyond the County's boundaries). Nutrient enrichment has been identified as a major cause of the reported stream impairments nationwide and can lead to low dissolved oxygen, fish kills, shifts in flora and fauna and blooms of nuisance algae. Figure 14 illustrates the results of sampling by DEQ for nitrogen and phosphorus in the surface waters from the watersheds of Loudoun County during 2017. Note that in 2017 four measurements on Limestone Branch (1ALIM001.16) averaged 1.8 mg/l nitrogen which is more than twice the criteria for nitrogen and averages 0.25 mg/l phosphorous which is almost 7 times the criteria.



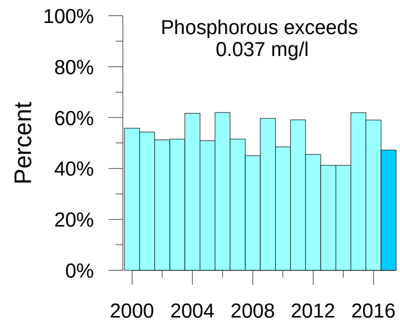




**Figure 14. Nutrient concentrations as percent of samples exceeding EPA guidance thresholds from 2000 to 2017.**

In 2000, the U.S. Environmental Protection Agency (EPA) developed ambient water quality criteria recommendations and information for 14 nutrient eco-regions in the continental United States. Individual states could adopt the criteria developed by EPA or elect to develop their own criteria and methodologies. Virginia has been working on a methodology to evaluate nutrient stress in wadeable streams since that time. As shown in Figure 14, the percent of stream samples which exceed the threshold levels for nitrogen and phosphorous between 2000 and 2017 are shown. In 2017, approximately 72 percent and 47 percent of the samples collected by DEQ contained nitrogen and phosphorus concentrations above the 0.69 mg/L and 0.037 mg/L EPA guidance criteria, respectively.

### Surface Water Microbiology

The primary microbiological area of concern for surface water relates to pathogens that may adversely affect human health. An accepted practice to test for pathogens from human and warm-blooded animal waste is to test water for *Escherichia coli* (*E. coli*) bacteria as an indicator of waste contamination. EPA uses *E. coli* concentrations as an indicator of whether the water is considered safe for humans after casual contact. This criterion is identified by EPA as "recreational use" and includes activities such as swimming, fishing and boating.

In 2017, DEQ collected and analyzed 72 samples from the watersheds of Loudoun County and found that approximately 46 percent were above the recreational limit of 235 *E. coli* colonies per 100 milliliters. Stream segments that are tested and exceed the recreational use criteria more than 10.5 percent of the time may be identified as "impaired" by DEQ. Using a similar approach, Table 4 summarizes the number of sites in which more than 10.5 percent of the samples exceeded the recreational limit over the last 9 years. Several programs are in place to reduce bacterial contamination in the impaired surface waters of Loudoun County including initiatives to repair or upgrade on-site wastewater treatment systems (e.g., septic systems and drain fields), reduce pet waste, and fence livestock out of streams.

**Table 4. Summary of surface water microbiological testing by DEQ.**

| Year | Number of Samples | Number of Monitoring Sites[1] | Number of Sites Exceeding[2] | Percent Sites Exceeding[3] |
|---|---|---|---|---|
| 2009 | 101 | 16 | 13 | 81% |
| 2010 | 122 | 20 | 8 | 90% |
| 2011 | 124 | 24 | 19 | 85% |
| 2012 | 117 | 24 | 19 | 79% |
| 2013 | 136 | 20 | 19 | 95% |
| 2014 | 62 | 10 | 8 | 80% |
| 2015 | 118 | 16 | 15 | 94% |
| 2016 | 123 | 14 | 12 | 86% |
| 2017 | 72 | 13 | 6 | 46% |

[1] Limited to stations with 6 or more samples annually.

[2] Exceeds recreational use criteria for *Escherichia coli* in more than 10.5% of the samples .

