

Date: May 5, 2020

To: City of Louisville

From: Patrick Radabaugh, PE, Melinda Brown, PE, Michael Syverson - Dewberry Engineers Inc.

Subject: City of Louisville and Redtail Ridge Development Projected Water Demands

BACKGROUND

The City of Louisville is located in southern Boulder along the Front Range in central Colorado. A general location map for the planning area is shown on **Figure 1**. The City of Louisville was founded in 1878 and incorporated in 1882. During its early days, Louisville was a coal mining town that was composed of many immigrant neighborhoods. The City is named after Louis Nawatny, a landowner during the City's early mining days, who platted a portion of his farmland and named it after himself. The City was a mining town until the closure of the last mine during the 1950s. Since that time, the City has transitioned to a suburban residential community.

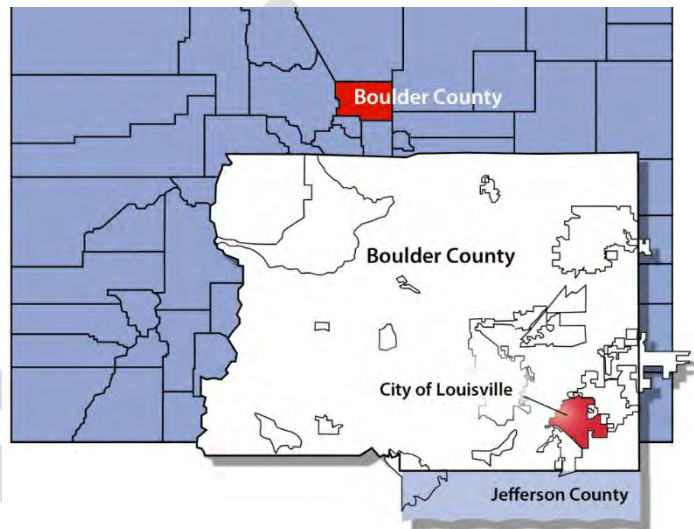


Figure 1 - City of Louisville Location Map

SERVICE AREA AND POPULATION

The service area is the City of Louisville's border. It encompasses 8.6 square miles and in addition to residences and commercial space, contains 26 parks and approximately 1,700 acres open space.

Figure 1 shows the City boundary and the service area. The City's Boundaries are US 36 to the south, the City of Broomfield to the southeast, City of Lafayette to the north, the Davidson Mesa Open Space/Unincorporated Boulder County to the west, and Broomfield County to the east. The City is comprised of primarily residential (single family and multifamily homes) with some industrial, commercial and retail space.

POPULATION

The City of Louisville has a current population of approximately 21,363. The City experienced rapid growth during the 1980s and 1990s, but growth slowed in the 2000s. In 1980, the population was 5,550. By Year 1990, the population had more than doubled to 12,870. By Year 2000, the population grew by approximately 50 percent to 19,051. Since Year 2000, the population of the City of Louisville has slowly grown to over 21,000 residents. Historical population from the US Census Bureau and estimated populations from recent years is given in **Table 1**.

Table 1 - City of Louisville Historical Populations

Year	Population
1980	5,550
1990	12,870
1998	18,177
1999	18,062
2000	19,051
2001	19,088
2002	18,747
2003	18,419
2004	18,574
2005	18,427
2006	18,723
2007	18,989
2008	19,461
2009	19,656
2010	18,376
2011	18,410
2012	19,014
2013	19,499
2014	19,993
2015	20,264
2016	20,719
2017	21,128
2018	21,205
2019	21,363

Notes:

1. Population from Years 2000, 2010 from U.S. Census Bureau.
2. Population from years 1980 and 1990 from www.Citydata.com which sites the US Census Bureau.
3. Population from years 2001-2009, 2011 from PRJCTNS spreadsheet from City of Louisville.
4. Population from years 2012-2019 from https://www.google.com/publicdata/explore?ds=kf7tgg1uo9ude_&met_y=population&idim=sub_county:0846355:0841835&hl=en&dl=en

WATER TREATMENT INFRASTRUCTURE

The City of Louisville secures water rights for its residents and owns and operates two water treatment plants (WTP). The North Water Treatment Plant (NWTP) was constructed in the 1980s and currently has a rated capacity of 8.0 MGD. The Howard Berry Water Treatment Facility (HBWTF), or South Treatment Plant, was constructed in 1993 and has a rated capacity of 5.0 MGD. **Figure 2** shows a map identifying the location of each treatment facility.

