

As the climate continues to change, in the next 30 years Columbia communities are likely to face vulnerabilities related to...

Drinking water supply and drought



Vulnerability Ranking

While warming temperatures, increasing drought, and other changes in precipitation may limit water resources and increase demand, Columbia's water supply is likely sufficient to meet demands even under future conditions, though investments may be needed to expand water infrastructure.

> MEDIUM-HIGH

Surface water quality



LOW-MEDIU

More heavy rain events will likely negatively impact water quality in Columbia's streams and lakes, which could harm habitats and limit recreational opportunities. However, Columbia's drinking water supply is largely protected from stormwater pollution due to the local groundwater hydrology.

Drinking water quality



Since Columbia's drinking water source is well-protected from stormwater pollution, it is unlikely to be harmed by more heavy rain events in the future. While the city's drinking water currently exceeds quality standards, some activities unrelated to climate change may pose a degree of contamination risk.



Drinking water supply and drought

Columbia residents use approximately 5 billion gallons of drinking water each year. Since the early 1970s, the city's total daily demand for water, on average, has gradually increased by about 7 million

gallons partly due to more customers as the city's population has grown [1]. However, the increase in demand has been contained thanks to water conservation efforts, as the average Columbia resident now uses less water per day than in the past [1].

Columbia draws its water supply for residential, commercial, and irrigation uses entirely from the McBaine aquifer—a portion of the Missouri River alluvial aquifer that is located in an area protected by a levee system managed by the McBaine Levee District. Columbia's annual use is about one-tenth of the 44 billion gallons of water stored in the McBaine aquifer [2]. Columbia pumps its

water from the aquifer through 15 wells dispersed across an area known as the McBaine Bottoms and treats the water before delivering it to residents [2]. But the geology of the aquifer makes some of the water inaccessible—meaning there is a natural limit to drinking water supply from the aquifer. In addition, as we withdraw water from the McBaine aquifer, it has to be regularly re-charged or replaced by precipitation, the Missouri River, and other surface waters [3].

The Missouri River and its floodplain also provide water for over half of Missouri residents, not to mention the residents in the nine other states that are partially or fully located in the Missouri River watershed [4]. Withdrawing water from the river for different needs—from residential drinking water to agricultural irrigation—must be balanced with keeping water in the river for downstream communities, groundwater recharge, and other natural ecosystem functions.

Water Supply and Quality

Although Columbia considers its current supply reliable and the City has a backup storage of water for emergencies, Columbia's water demand is projected to grow in the future [5]. By 2040, peak daily water demand is expected to be nearly twice as much as the demand in 2016 [1]. Climate change will also bring new risks. For example:

- Increasing drought: In the future, as summer drought becomes more common across Missouri and the Midwest, water management in the Missouri River watershed will become more challenging [6]. Under drier conditions, there may be less water available in reservoirs along the Missouri River and its tributaries, which are important to managing streamflow and contribute to recharging of the McBaine aquifer [4]. The change in precipitation patterns may also reduce aquifer recharge. The result may be limitations on Columbia's water supply, meaning less water may be available for the community's irrigation needs in the summer.
- Warmer temperatures: By the 2050s, average temperatures in Columbia will be regularly above what has been considered normal since 1970 [7]. Warmer temperatures will increase evaporation of surface water, reduce soil moisture, and increase demand for irrigation.
- Heavier rain events: Projections of future precipitation show that we can expect more frequent heavy rain events [7]. These events may pose a higher risk of flooding, which can damage water infrastructure and disrupt the delivery of drinking water to residents. Although the City's water production plant and wells are protected by levees that are actively managed and have already undergone upgrades to protect against flooding, they are still vulnerable to extreme flooding events like those that occurred in 1993. In addition, flooding can damage or inundate roads, limiting access to these facilities.

As water demand increases and climate change impacts may place more stress on infrastructure and facilities, it is important for regular maintenance and improvements to be completed to maximize efficiency and supply. To this end, the City assessed the condition of infrastructure at the McBaine Water Treatment Plant, well field, and the West Ash Booster Pump Station in 2016 and incorporated the needed equipment replacements and upgrades identified in the assessment into the water utility's capital improvement plan.

Three types of customers in Columbia have the greatest water needs and may be negatively impacted by water supply constraints: 1) industrial customers, such as Columbia Foods, 3M, and Linen King; 2) hospitals and healthcare facilities, including Boone Hospital and the Veterans Administration Hospital; and 3) educational facilities, including Columbia Public Schools and The University of Missouri.



Water Supply and Quality

Surface water quality

Columbia's nearby surface water bodies include over 100 lakes and approximately 300 miles of streams, including its six major streams: Hinkson Creek, Hominy Branch, Grindstone Creek, Gans Creek, Little

Bonne Femme, and Flat Branch [8].

When precipitation does not soak into the ground, it runs off as stormwater into Columbia's storm drain pipes and is discharged into the nearest waterway, such as Hinkson Creek, Flat Branch Creek, or Bear Creek-all of which eventually flow into the Missouri River. This stormwater is not treated, meaning that any oil, grease, pet waste, chemicals, fertilizers, and other pollutants on roads, sidewalks, lawns, and the urban landscape can potentially contaminate our waterways, decreasing surface water quality. Some of the streams running through Columbia, including Hinkson Creek, Hominy Branch, and Gans Creek, as well as some lakes have been designated as impaired waterways by the U.S. Environmental Protection Agency due to water quality concerns [8]. Restoring these waterways to a better condition is essential to supporting vibrant, healthy ecosystems as well as healthy human populations. To reduce pollution from stormwater runoff and protect surface water quality, the City of Columbia, Boone County, and the University of Missouri work together to develop, implement, and enforce a stormwater management program and plan.