3 Percent of the sites when more than 10.5% of samples exceeded recreational use criteria.

## Benthic Macroinvertebrates

Benthic macroinvertebrates are stream bottom-dwelling invertebrate organisms (mostly insect larvae) that can be seen without magnification. Their tolerance of poor water quality varies depending on the species and, as a result, these organisms are used as indicators of water quality.

Sampling a stream for benthic macro-invertebrates usually involves collecting all the organisms within a small area of the stream bottom, identifying the types of organisms collected to the order, family or genus taxa level, and counting the number of each type. These results are then converted to a "macroinvertebrate score" which is used to qualitatively grade the water quality. In 2017, two techniques were used to evaluate the benthic macro-invertebrate populations: the Virginia Stream Condition Index (VA SCI) at both the family and genus level used by DEQ and the Virginia Save Our Streams (VA SOS) index used by several citizen volunteer organizations in and adjacent to the county.

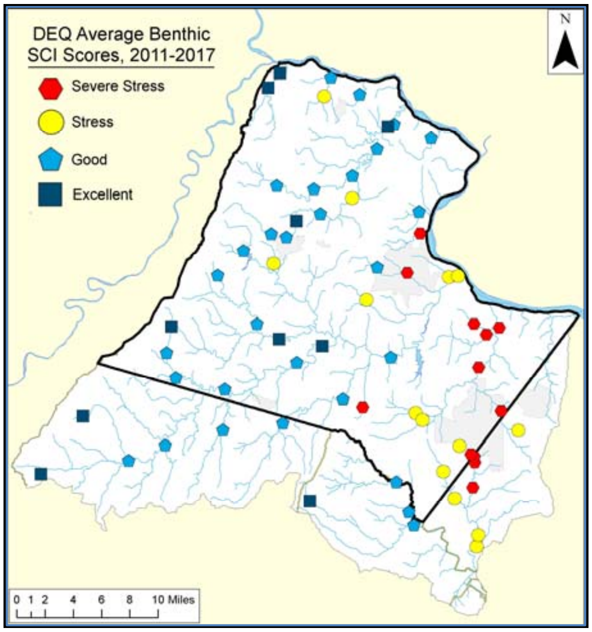



**Figure 15. Summary of DEQ benthic monitoring results.**

During the period 2011 through 2017, DEQ sampled a total of 187 times at 67 locations in Loudoun and calculated VA SCI scores which ranged from Severe Stress to Excellent. Figure 15 illustrates the average stream conditions from benthic samples collected by DEQ between 2011 and 2017 where the annual average number of stations was less than 27.

Several volunteer organizations in Loudoun Watershed Watch collect benthic macro-invertebrate data. From 2011 through 2017, Loudoun Wildlife Conservancy, Goose Creek Association, and other volunteer groups collected 137 samples from approximately 56 locations using the VA SOS methodology. Results ranged from Acceptable to Unacceptable as shown in Figure 16.

*Benthic macroinvertebrate species vary in their tolerance of poor water quality. Monitoring benthic populations is an efficient way for professionals and volunteers to assess one aspect of stream water quality.*