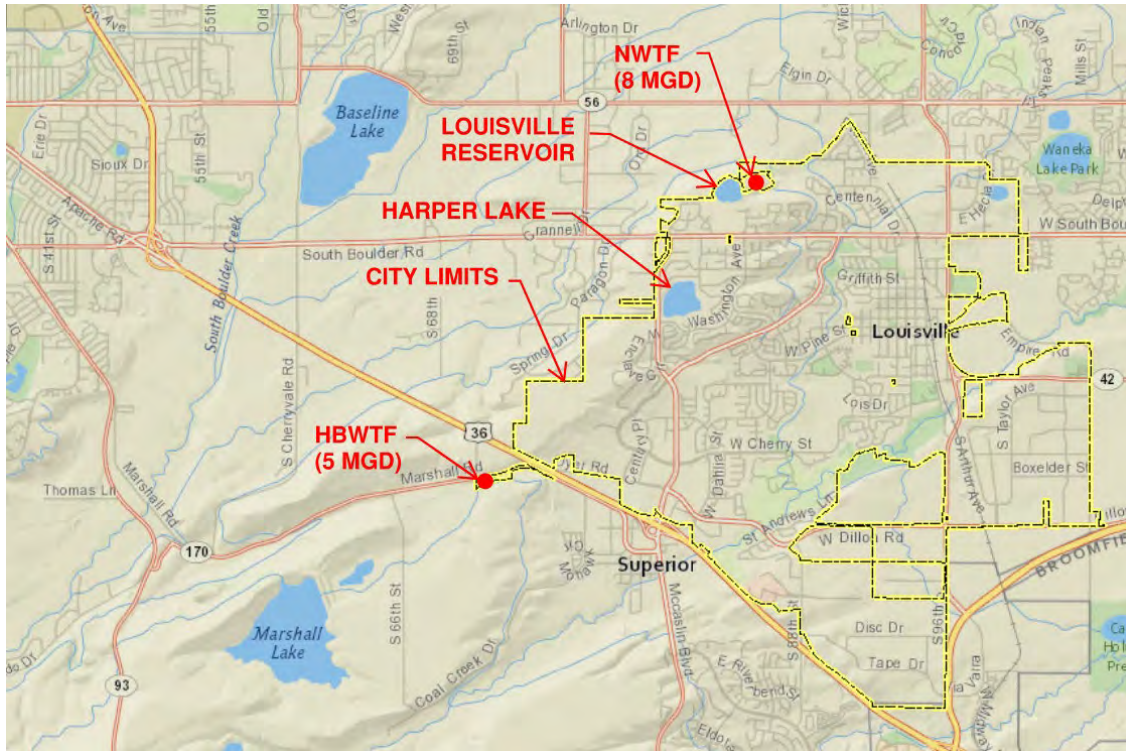


Figure 2 - Water Treatment Facility Location Map

Both facilities are conventional water treatment facilities consisting of coagulation and flocculation, sedimentation, filtration, disinfection, and chemical treatment. **Table 2** provides a summary of the existing infrastructure and process capacities for each plant. A photo of each facility is shown in **Figures 3** and **4**.

Table 2 - Summary of Existing Treatment Processes

Parameter	Number of Units	Max Capacity per Unit
North Treatment Plant		
Rapid Mixers	1	0.82 min detention time at 8 MGD
Flocculation	2	5.8 MGD at max velocity
Sedimentation	2	5.2 MGD at max surface loading rate
Filtration	4	2.5 at max hydraulic loading rate
Disinfection	1	8 MGD
South Treatment Plant		
Rapid Mixers	2	2.07 min detention time at 5 MGD 1.03 min detention time at 10 MGD
Flocculation	1	7.6 MGD at max velocity
Sedimentation	1	5.2 MGD at max surface loading rate
Filtration	2	2.5 MGD, each at max loading rate
Disinfection	1	10 MGD



Figure 3 - Aerial View of the NWTP



Figure 4 - Aerial of the HBWTF

WATER DISTRIBUTION SYSTEM

The City’s water distribution system consists of three pressure zones: High Zone, Mid Zone and Low Zone, by which water is delivered from the two treatment plants via a combination of gravity flow and pumping, as shown in **Table 3**. Water from the HBWTF flows to the Mid Zone by gravity, and can also be pumped to the High Zone by a High Zone Pump Station. Water from the NWTP flows into the Low Zone by gravity, and can be pumped to the High Zone from the High Zone Pump Station. Water can flow from the High Zone to the Mid Zone, or from the Mid Zone to the Low Zone, through interconnecting PRVs or from zone valves operated by City staff.

Table 3 - Summary of Existing Water Delivery to Pressure Zones

Zone	HBWTF	NWTP
High Zone	Pumped	Pumped
Mid Zone	Gravity Flow	Pumped to High Zone and Gravity Flow to Mid Zone
Low Zone	Gravity Flow via Mid Zone	Gravity Flow

During higher demand periods, when both water treatment plants are online, the City takes advantage of lower pumping heads to pump water from the HBWTF to the High Zone, minimizing electrical costs. However, during times of lower water demand, the City may only operate one plant, pumping to the High Zone and gravity flowing water to Mid and Low zones. Pumping capacity from the NWTP is limited by high velocities in the transmission line and distribution system. The firm pumping capacity of the HBWTF is based on the largest pump being out of service. Distribution system pumping capacity is shown in **Table 4**.

