



City of Phoenix 2024 Equivalent Demand Unit Study Final Report

Prepared for:

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Report
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City of Phoenix Equivalent Demand Unit Study — Executive Summary

This study updates the water use estimates for different types of customers for the City of Phoenix Water Services Department to utilize in planning, development and impact fee assessments. An Equivalent Demand Unit (EDU) is the expected water demand for various priority use types compared to the average expected water demand for one single family (SF) home. Water use for different types of non-SF customers are expressed in terms of EDU equivalents for different types of Phoenix Water Services Department (WSD) financial and planning studies. Keen Independent Research performed these analyses.

Prior to this study, WSD used EDU analyses prepared based on water use for fiscal years 2012 and 2013 for properties built between 2002 and 2008 (2020 WSD report). Keen Independent’s 2024 update improves upon the previous EDU estimates by analyzing a greater number of water users from a more detailed set of property use types, over a longer period. A secondary task of this study was to assess potential short- and long-term impacts of the COVID-19 pandemic on water use patterns among residential and non-residential customers.

WSD provided monthly water use data per Service Point (SP) and Assessor’s Parcel Number (APN). SPs and APNs were anonymized so that user consumption behaviors could not be traced to the individual customer. WSD supplemented anonymized water use data with Maricopa County Assessor data, landscape information determined from LiDAR (2015) data, regional Census characteristics and other data to describe customer profiles.

Property use types examined below may be paired with state demographer growth projections to forecast employment and households for the City. Types examined include SF and multifamily (MF) residential as well as non-residential property use types. Water use patterns are also examined by geographic region within City of Phoenix boundaries, as well as by year built and landscape type.

1. Average demands from 2020 WSD report and 2024 Keen Independent report

Property type	Avg. annual gal/day	
	2020 WSD report	2024 update
Residential (per unit)		
SF per unit	299	289
MF (any build year)	172	162
CII (per 1,000 sqft)		
Commercial/retail	63	52
Industrial	30	57
Institutional		59
Office/Storage	39	28
Public/Other		41

Source: Keen Independent analysis of City of Phoenix water use data, April 2010 through March 2023.

Figure 1 includes the updated average demand for SF homes, as well as the EDU factors for MF and CII properties. See the following sections for additional details on the data and assumptions used to produce these estimates for:

- SF water use;
- MF water use;
- CII water use; and
- Wastewater flows for different customer types.

City of Phoenix Equivalent Demand Unit Study — Executive Summary

For each major customer group, key results include the following.

Single family

- SF water use remains consistent over time. The updated SF average demand is estimated at 289 gallons per unit per day for homes built since 2010 (calculated using water use data from April 2013 to March 2023), which is down from the prior study at 299 gallons per unit per day.
- There has been little fluctuation in average annual SF water use since 2010, although 2023 had the lowest annual average in the data examined here.
- Parcel sizes of new homes have grown very slightly since 1995, while livable areas of homes have steadily grown. Homes built in 2019 had, on average, 20 percent more livable space than homes built in 1995.
- Impacts of the COVID-19 pandemic on SF water use were temporary. There was a substantial increase in water use during the April 2020 to March 2021 period. Water use returned to pre-pandemic levels (and below) after April 2021.
- Homes “on-project” (homes on parcels serviced by the Salt River Project) tended to have lower water usage levels compared to “off-project” homes. Biltmore-Arcadia-Paradise Valley had the highest water usage for SF homes.
- There was substantially higher water use among homes with high-intensity landscaping compared to homes with less-intensive landscaping. Newer homes tend to have a smaller percentage of the parcel covered in vegetation.

Multifamily

- MF water use for the April 2013 to March 2023 period was 162 gallons per unit per day (down from 172 in the previous WSD report).
- Average daily water use per MF unit has decreased.
- Average daily use per MF unit is lower for newer properties. There was no clear relationship between MF per unit water use and the height (or number of stories) of the MF residence.
- Similar to SF water use, the impact of the pandemic on MF use appears to have been temporary. Average annual gallons per unit per day increased during the pandemic and dropped below pre-pandemic levels the following year.

Commercial, Institutional and Industrial (CII)

- Non-residential CII water use is generally decreasing for Retail/Commercial, Institutional, Public/Other and Office/Storage but increasing for Industrial properties.
- Most CII property types were only temporarily affected by the COVID-19 pandemic, quickly returning to pre-pandemic water use levels following lockdowns and other precautions.

Wastewater

- Keen Independent estimated single family home wastewater generation to be 153 gallons per unit per day (53% of billed water) and multifamily wastewater generation to be 103 gallons per unit per day (67%). CII wastewater flows are estimated to be 67 percent of billed water use, on average.

Single-family Water Use

This section includes the following analyses.

- Single-family water use data;
- Single-family EDU;
- Effect of COVID-19 on single-family water use;
- Trends in single-family property characteristics;
- Water use by year built; and
- Other patterns of water use for single-family units.

Single-family Water Use Data

WSD supplied data on billed monthly water use for about 367,000 unique Service Points for single-family properties.

Keen Independent analyzed single-family water users with the following characteristics.

- Categorized as a single-family home according to the following property use types: SF, MF, Commercial/Retail, Office, Industrial, Institutional, Public/Other;
- The property was built in 2010 or later according to Assessor data;
- The water meter size was typical for a single-family home (3/4", 5/8" or 1"); and
- The number of days in a billing period was non-zero.

The study team identified outliers for omission from estimation of the single-family EDU. WSD reviewed a sample of the water users with the highest daily consumption and verified that the top 1 percent of water users were likely due to data entry error.

Following data processing, single-family EDU analyses were based on water use patterns for 23,007 single-family properties.