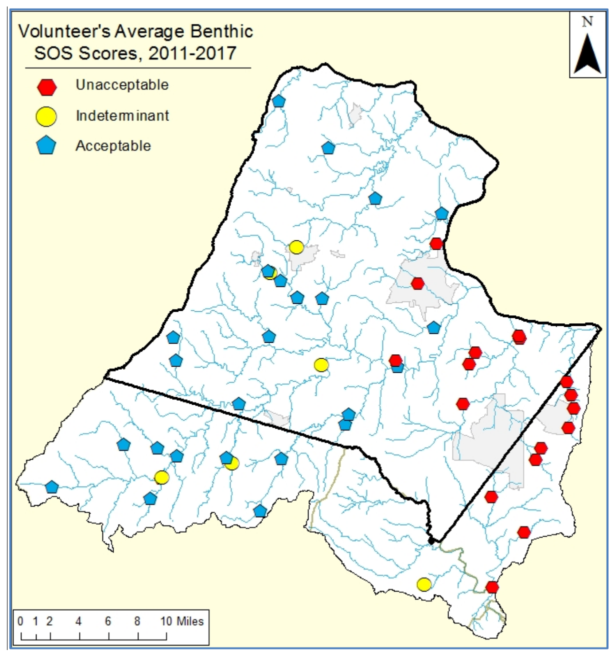



**Figure 16. Summary of volunteer benthic monitoring results.**

## Stream Impairments

Each year, DEQ tests a statistically significant fraction of Virginia's streams, rivers, lakes, and tidal waters as part of their water quality assessment program. Over 130 different pollutants are monitored to determine whether the waters can be safely used for swimming, fishing and drinking. Waters that do not meet the adopted standards are reported to EPA in the Clean Water Act 303(d) Impaired Waters Report. DEQ has developed lists of impaired waters every even calendar year since 1992. In Loudoun County, DEQ water quality impairments have included:

- aquatic life (benthic macroinvertebrates)
- recreational/swimming (bacteria)
- fishing/consumption (tissue analysis)

In the latest report, there were over 200 stream miles in Loudoun County identified as impaired for one or more criteria. Listing a stream as "impaired" begins a multi-year process of identifying pollution sources, determining appropriate pollution loadings, and designing and implementing corrective measures. Figure 17 through Figure 20 illustrate the impairments for aquatic life use, recreational/ swimming use, fish consumption and public water supply, respectively. The most recent EPA 305(b)/303(d) Water Quality Assessment Integrated Report is for 2016 which was approved on March 6, 2018.

*Surface water quality impairments are reported to the Environmental Protection Agency every two years by the Virginia Department of Environmental Quality (DEQ). The FINAL 2016 305(b)/303(d)* Water Quality Assessment Integrated Report *(Integrated Report) summarizes the water quality conditions from Jan. 1, 2009, to Dec. 31, 2014.*