Table 4 - High Zone Pumping Capacity

WTP	Total Pumping Capacity	Firm Pumping Capacity
HBWTF	6.0	3.5
NWTP	5.0	3.0

In general, water utilities provide water treatment capacity to meet Maximum Day Demands, while providing storage volume to meet emergency and fire flow needs, as well as, operational volume for daily flow variations. In practice, considerations are made to provide the optimal balance between providing a robust system, controlling capital costs, and managing water quality. The City’s distribution system contains 3 storage tanks that store approximately 8.5 million gallons of water, as shown in **Table 5**. A hydraulic profile schematic is shown in **Figure 5** below that depicts flows from each treatment facility and tanks to the associated pressure zones.

Table 5 - Distribution System Storage Volume

Zone	Water Storage Volume (MG)
High Zone	2
Mid Zone	3.5
Low Zone	3
Total Storage	8.5

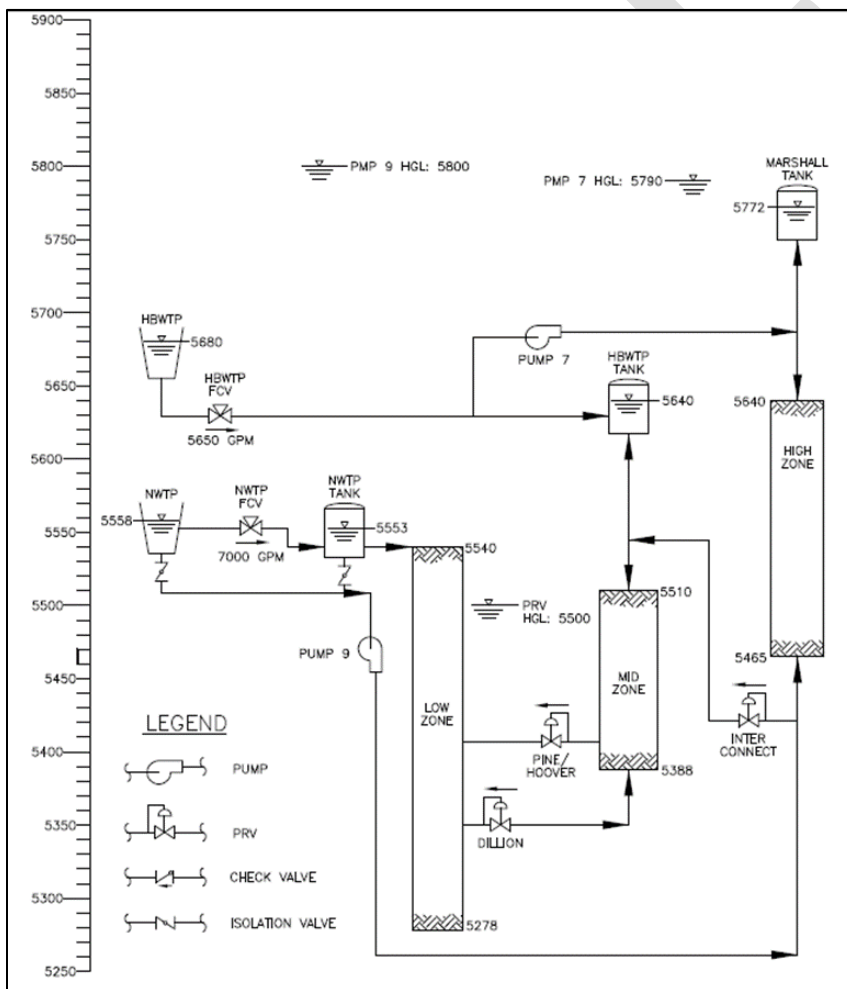


Figure 5 - Existing Distribution System Pressure Zones

PLANNED FUTURE GROWTH

The City of Louisville has planned for growth in the future. New forecasted growth will be infill within the City limits. In the near term, growth contemplated master plan buildout by 2025 in the City; the forecasted growth is expected to come from infill development including the Foundry, Caledonia Place, Delo Lofts and North End Developments. Planned commercial developments are primarily on the south end of town.

POPULATION PROJECTIONS

The current population of the City of Louisville is about 21,163 people per the most recent U.S. Census Bureau website. The town has planned for a population build-out of 23,000 people. Based on available data and trends, the current population growth Population projections for the City of Louisville are given in **Table 6**.