Single-family Water Use

Single-family EDU

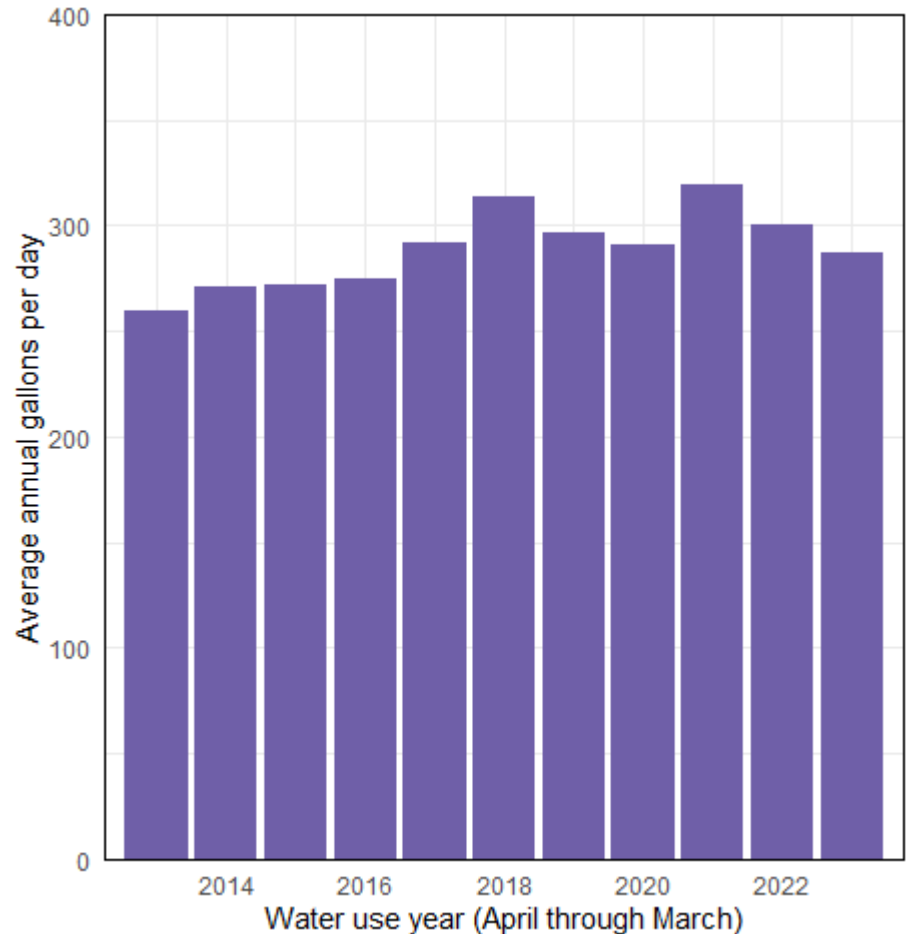
To calculate the SF EDU, the Keen Independent study team divided the total volume of water use (in gallons) by the total number of days in a billing period by year. In these analyses, years span from April to March in order to analyze annual totals of the 12-month lock down period from late March of 2020 to March of 2021. Treating years in this way also allows analysis of the most recent water use data at the time of analyzing these data (March 2023).

The study team calculated the average of the past 10 years of water use data to estimate a SF water use EDU of 289 gallons per day. This was to estimate the average demand for newer construction SF homes.

The SF average demand is not materially sensitive to the number of years selected to determine the average annual gallons per day. For example, an EDU calculated from the past five years of data would produce an average annual gallons per day estimate of 299 (or 294 when omitting 2021). It is also equivalent to the previous single-family EDU estimate.

Figure 2 shows these results. Note that “year” refers to the end of the 12-month period (e.g., “2011” is for the 12 months of use ending in March 2011).

2. SF average demand by year (April 2013–March 2023)



Note: Years range from April through March of the following year to correspond to significant disruptions in consumer behavior due to the implementation and later relaxation of pandemic restrictions and safety guidelines. Limited to properties constructed in 2010 or later.

Source: Keen Independent analysis of City of Phoenix single-family home water use data, April 2013 through March 2023.

Single-family Water Use

Single-family Water Use Overview

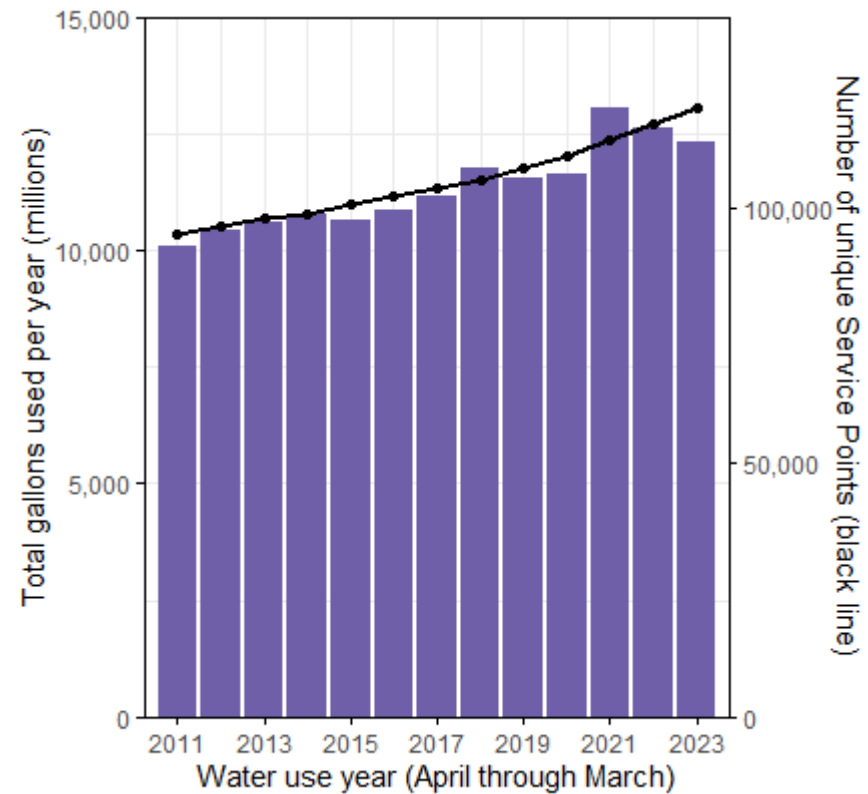
WSD provided monthly water use data per Service Point (SP) and Assessor’s Parcel Number (APN).¹ The study team calculated monthly water use in terms of gallons per day by dividing the number of gallons used in a billing period by the number of days on record for that billing period.²

Keen Independent identified SF homes according to the Master Plan Category used by the Maricopa County Assessor. Master Plan Categories include SF, MF, and Commercial/Retail, Industrial, Institutional, Office, Public/Other. Keen Independent also examined CII water use according to a detailed property use code. WSD provided a table defining the relationship between property use codes and CII categories (see Appendix B).

Figure 3 illustrates the increase in total water billed for single-family properties per year from April 2010 through March 2023 (for properties built in 1995 and later).

Total single-family water use increased by about 190 million gallons per year, on average. The number of unique service points per year has increased at a similar rate, with an increase of about 2,100 new users IDs per year (illustrated by the black line and in Figure 3).