As the climate changes, more heavy rain events in Columbia may increase the risk of pollution from stormwater runoff, which is expected to wash more nitrogen and phosphorus from agriculture and other activities into nearby streams and lakes, contributing to more algal growth that can be toxic [9]. Heavier rain may cause flooding, which can also increase the risk of surface water pollution by causing overflows at waste treatment plants. These impacts could potentially expose more people to contaminated water in their recreational use of streams and lakes. Exposure to contaminated water may lead to increased incidents of waterborne diseases.

Heavier rain events may also destabilize and erode stream banks, especially if there is little vegetation to hold the soil in place. Erosion causes sediment to enter streams, reducing surface water quality and harming habitats.



Drinking water quality

Columbia's drinking water supply is largely protected from stormwater pollution due to the groundwater hydrology of the McBaine Aquifer, which collects water from precipitation that has

been naturally filtered through the Earth's surface. The current quality of Columbia's drinking water exceeds the federal standards for lead, copper, fluoride, and other regulated substances [10]. However, several activities and infrastructure unrelated to climate change pose a contamination risk, including tampering with wells, seepage from the city's wastewater treatment discharge wetlands, petroleum pipelines running through the well field, and land use activity [11].





City spotlight: Hinkson Creek

Hinkson Creek flows through Columbia. It has experienced water quality problems like those in other urban area streams; these include contamination from urban stormwater flows and siltation from nearby construction sites [12]. In some places, particularly in the upper watershed, its banks have been scoured by high-velocity flows after heavy rains, which is expected to occur more often as the climate changes [13].

The University of Missouri has hosted a monitoring project on the creek. Climate stations, stream gauges, and sediment samplers were put on five bridges [12]. This project was aimed at helping to understand how Hinkson Creek responds to precipitation events. This kind of information will be useful for better understanding how the creek and surrounding areas will be impacted by climate change in addition to land use change.

Today, an effort is underway to improve water quality in Hinkson Creek by using a science-based approach guided by a local stakeholder committee. It assesses the entire stream system, including the creek and other parts of the watershed. Improving the ecosystem should help support the return of the biological community to a fully functioning level as well as address other pollutants that may be contributing to water

quality issues. A Collaborative Adaptive Management (CAM) approach is being used to allow a wide range of actions to be investigated. Each of these actions is expected to contribute to reaching the water quality goals; some of these activities may reduce peak stormwater runoff, others may reduce the pollution in the runoff; both can contribute to the solution by improving the water quality and supporting the biological community. By learning as we implement actions, we hope to find the most effective approaches to address the water quality challenges in the watershed.

References

- [1] City of Columbia Water and Light Department, "Integrated Water Resource Plan, Final Report, Draft," 2017.
- [2] G. Grigsby, "The geology behind Columbia's water supply," KBIA News, 1 April 2014. [Online]. Available: http://kbia.org/post/ geology-behind-columbias-water-supply#stream/0.
- [3] B. Smith, "Ground-Water Flow and Ground- and Surface-Water Interaction at McBaine Bottoms, 2000-02," U.S. Geological Survey, 2002.
- [4] MOGreenStats: Missouri's Environmental Statistics, "Will Climate Change Affect Water Supply on the Missouri River?," 22 June 2017. [Online]. Available: https://mogreenstats.com/2017/06/22/will-climate-change-affect-water-supply-on-the-missouririver/. [Accessed 23 March 2018].
- [5] J. Lu, "City backs off storage of drinking water in underground aquifer," Missourian, 11 January 2016.
- [6] U.S. Environmental Protection Agency, "What Climate Change Means for Missouri," 2016.
- [7] C. J. Anderson, J. Gooden, P. E. Guinan, M. Knapp, G. McManus and M. D. Shulski, "Climate in the Heartland: Historical Data and Future Projections for the Heartland Regional Network," Urban Sustainability Directors Network, 2015.
- [8] City of Columbia, Missouri, "Technical Memorandum 1: Surface Water Quality and Biological Conditions, Columbia Wastewater and Stormwater Integrated Management Plan," Columbia, Missouri, 2017.
- [9] E. Sinha, A. M. Michalak and V. Balaji, "Eutrophication will increase during the 21st century as a result of precipitation changes," Science, vol. 357, no. 6349, pp. 405-408, 2017.
- [10] Columbia Water and Light, "2016 Water Quality Report," Columbia, Missouri, 2016.
- [11] City of Columbia Source Water Protection Task Force, "Source Water Protection Plan for the City of Columbia, Missouri," 2013.
- [12] Hinkson Creek Watershed Restoration Project, Phase II, "Hinkson Creek Watershed Management Plan," Columbia, MO, 2010.
- [13] Boone County, "Headwaters of Hinkson Creek," [Online]. Available: http://boonecountymogis.maps.arcgis.com/apps/MapTour/ index.html?appid=bf7c9ef678494abca21b655bc6a18cee. [Accessed 27 April 2018].