Table 6 - City of Louisville Population Projection

Year	Population	Reference
2019	21,163	U.S. Census Bureau
2020	21,649	Projected Growth at 1.013%
2021	21,938	Projected Growth at 1.013%
2022	22,231	Projected Growth at 1.013%
2023	22,529	Projected Growth at 1.013%
2024	22,830	Projected Growth at 1.013%
2025	23,000	Buildout per Master Plan

Commercial and industrial connections to the City water system typically increase by one tap per year. Growth in commercial/industrial connections is projected to increase between Year 2019 and Year 2030 to a total number of connections of 604 in Year 2030. Projected commercial/industrial connections are provided in **Table 7**.

Table 7 - Projected Commercial Connection Growth

Year	Connections
2019	559
2020	570
2025	576
2030	604

HISTORICAL WATER PRODUCTION SUMMARY

The City of Louisville provided water production and water demand data from 2010 through 2019. The monthly water production data is shown graphically in **Figure 6**. Trends in total production were reviewed from 2010 through 2019. Water production is seasonal with the majority of the City's water being produced the warm weather months. As shown in **Figure 6**, summer production rates are typically about three times the winter water production rates (see analysis later in this technical memorandum). As a result, peak day demands are used to size water treatment plant capacity and water transmission systems.

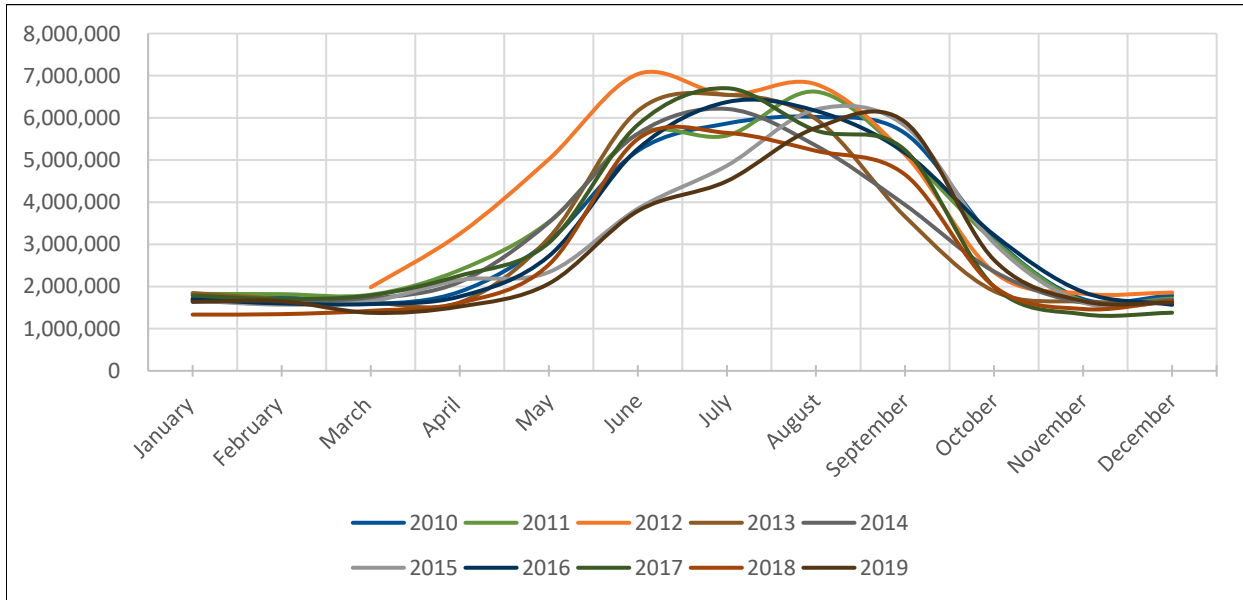


Figure 6 - Total Monthly Average Water Production

Peak water production from 2010 to 2019 was typically observed in the months of July and August. This is typical with communities such as the City of Louisville where winter months, or dry weather months, do not require irrigation which significantly decreases production rates. Dewberry analyzed total water production on an annual and seasonal basis, as shown in Figure 7.