3. Water billed for SF properties built in 1995 and later (2011–2023)



Note: Years range from April through March of the following year to correspond to significant disruptions in consumer behavior due to the implementation and later relaxation of pandemic restrictions and safety guidelines.

Source: Keen Independent analysis of City of Phoenix single-family home water use data, April 2013 through March 2023.

¹ Service Points and Assessor Parcel Numbers were anonymized so that water users could not be identified.

² Water usage was initially recorded in hundreds of cubic feet (CCF), which was converted to gallons using a factor of 748.052 (CCF × 748.052). A small portion of water

use data was excluded from analyses for potential outlier effects on EDU estimates. See Appendix A for details.

Single-family Water Use

Pandemic Impact on Single-family Water Use

The COVID-19 pandemic caused substantial disruptions in water use behaviors. In March 2020, Maricopa County implemented official lockdowns and other precautionary measures to prevent the spread of the virus. These measures included stay-at-home orders, temporary closure of non-essential businesses and school closures. There was a shift in water use patterns from nonresidential to residential properties due to more people staying at home for extended periods, reflecting higher usage for hygiene, cooking and landscaping. All Maricopa County official restrictions related to COVID-19 were lifted in March 2021.

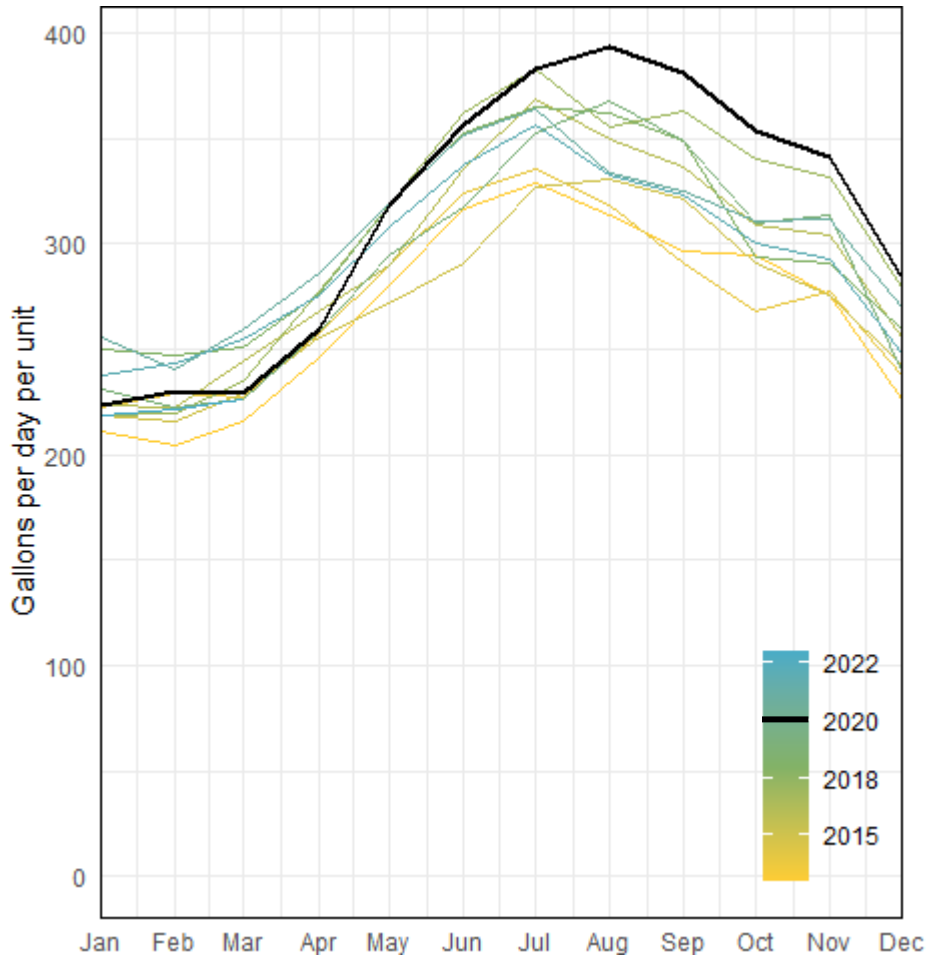
The study team examined average annual water use (April through March) as well as monthly water use to analyze the short- and long-term impact of the COVID-19 pandemic on residential water use. These analyses are limited to single-family properties built in 2010 or later.

Figure 4 shows the average gallons per day by month. The figure includes a solid black line to indicate water use for 2020, during the COVID-19 pandemic lockdowns. The figure color codes consumption year by color, with earlier years appearing as yellow, pre-pandemic appearing as green and post-pandemic as blue.

During the lockdown period (April 2020 through March 2021), SF water use was substantially higher than water use for the same month in previous years. However, SF water usage quickly returned to pre-pandemic levels. For example, SF homes used about 393 gallons per day in August of 2020, compared to 334 gallons per day in August the following year.

It should also be noted that the Pandemic lockdown year was also a hot, dry year, which would also contribute to increased water demand.

4. Average annual SF water use for homes built in 2010 and later (January 2013–March 2023)



Source: Keen Independent analysis of City of Phoenix single-family home water use data, April 2013 through March 2023.