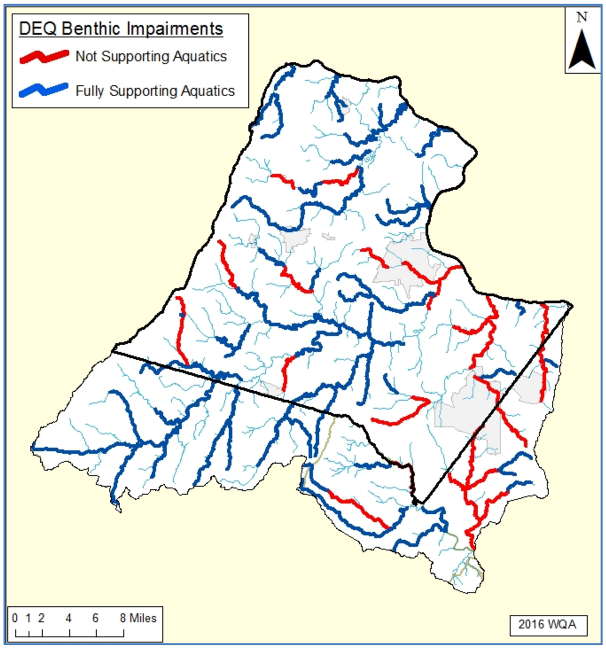



**Figure 17. Aquatic life use (benthic macroinvertebrates) impaired stream segments.**

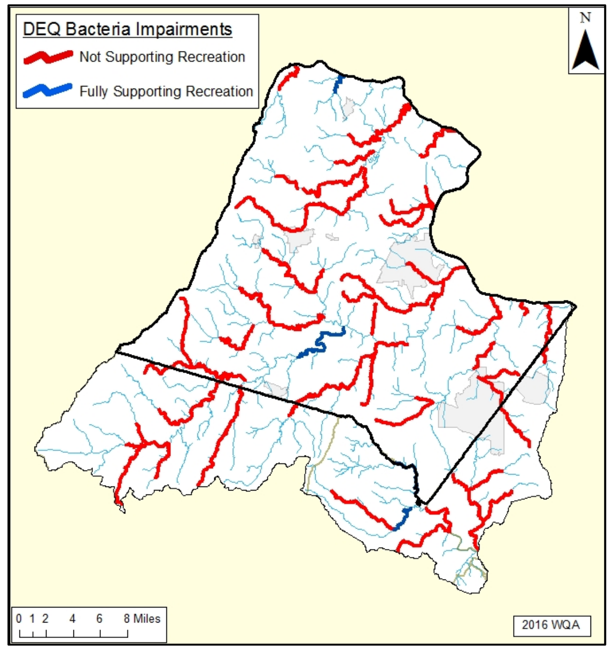



**Figure 18. Recreational/swimming use (bacteria) impaired stream segments.**

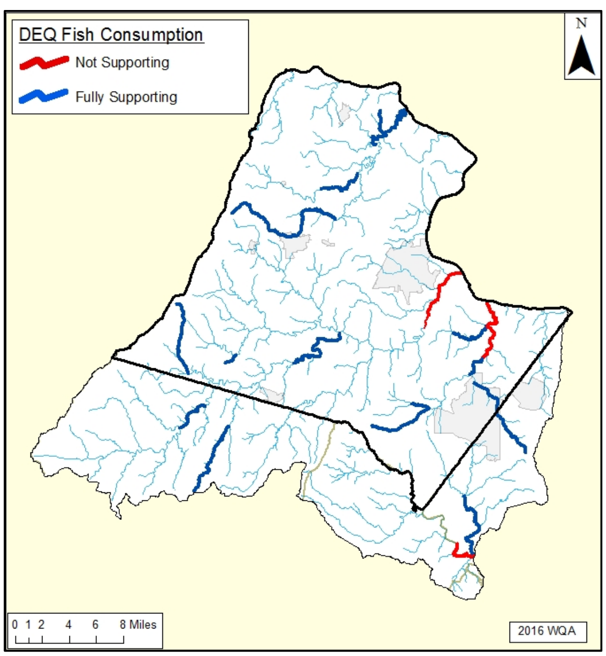



**Figure 19. Fish consumption use (PCB and mercury in fish tissue) impaired stream segments.**

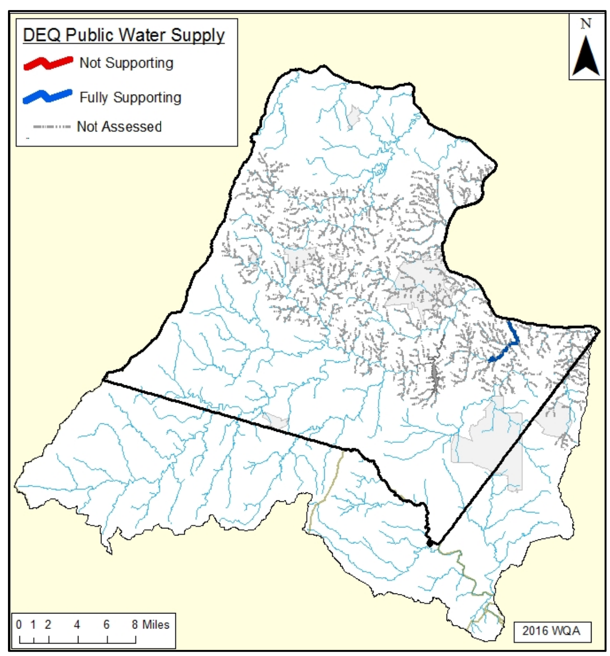



**Figure 20. Public water supply use (chemicals) impaired stream segments.**

## Groundwater Quality

Groundwater is the source of drinking water for most of Loudoun County outside of Loudoun Water's central service area (see Figure 1) and the Town of Leesburg. Information on groundwater quality is obtained from several sources. Before new potable water wells can be used, they must be tested and pass drinking water quality standards for a wide range of chemical parameters listed by the County Health Department. In 2017, groundwater samples collected and analyzed from new wells were generally consistent with historical data (Table 5). There are large areas of the county that have elevated levels of iron and manganese; aesthetic contaminants that do not adversely affect human health at the concentrations found in the county. In general, groundwater quality in the county is good.