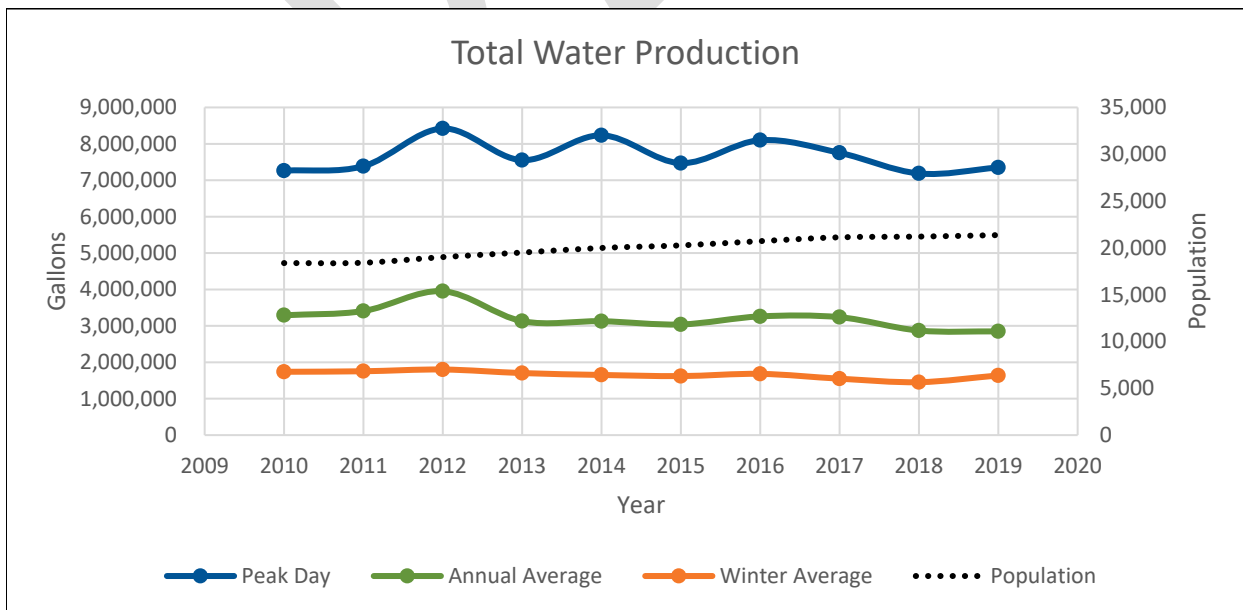


Figure 7 - City of Louisville Historical Water Production

Peak day, annual average, and winter average water production has remained relatively constant from 2010 to 2019. In 2012, the City saw an increase in annual average daily water production. The consistent water production with an increasing population indicates water demand per capita is decreasing over time. It is common practice for water practitioners to use the past five years of data to evaluate treatment plant capacity and typical demand. Analysis of this data was performed using data from 2015 to 2019. **Table 8** lists peak day, average annual day, and seasonal average water production from 2015 to 2019.

Table 8 - Historical Water Production

Parameter	5-year average, MGD
Peak Day Total Production	7.6
Average Summer Day Production	4.7
Average Annual Day Production	3.1
Average Winter Day	1.6

HISTORICAL PER CAPITA WATER DEMAND SUMMARY

Historical water demand was analyzed while considering population and precipitation data. Trends in water use are typically examined over multiple years. **Figure 8** shows a graph of average summer water demand per capita versus population since the mid 1990's.