Single-family Water Use

Trends in Single Family Lot Size and Livable Area

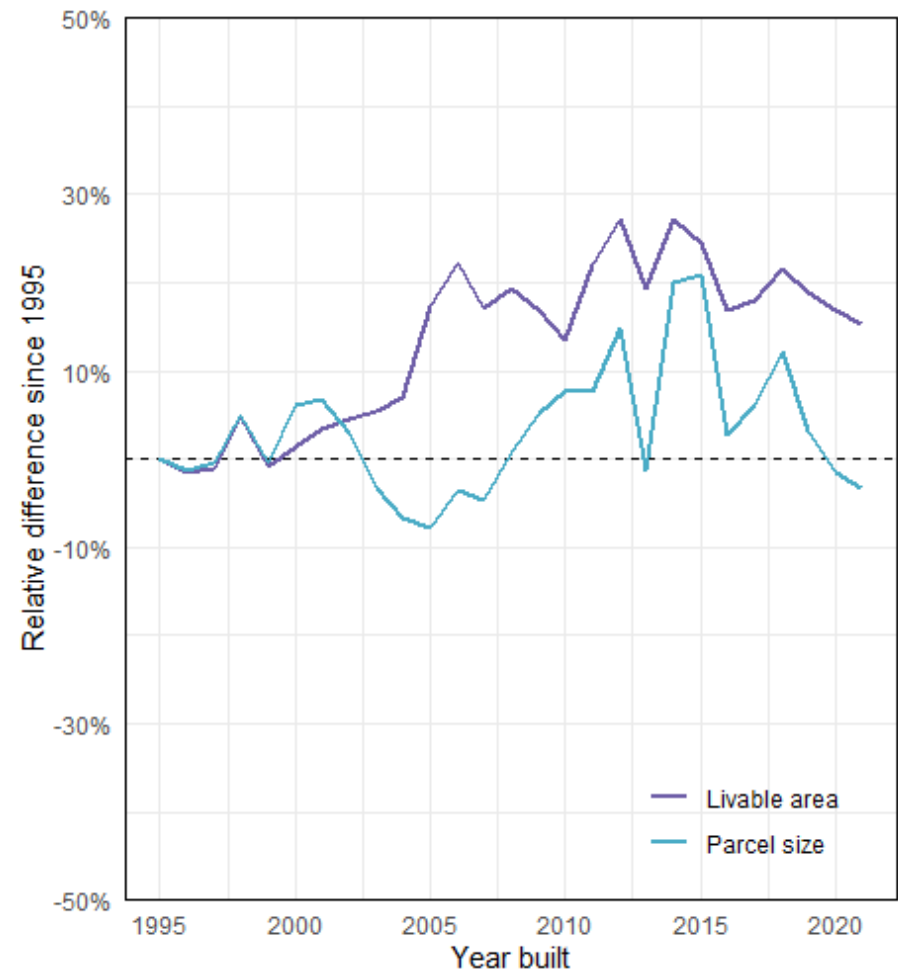
The size of homes and the size of the surrounding property are key factors influencing water use for single-family residences. In general, homes with more living space tend to house more occupants, leading to increased usage of water-dependent appliances. Additionally, larger parcel sizes indicate more outdoor space that, depending on homeowner landscaping decisions, may require more water for irrigation or pool evaporation.

The study team analyzed trends in the amount of livable area as well as parcel lot size for the year that a single-family home was built. Assessor data include the square footage of homes' livable area, square footage of lot size and year that the home was built.

Figure 5 illustrates the trends in livable areas and parcel lot sizes by the year that the home was initially constructed. Since 1995, the average single-family home parcel area has decreased slightly. The average lot size was about 7,700 sq. ft. for homes built in 1995 and about 7,400 in 2021. Although parcel sizes appear to have increased between 2009 and 2016, this may have been due to decreased development of single-family homes following the housing market crash in 2009. The number of homes built per year in that period was lower than any other period and these homes tended to be higher-value homes. Parcel sizes reverted to 1995 levels by 2011.

The average livable area of single-family homes built in Phoenix appears to have increased since 1995. The average livable area was about 2,000 sq. ft. for homes built in 1995. Homes built in 2021 had livable areas of about 2,300 sq. ft. (15 percent larger than homes built in 1995). Unlike parcel size, the average livable area of homes has not returned to 1995 levels.

5. Trends in SF lot size and livable area, by year built (1995–2021)



Source: Keen Independent analysis of City of Phoenix single-family home water use data, April 2011 through March 2023.

Single-family Water Use

Water Use by Year Built

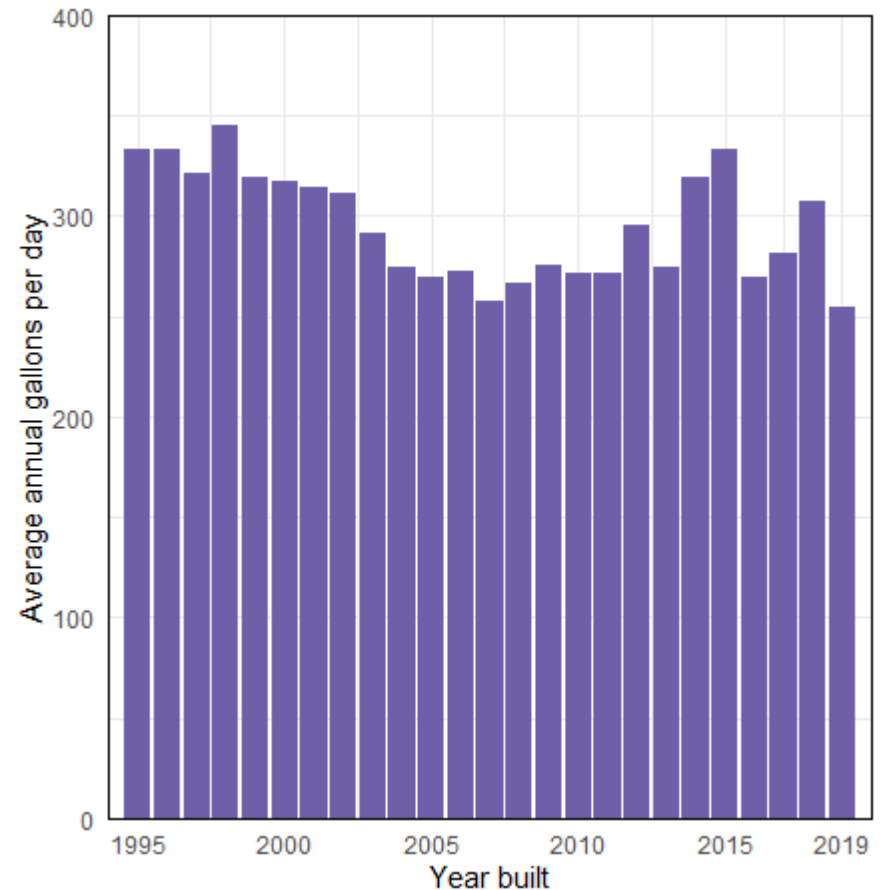
There are several factors that may contribute to newer residential buildings using less water than older homes: modern building codes, advanced plumbing fixtures, advances in water-dependent appliance efficiencies, improved insulation and a shift toward water-conscious landscaping. Thus, the Keen Independent study team analyzed single-family water use by year built.³

Figure 6 illustrates the average annual gallons per day for single-family homes by build year, including homes from 1995 through 2018. The values in Figure 6 include the third year of water use after building construction and every year after through March 2023.

The figure indicates that average water use tends to be lower for relatively newer homes. SF homes built between 2003 and 2018 in general consumed less water than homes built prior to 2003. SF homes built in 1995 used about 330 gallons per day while homes built in 2005 used about 270 gallons per day.