### Table 5. Statistics for selected groundwater chemistry parameters.

**Table 5. Results of Water Quality Analyses. All records vs. 2017.**

| Analyte | MCL(mg/L) | Samples | | # above MCL | % above MCL |
|---|---|---|---|---|---|
| Nitrate | 10 | *All* | 4461 | 25 | 0.6% |
| | | *2017* | 100 | 0 | 0.0% |
| Sulfate | 250 | *All* | 4521 | 16 | 0.0% |
| | | *2017* | 100 | 0 | 0.0% |
| Lead | 0.015 | *All* | 4425 | 44 | 1.0% |
| | | *2017* | 99 | 0 | 0.0% |
| Fluoride | 4 | *All* | 4435 | 10 | 0.2% |
| | | *2017* | 100 | 0 | 0.0% |
| Arsenic | 0.01 | *All* | 4420 | 17 | 0.0% |
| | | *2017* | 99 | 0 | 0.0% |
| Manganese | 0.05* | *All* | 4516 | 2975 | 65.9% |
| | | *2017* | 100 | 62 | 62.0% |
| Iron | 0.3* | *All* | 4527 | 3136 | 69.3% |
| | | *2017* | 100 | 68 | 68.0% |
| TDS | 500* | *All* | 4004 | 31 | 0.0% |
| | | *2017* | 0 | 0 | 0.0% |

* Secondary MCL for taste, color, and odor.

There are a few isolated locations in the County where significant groundwater contamination is known to exist. The most notable location is the Hidden Lane Landfill in northeast Loudoun, which was placed on the EPA's National Priorities List (Superfund). The EPA has developed fact sheets to update citizens on clean-up and investigation activities at the site. The latest Hidden Lane fact sheet and more information can be found by visiting the EPA web site.

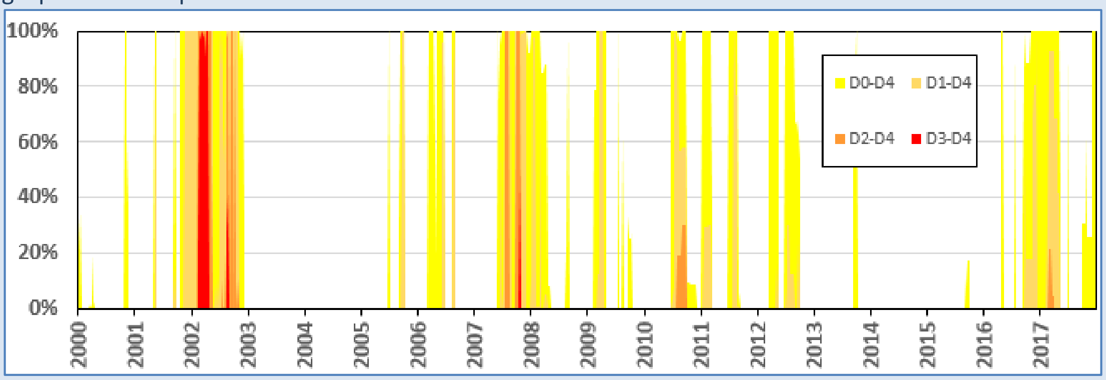
The most prevalent sources of potential groundwater pollution are the on-site wastewater treatment systems (OWTS) serving homes and small businesses in the rural areas of the county. There are approximately 17,377 active OWTSs in the county and during 2017, 170 new OWTSs were installed of which 60 were alternative. An OWTS that is properly installed and serviced should not pose a threat to groundwater quality. However, improper OWTS installation or maintenance can cause wastewater to be untreated or undertreated and lead to groundwater or surface water contamination. Because OWTSs are typically used in areas with private water wells, it is important to properly maintain the OWTS and regularly have the well water sampled and tested to assure that it is safe to drink. The Loudoun County Department of Environmental Health can provide information on maintenance and testing of private water wells and OWTSs (703-777-0234 and www.loudoun.gov/onsite).