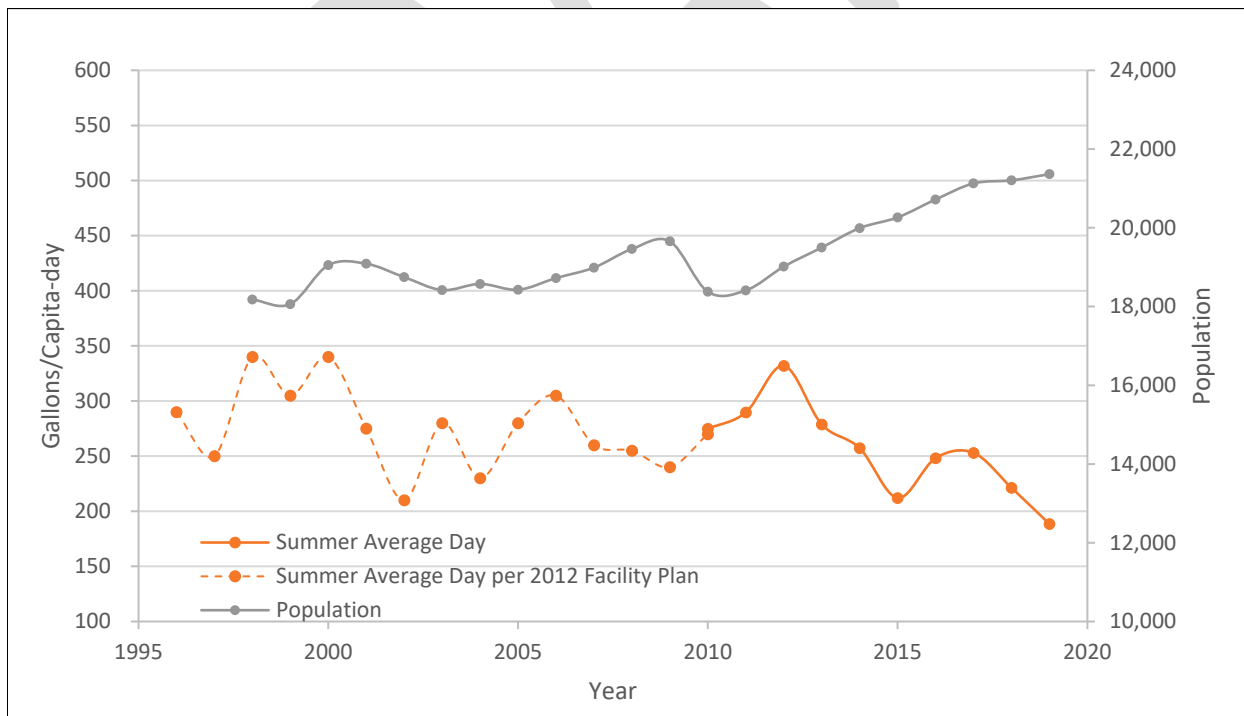


Figure 8 - Average Summer Demand vs Population

Figure 8 shows a decreasing trend in average summer per capita use from 1996 to 2019 with an increasing population. In particular, the average summer day water use has decreased consistently from 2012 to 2019 from 332 gallons per capita per day (gpcpd) to 188 gpcpd, respectively. This observed downward trend is likely due to water conservation efforts put forth by the city. This impact could be a result of residential and commercial spaces upgraded with low flow water fixtures as well as ‘smart’ household irrigation systems. In addition, The City of Louisville has implemented voluntary water restrictions in the recent years.

The data presented in **Figure 9** reflects a total per capita use for the entire population and annual precipitation. There is a decreasing trend in water use (this information includes irrigation) per capita over time from 2012 to 2019. Annual average water use ranged from 208 gpcpd in 2012 to 133 gpcpd in 2019. Boulder county has seen an average annual precipitation of 22.2 inches, according to the National Oceanic and Atmospheric Administration (NOAA). The high average rainfall shown in 2013 is a result of the historic rainfall event seen in September of 2013 which resulted in disastrous flooding. The annual precipitation data from Year 2012 and Year 2016 (**Figure 9**) suggest 2012 and 2016 may have been in a drought scenario as observed by the increased water demand in 2012 and slight uptick in 2016. Overall, the City has observed a decreasing trend in water consumption over the past decade. **Table 9** lists average water demand per capita from 2010 to 2019 for the City of Louisville.