On average, water demand appears to be increasing for the newest SF homes. Annual water use by build year was somewhat higher for single-family homes built in 2012, 2014, 2015 and 2018, compared to homes built in 2010.

6. Average annual SF water use in gallons per day by year built (water used between April 2011 and March 2023)



Source: Keen Independent analysis of City of Phoenix single-family home water use data, April 2011 through March 2023.

³ Note that water use is analyzed three years after year built to allow time for homeowners to settle and install landscape.

Single-family Water Use

Water Use by Landscape Type

Of the property characteristics examined by Keen Independent, none explained water use levels better than landscape type. Using 2015 satellite Light Detection and Range (LiDAR) data, WSD classified parcels into landscape types based on the presence and prevalence of turf grass and other water-intensive vegetation.

The study team calculated average demand for properties classified as “Extensive” or “Turf” (high-intensity landscape) compared to properties labeled as “Moderate” and as “Arid” or “Sparse” (low-intensity landscape) according to the percentage of the property covered in vegetation. WSD uses the following definitions for landscape type:

- **Extensive.** More than 50 percent of a parcel is covered in extensively irrigated vegetation;
- **Turf.** More than 35 percent of a parcel is covered in turf;
- **Moderate.** Less than 35 percent of a parcel is covered in turf;
- **Sparse.** Limited irrigation, no turf; and
- **Arid.** No irrigation.

Figure 7 presents average annual SF water demand between April 2013 and March 2023 for homes built in 2010 or later (by landscape category).

Properties with water-intensive landscaping exhibit greater water use. This increased demand primarily stems from the need to regularly irrigate lawns, gardens, and ornamental plants that require abundant water to thrive, especially in climates not naturally suited to such vegetation. Properties with high-intensity landscape had substantially higher water use compared to properties with moderate- and low-intensity landscape (nearly three times the overall single-family usage).

7. Water use by landscape type, period built (water used between April 2013 and March 2023)

Land use	Avg. annual gal/day	EDU factor
Overall		
Single family	289	1.00
SF built 2010–2012		
High-intensity landscape	1,318	4.56
Moderate	405	1.40
Low	223	0.77
SF built 2013 or later		
Built 2013–2016	303	1.05
Built 2017–2019	277	0.96

Source: Keen Independent analysis of City of Phoenix single-family home water use data, April 2013 through March 2023.

Note that Keen Independent did not analyze landscape information for single-family properties built after 2012. LiDAR data were compiled from aerial imagery collected in 2015. Keen Independent implemented a three-year lag on water use data from the construction year for SF properties to allow for changes in homeownership and landscape development. Thus, the impact of landscape type on SF water use could not be determined for properties built in 2013 or later.

Single-family Water Use

Water Use by Fee Area

The City of Phoenix collects Water and Wastewater Impact Fees and a Water Resources Acquisition Fee (WRAF) depending on parcels' geographic relationship to Salt River Project (SRP) boundaries. The study team separately examined water use patterns among "On-Project" water users (properties holding SRP water rights) as well as "Off-Project" water users. The Biltmore-Arcadia-Paradise Valley (PV) area, which is geographically Off-Project, was analyzed separately. These analyses are for SF properties built in 1995 and later, as well as for SF properties built in 2010 and later.

On-Project SF properties tend to use less water than the average SF demand. SF properties in the Biltmore-Arcadia-PV area used about 133 percent more than the average demand for homes built in 1995 and later, or about 186 percent more than the average demand for homes built in 2010 and later.

8. Usage by Water Resources Acquisition Fee Areas (April 2013–March 2023 water use)

Project status	Avg. annual gal/day	EDU factor
SF built 1995 and later	299	1.03
On-project	256	0.89
Off-project	312	1.08
Biltmore-Arcadia-PV	674	2.33
SF built 2010 and later	289	1.00
On-project	235	0.81
Off-project	291	1.01
Biltmore-Arcadia-PV	826	2.86

Source: Keen Independent analysis of City of Phoenix single-family home water use data, April 2013 through March 2023.

Multifamily Water Use

Keen Independent analyzed the water use of about 6,100 multifamily residences from April 2013 through March 2023. Multifamily water users include apartment complexes, condominiums, duplexes, triplexes and other types of multifamily residential units. This section includes discussion of the following:

- Multifamily water use data;
- Multifamily EDU factor;
- Multifamily water use by year;
- Pandemic impact on multifamily water use; and
- Multifamily water use by number of stories.

Multifamily Water User Data

WSD provided Keen Independent with monthly water use data for about 13,500 properties assigned as multifamily according to their property use category. The study team analyzed water use patterns for multifamily properties with a valid number of units in the Assessor data. About 6,100 multifamily properties were selected for analysis (about 122,000 units).

Keen Independent supplemented existing WSD and Assessor data with information from third-party sources related to property characteristics such as number of stories and number of units. As with single-family data, the study team removed the top 1 percent of daily water consumers, which may have been data entry errors.

The analysis was for multifamily properties built in any year.

Multifamily Water Use

Multifamily EDU Factor

As multifamily properties can range between two and hundreds of units, the MF EDU factor is calculated by scaling water use by the number of units in a multifamily property. Annual water use per MF unit averaged 162 gallons per unit per day (g/unit/day).

The study team divided the average annual gallons per day for a MF unit by the average SF water demand for a MF EDU of about 0.56.

MF water use was analyzed separately for properties built before 1995, between 1996 and 2009, and properties built in 2010 or later. As illustrated in Figure 9, the average annual g/unit/day is lower for multifamily newer properties compared to older properties.

9. Multifamily water usage (April 2013–March 2023 water use)

Type and year built	Avg. annual g/unit/day	EDU factor
SF built 2010 or later	289	1.00
All MF properties	162	0.56
Built pre-1995	163	0.56
Built 1996–2009	158	0.55
Built 2010 or later	86	0.30

Source: Keen Independent analysis of City of Phoenix multifamily residential water use data, April 2011 through March 2023.