*Of the 100 groundwater samples reported in 2017, no samples had individual analyte concentrations higher than the EPA Maximum Contaminant Level (MCL). Only secondary MCL for manganese and iron were exceeded. Groundwater quality in Loudoun is generally good, but these data show why private drinking water well owners should have their well water tested regularly to assure that the water is safe to consume.*

## *WATER RESOURCES 2017 HIGHLIGHT:*

The Unites States Geologic Survey (USGS) developed equations which help predict the probability or likelihood of a summer drought based on streamflow readings from the previous winter months. Loudoun County has ten stream gages in which three have long-term records of several decades. The USGS approach uses the approach of maximum likelihood logistical regression (MLLR). The maximum likelihood logistic regression models identify probable streamflow from 5 to 8 months in advance. These model equations produce summer month (July, August, and September) drought flow threshold probabilities as a function of streamflow during the previous winter months (November, December, January, and February).

One of the more significant recent droughts in Loudoun County was in 2002 as shown in the graphic which spans 2000 to 2018.




| Category | Description | Possible Impacts |
|---|---|---|
| D0 | Abnormally Dry | Going into drought:<br>▪ short-term dryness slowing planting, growth of crops or pastures<br>Coming out of drought:<br>▪ some lingering water deficits<br>▪ pastures or crops not fully recovered |
| D1 | Moderate Drought | ▪ Some damage to crops, pastures<br>▪ Streams, reservoirs, or wells low, some water shortages developing or imminent<br>▪ Voluntary water-use restrictions requested |
| D2 | Severe Drought | ▪ Crop or pasture losses likely<br>▪ Water shortages common<br>▪ Water restrictions imposed |
| D3 | Extreme Drought | ▪ Major crop/pasture losses<br>▪ Widespread water shortages or restrictions |
| D4 | Exceptional Drought | ▪ Exceptional and widespread crop/pasture losses<br>▪ Shortages of water in reservoirs, streams, and wells creating water emergencies |

Drought conditions peaked in March 2002, where of Loudoun County was nearly all classified as D3-D4 which is described generically as widespread water shortages and major crop/pasture losses. By the September 2002, the D3-D4 conditions persisted in over 40% of the County.

*Austin, S.H., 2014, Methods for estimating drought streamflow probabilities for Virginia streams: U.S. Geological Survey Scientific Investigations Report 2014–5145, 20 p., http://dx.doi.org/10.3133/sir20145145.*

# 2017 – Moment to Remember

**The Family of Five Rescued From Goose Creek Reservoir Dam**

Ashburn, VA. - At approximately 5:30pm, Monday April 10th, 2017, the Loudoun County Emergency Communications Center received a call from an individual stating he and his family were stranded in a boat on top of the Goose Creek Reservoir Dam. The motor on the small fishing boat had failed leaving them to drift and ultimately stop atop of the 20ft dam with a portion of the boat hanging over the edge of the dam. The Goose Creek.

Fire and Rescue units from Ashburn, Lansdowne and Leesburg were dispatched along with rescue boats from Leesburg, Cascades and Lucketts. When the first unit arrived they found a small boat teetering precariously on the edge of the 20ft. dam. The boat was occupied with two adults and three small children. The swift moving current made the boat very unstable and all the occupants were seated in the bow of the boat to keep it from falling over the dam. With the exception of one adult, all were wearing life vests.

Initial attempts to reach them using an aerial ladder were unsuccessful as the stranded boat was too far from shore, however first responders were able to successfully deploy an additional lifejacket to the stranded vessel using a throw rope from the end of the aerial device. Crews were also deployed downstream with rescue equipment in the event that the vessel fell over the Dam. Upon arrival of the water rescue team, a boat and crew quickly launched and made their way out to the stranded family. Rescuers connected a tow rope to the fishing boat and pulled the family safely to shore. Once on land, each of the family members were evaluated by Emergency Medical Technicians and found to be without injury.

Chief Keith Brower praised the work of the rescue crews. “Swift water rescue incidents are among the most dangerous activity we perform. In this case, five lives were saved due to the combined efforts of the men and women of our Fire and Rescue System. I am extremely proud of their efforts.” Reservoir Dam is located just upstream from the Luck Stone Quarry off of Belmont Ridge Road. ***Photo courtesy of LCFR.***