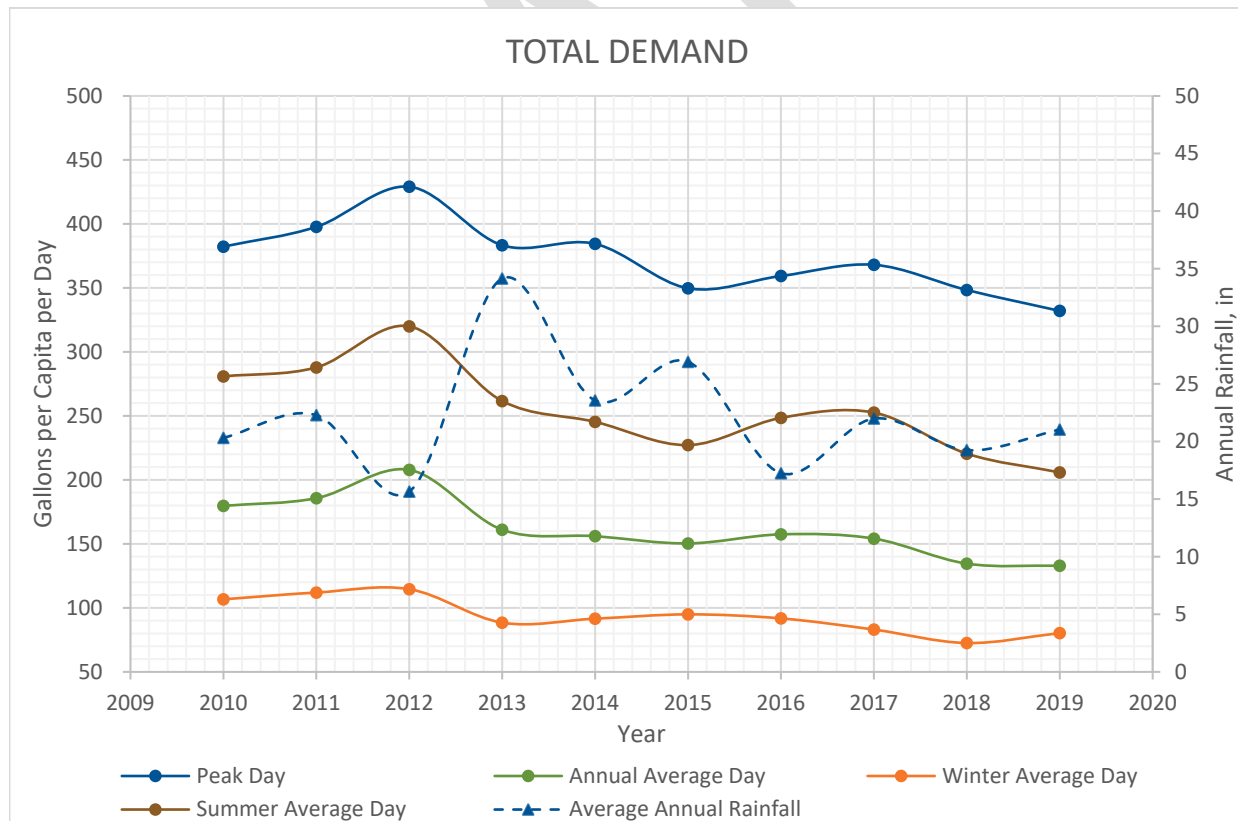


Figure 9 - Historical City of Louisville Total Water Demand per Capita

Table 9 - Historical Water Demand

Parameter	10-year Average, Gallons per Capita per Day
Peak Day Demand	373 (420 historical max)
Summer Average Day Demand	255
Annual Average Day Demand	162
Winter Average Day Demand	94

CITY OF LOUISVILLE PROJECTED WATER DEMANDS

Dewberry was hired to provide an existing capacity evaluation of the water treatment and distribution system, and evaluate the feasibility of incorporating demands from the proposed Redtail Ridge Development. The projections presented below are categorized by future city projections without Redtail Ridge, and projections for Redtail Ridge alone. Irrigation flows for Redtail Ridge are estimated differently than the historical data provided by the City, and historical demand data with irrigation included cannot be used directly. Total projected flows from Redtail Ridge consist of a combination of projections based on historical data and separately estimated irrigation flows. The sections below present the assumptions and methods used for projecting future water demand for the City of Louisville without Redtail Ridge, and Redtail Ridge separately.

City of Louisville Projected Water Demand

Historical data from the City with irrigation included was used to estimate future water demand for the City of Louisville without Redtail Ridge. The assumptions based on 10-year historical data are the following:

- Winter Average Day flow of 94 gpcpd (10-year average)
- Annual Average Day flow of 162 gpcpd (10-year average)
- Max Month Peaking Factor of 2.08 (maximum observed)
- Peak Day Peaking Factor of 2.59 (maximum observed)

Buildout Projections were estimated using the future population data found in **Table 6**. Annual average day and winter average day projections were developed by multiplying the projected populations by the average per capita water production. Max month and peak day demands were calculated by multiplying the average day demand by the respective peaking factors. Projections for annual average day, max month, and peak day are provided in **Table 10** below.

Table 10 - City of Louisville Water Demand without Redtail Ridge

Parameter	Buildout Water Demand, gallons per day
Winter Average Day	2,152,995
Annual Average Day	3,726,000
Average Day in Max Month	7,768,075
Peak Day	9,650,340

REDTAIL RIDGE WATER DEMAND

Dewberry used the historical City of Louisville per capita water flow values to estimate the water demand for the Redtail Ridge proposed development without irrigation. Separate flows for irrigation were estimated and described in the section below. Projections for irrigation were developed using estimated irrigated areas with assumptions for annual irrigation requirements. Four phases of development are planned. The timing of these developments is approximately every five years with the assumption that phase 1 occurs in 2025, phase 2 in 2030, phase 3 in 2035 and phase 4 in 2040. Each phase of development includes residential and commercial zoning. Residential is comprised of continuing care retirement communities and commercial is comprised of general office buildings, business hotels, and shopping centers.

Redtail Ridge Non-Irrigated Water Demands

Dewberry developed a range of projections anticipating low, mid, and high-level growth. These projections were developed from several commonly accepted literature sources, historical population and flow and load data in Louisville, and state and county regulations. **Table 11** summarizes our engineering assumptions.

Table 11 - Engineering Assumptions

Commercial or Residential Units	Annual Average Non-Irrigated Water Demand, Gallons per Capita per Day
General Residential, demand per capita ¹	94
Continuing Care Retirement Community, demand per capita	113
Shopping Center, gal/ft ²	0.46
Business Hotel, gal per day person	54
General Office, gal/day-person	24

¹ Town of Louisville Historical Data for average winter demand. All other water demands assumed to be 20 percent higher than the wastewater production numbers found in the Wastewater Flow and Load Tech Memo 1.

Table 11 above includes the assumptions for per capita contributions for commercial and residential units. The historical water use of 94 gpcpd is the winter average day use and based on the maximum value in the last 10 years of data provided. This is considered the baseline non-irrigation flow for the development and is assumed to remain constant throughout the year.

Table 12 provides projection assumptions for low, medium, and high flow contributions. These projections assumptions were adjusted based on U.S. Census Bureau Data and typical office space per person in the Denver metropolitan area.

Table 12 - Flow and Loading per Capita Contribution Assumptions

Commercial or Residential Unit Assumptions	Low	Medium	High
Residents per Unit	2	2.5	3
Retirement Community Residents per Unit	1	1.3	1.6
Hotel Occupants per Unit	1	1.5	2
Office Space sq ft/person	350	300	250

Table 12 above is instrumental for development of low, medium, and high flow and load projections. The assumptions relate to population density. The City of Louisville has an average of 2.45 residents per dwelling per the U.S. Census Bureau. Typical hotel rooms generally have 1 to 2 occupants per night per room. Office space per person assumes a 15-foot-wide by 15-foot-long office with accounting for common space use such as conference room space, hallways, restrooms, stairwells, breakrooms, kitchens, and shipping and receiving areas.