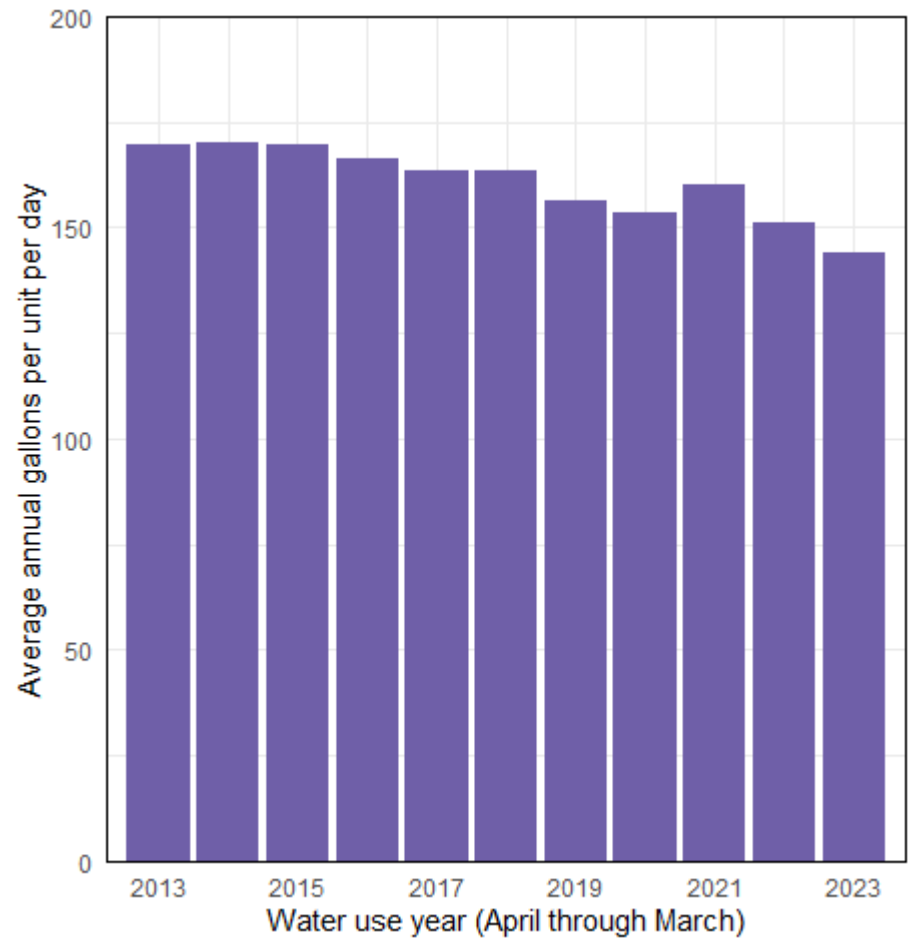
Multifamily Water Use

Multifamily Water Use by Year

Multifamily water use per unit appears to be decreasing with time. The water use in 2013 was about 169 g/unit/day and fell to about 144 g/unit/day in 2023.

Only the Covid-19 pandemic temporarily halted this trend, as shown in the results for the 2021 water year in Figure 10. MF water demand in this year was about 160 g/unit/day.

10. Annual MF gallons per unit per day (April 2013–March 2023 water use)



Note: Years range from April through March of the following year to correspond to significant disruptions in consumer behavior due to the implementation and later relaxation of pandemic restrictions and safety guidelines.

Source: Keen Independent analysis of City of Phoenix multifamily residential water use data, April 2013 through March 2023.

Multifamily Water Use

Pandemic Impact on Multifamily Water Use

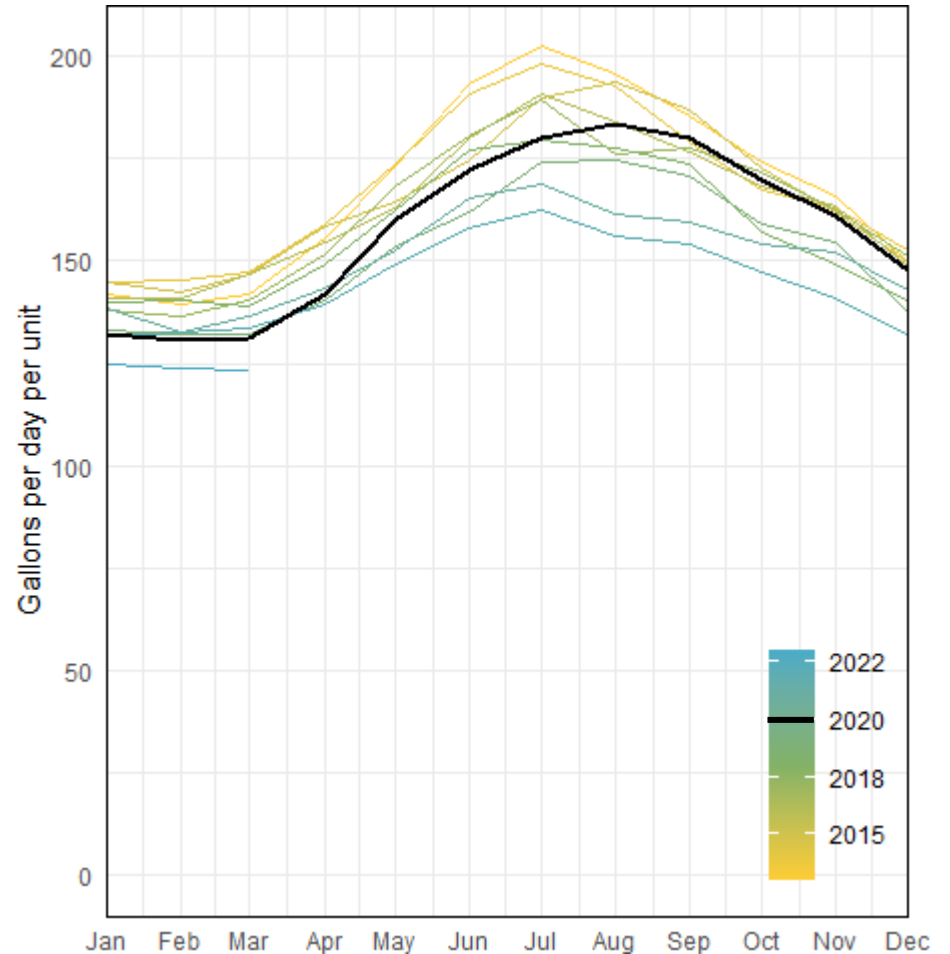
As discussed above, precautionary measures to stop the spread of the COVID-19 virus caused substantial shifts in water use. Stay at home orders, temporary closures of businesses, offices and schools between March 2020 and March 2021 shifted water use from retail, offices and institutional water meters to residential properties.