Table 13 provides low, medium, and high flow estimated projections associated with the Redtail Ridge Development. Annual Average non-irrigated flows from Redtail Ridge are estimated to be in the range of 0.6 MGD to 0.9 MGD.

Table 13 - Redtail Ridge Non-Irrigation Water Demand Projections

Flow	Average Annual Day, gpd		
	Low	Medium	High
Phase 1	242,242	303,185	367,784
Phase 2	160,762	198,725	239,384
Phase 3	78,428	94,740	113,293
Phase 4	36,771	41,000	46,920
Total	518,204	637,649	767,381

Note: gpd = gallons per day

Redtail Ridge Irrigated Water Demand Projections

Flows for irrigation demand were estimated using parcel areas provided in the ConocoPhillips Campus General Development Plan, 1st Amendment and common assumptions for irrigated areas. Assumptions for irrigation were developed with consultation from Norris-Design. The following are assumptions for the irrigated flows for Redtail Ridge:

- All irrigation areas receive 25 gallons per square foot per year
- 30% of the total area is irrigated
- 30% of the annual irrigation volume is observed in the max month
- 20% of the annual irrigation volume is observed in the average summer month
- Ratio of peak day irrigation use to max month irrigation use is 1.41.



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The peak day to max month ratio was developed using historical data from 2010 to 2019. The City's historical average winter demand is considered to be the baseline non-irrigated flow from Redtail Ridge. Historical irrigation demand was estimated by subtracting the average winter day from both peak day and max month for each year. The ratio used is the highest value from 2010 to 2019. **Table 14** provides projections for the irrigation for each phase of development. Phasing for irrigation demands is unknown and was assumed using the best available information.

Table 14 - Redtail Ridge Irrigation Demand

Flow	Average Irrigation, gpd	Max Month Irrigation, gpd	Peak Day Irrigation, gpd
Phase 1	347,610	521,415	737,371
Phase 2	161,826	242,739	343,275
Phase 3	220,197	330,295	467,094
Phase 4	305,865	458,798	648,818
SUM	1,035,498	1,553,247	2,196,557

Note: gpd = gallons per day

The projected irrigation demands above represent conservative estimates and do not account for the low irrigation landscaping measures intended to be designed for the Redtail Ridge Development. Dewberry's estimate assumes all irrigated landscaping is turf, and requires a considerably higher amount of watering per square foot compared to more water conscious landscaping designs. It should be noted that based on conversations with Norris-Design, the anticipated landscaping design may contain approximately 15 to 20 percent turf. The remaining landscaping is intended to be low water use landscaping consisting of planting areas and native vegetation requiring approximately 5 to 10 gallons per square foot per year. This results in landscaping flows that are approximately 45 percent of those shown in **Table 14** above.

TOTAL BUILDOUT WATER DEMAND

The flows presented below represent the total future water demand projections for the City of Louisville with Redtail Ridge. The implications of these projected flows on infrastructure will be presented in Tech Memo 2. Total projections are estimated by phase with a buildout year of 2040 when phase 4 is anticipated to be implemented. **Table 15** provides cumulative total water demand buildout projections for average day in max month and peak day.

Table 15 - City of Louisville with Redtail Ridge Water Projections

Year	Phases	MMF, gpd			PDF, gpd		
		Low	Medium	High	Low	Medium	High
2025	Phase 1	8,531,733	8,592,675	8,657,275	10,629,953	10,690,895	10,755,495
2030	Phases 1-2	8,935,234	9,034,139	9,139,398	11,133,989	11,232,894	11,338,153
2035	Phases 1-3	9,343,957	9,459,174	9,582,986	11,679,511	11,794,728	11,918,540
2040	Phases 1-4	9,839,526	9,958,972	10,088,703	12,365,101	12,484,547	12,614,278

Note: gpd = gallons per day, MMF = average day in the max month flow, PDF = peak day flow



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Total buildout max month demands range from 9.9 to 10.2 MGD. Buildout peak day demand projections range from 12.4 to 12.7 MGD. The NWTP and HBWTF have a rated capacity of 8.0 MGD, and 5.0 MGD, respectively. All four phases of development would require approximately 23 percent of the total rated capacity. In the last five years, the City has seen an average peak day demand of 7.3 MGD and average peak day total production of 7.6 MGD. The City currently utilizes approximately 58 percent of its rated capacity to meet peak day demands. The water system and water distribution infrastructure improvements required to meet the Redtail Ridge projections are discussed in Technical Memorandum 2

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