As illustrated in Figure 10 on the previous page, there was a downward trend in annual gallons per unit per day that was disrupted by the COVID-19 pandemic. The study team also analyzed monthly water use behavior and found that the overall impact on multifamily water use was substantial yet brief.

Figure 11 shows the average monthly gallons per unit per day for MF properties by year. The figure includes a black line to highlight MF water use during the Pandemic year, 2020. Earlier water use is indicated in yellow and later water use is in blue. There is a clear pattern from relatively high water use in yellow (earlier years) to relatively lower water use in blue (later years).

In 2020, monthly gallons per unit per day reached pre-2020 levels by September. However, the average MF gallons per unit per day reduced substantially in 2021 and 2022.

11. Monthly MF gallons per unit per day (Jan 2013–March 2023 water use)



Source: Keen Independent analysis of City of Phoenix multifamily residential water use data, January 2013 through March 2023.

Multifamily Water Use

Patterns of Water Use by Number of Stories

The study team analyzed water use patterns according to the number of stories in a MF residence, as determined through Assessor and third-party data. Multifamily properties include single-story duplexes up to multi-story apartment complexes. There is no clear relationship between number of stories and MF demand.

Single story MF residences used about 160 gallons per unit per day on average, below the 162 gallons per unit per day average for all multifamily properties selected for analysis. Two-story MF residences had higher average use at 172 gallons per unit per day, three-story residences used 148 gallons per unit per day while four-story (and taller) residences used 199 gallons per unit per day.

Note that these analyses do not control for occupancy at the time of water use. SF data are for properties with the most recent construction date of 2010 or later while MF properties include any year built.

12. MF water demand (April 2013–March 2023 water use)

Number of stories	Avg. annual g/unit/day	EDU factor
SF built 2010 or later	289	1.00
All MF properties	162	0.56
1 story	160	0.55
2 stories	172	0.60
3 stories	148	0.51
4+ stories	199	0.69

Source: Keen Independent analysis of City of Phoenix multifamily residential water use data, April 2010 through March 2023.

Commercial, Institutional and Industrial (CII) Water Use

Keen Independent analyzed the water use of about 19,200 non-residential properties from April 2010 through March 2023. Non-residential (or CII) water users include Retail/Commercial, Industrial, Institutional, Office/Storage and Public/Other buildings.

This section covers the following topics.

- CII water use data;
- CII EDU adjustment factor update;
- CII EDU comparison;
- CII EDU update;
- CII water use by meter type;
- CII water use by year; and
- Effect of COVID-19 on CII water use.

CII Water Use Data

To scale CII water use for comparison to single-family water use, the Keen Independent study team divided CII water use by total square footage in a property. However, square footage data from the Assessor apply to parcel level while water use data (and property use codes) apply to the Service Point (SP) level. Several Assessor Parcel Numbers (APNs) were associated with more than one SP identification number.

Because Assessor data express characteristics for an entire parcel, the water use of each SP was summed according to the APN for these properties. For each APN associated with multiple SPs, the study team classified the APN according to the SP-level Property Use Code (PUC) that accounted for the greatest share of water use for that APN. As with single-family and multifamily, the study team identified and removed certain properties from analysis for likely data entry errors: observations in the top one percentile of daily water users were omitted as well as properties with building footprints below 500 sq. ft.

WSD provided a relationship table between PUCs and CII categories. The relationship table provided a hierarchical structure of 558 distinct PUCs, 44 simplified or “aggregated” PUC categories, and five CII categories (see Appendix B). The five CII categories are listed below:

- Retail/Commercial;
- Industrial;
- Institutional;
- Office/Storage; and
- Public/Other.

The Keen Independent study team analyzed water use at each of the CII levels as well as aggregated PUC levels (APUCs) in the following analyses.

Commercial, Institutional and Industrial (CII) Water Use

CII EDU Adjustment Factor Update

An adjustment factor is applied to CII EDU factors to address the tendency for CII meters to use more water than SF meters of the same size. The City of Phoenix *Infrastructure Financing Plan: 2020 Update* estimated a CII adjustment factor of 2.12.

The adjustment factor is estimated by dividing the total annual single-family water use (hundred cubic feet, or “CCF”) by the meter-based EDU. The total number of meter-based EDUs is calculated by multiplying the number of unique meters in an annual billing cycle by a scale provided by the American Water Works Association (AWWA) based on recommended maximum rates for continuous operation.

Figure 13 illustrates the estimation of the updated CII adjustment factor. The adjustment factor is updated to 2.61 using the average of annual meter-based EDUs and annual CCF totals from April 2013 through March 2023.

13. CII adjustment factor estimation (April 2013–March 2023 water use)

	Avg. Meter-Based EDU	Avg. Annual CCF (Apr 2013–Mar 2023)	CCF/EDU /DAY
SF standard	3,597	469,561	0.36
CII	12,567	4,288,493	0.93
Non-SF EDU adjustment factor			2.61

Note: Years range from April through March of the following year to correspond to significant disruptions in consumer behavior due to the implementation and later relaxation of pandemic restrictions and safety guidelines.

Source: Keen Independent analysis of City of Phoenix single-family and CII water use data, April 2013 through March 2023.

Commercial, Institutional and Industrial (CII) Water Use

CII EDU Comparison

The Keen Independent study team compared the EDU factors for different types of CII properties to past analyses in the City of Phoenix *Infrastructure Financing Plan: 2020 Update*. The results of the present study provide results for a greater number of properties and more types of properties in City of Phoenix boundaries. We advise caution in comparing the studies directly, however, as there were substantial differences in the magnitude of the data examined, the definitions of the CII categories, as well as the update to the CII adjustment factor.

Figure 14 provides estimate EDU factors for Retail/Commercial, Industrial, Institutional, Office/Storage and Public/Other buildings, as defined through aggregated PUCs (see Appendix B). CII water demand is scaled per one thousand square feet (ksf). The EDU factor is calculated as the number of gallons per day per ksf (g/day/ksf) divided by the SF average demand (289 gallons per day), which is then multiplied by the adjustment factor (2.61) calculated in Figure 13 on the previous page.

- Commercial and retail properties used about 25.6 million gallons per day each year between 2013 and 2023. The average total floor area for these properties was about 496,000 sq. ft. The average annual gallons per day per thousand square feet (g/day/ksf) was about 52.
- Industrial properties used about 57 g/day/ksf on average.
- Institutional properties used about 59 g/day/ksf.
- Offices used about 28 g/day/ksf.
- Public buildings used about 41 g/day/ksf.

14. CII EDU factor by Aggregated PUC (April 2013–March 2023 water use)

	Gal/day (millions)	Area (ksf)	Avg. annual g/day/ksf	EDU factor
Commercial/Retail				
2024 update	25.6	496,355	52	0.47
2020 WSD report	3.2	51,215	63	0.43
Industrial				
2024 update	8.2	144,109	57	0.51
2020 WSD report	0.5	17,527	30	0.22
Institutional				
2024 update	11.3	192,659	59	0.53
2020 WSD report	N/A	N/A	N/A	0.22
Office				
2024 update	5.5	199,411	28	0.25
2020 WSD report	1.6	41,480	39	0.28
Public/Other				
2024 update	0.9	20,909	41	0.37
2020 WSD report	N/A	N/A	N/A	0.22

Note: Years range from April through March of the following year to correspond to significant disruptions in consumer behavior due to the implementation and later relaxation of pandemic restrictions and safety guidelines.

Source: Keen Independent analysis of City of Phoenix CII water use data, April 2013 through March 2023, and the City of Phoenix *Infrastructure Financing Plan: 2020 Update*.

Commercial, Institutional and Industrial (CII) Water Use

CII EDU by Meter Type

The study team separately analyzed landscape meter and non-landscape meter water use for CII properties. Non-landscape meter properties were scaled by total floor area while landscape meters were scaled according to the non-building parcel area. The non-building parcel area was calculated as the parcel area subtracted by the building footprint estimated according to LiDAR data (2015). (See Figure 15 for these results.)

CII Water Use by Year

Figure 16 on the following page illustrates long-term trends in water use for the five CII property use categories. The figure indicates clear trends in water use by type:

- Commercial/retail, institutional and office properties are on a downward trend in gallons per day per thousand square feet (decreasing by about 0.27, 0.31 and 0.25 g/day/ksf each year on average).
- Industrial has increased in water use by about 1 g/day/ksf each year on average.
- Public/other properties have varied in annual g/day/ksf but show no clear trend up or down in the April 2013 to March 2023 period.

Analyses of annual CII g/day/ksf show very little impact of the Covid-19 lockdown period in 2020 and 2021. The study team provides additional detail on specific property use codes later in this section.

15. EDU factor by Aggregated PUC (April 2013–March 2023 water use)

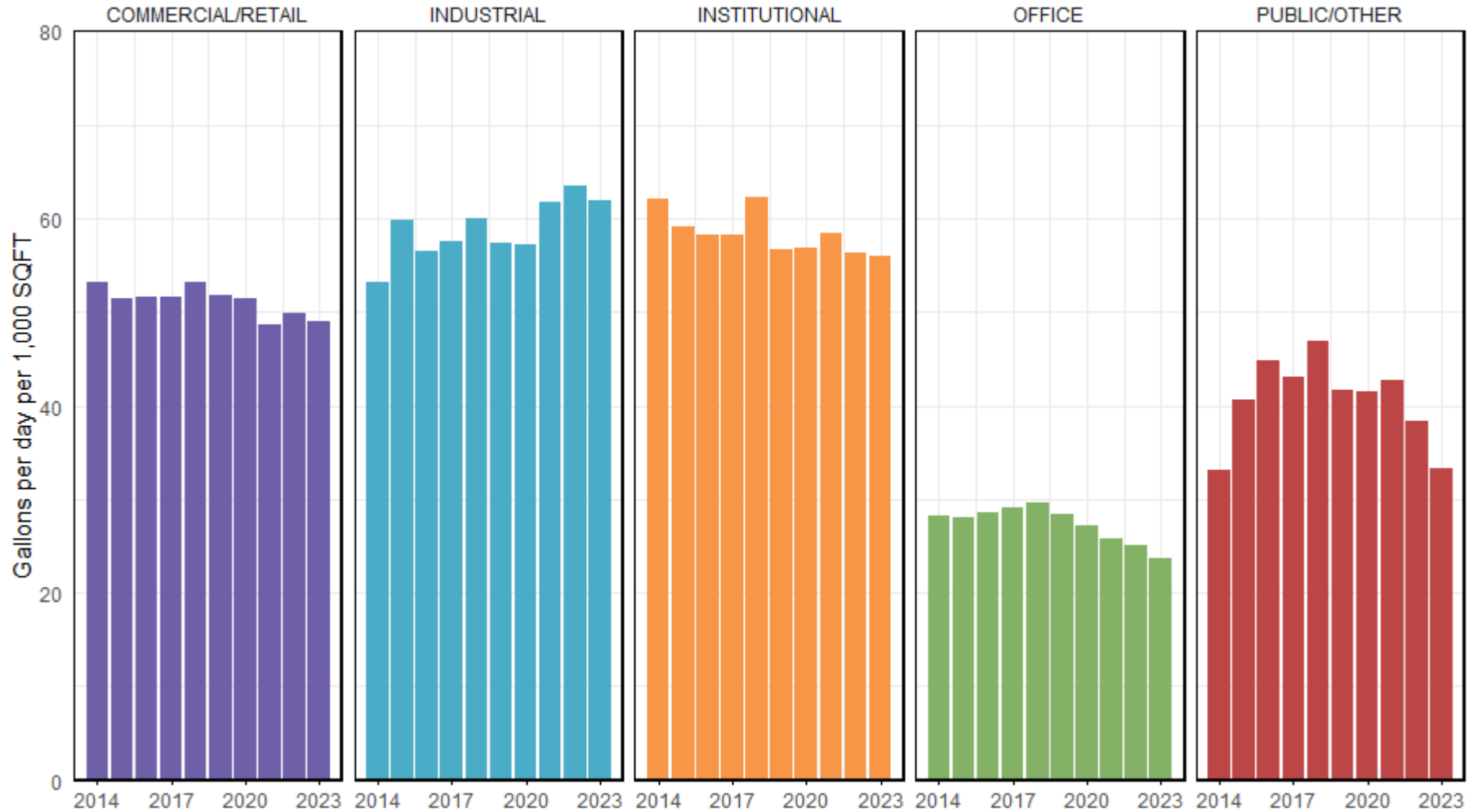
	Gal/day (millions)	Area (ksf)	Avg. annual g/day/ksf	EDU factor
All meters (floor area)				
Commercial	25.6	496,355	52	0.47
Industrial	8.2	144,109	57	0.51
Institutional	11.3	192,659	59	0.53
Office	5.5	199,411	28	0.25
Public/Other	0.9	20,909	41	0.37
Non-landscape meters (floor area)				
Commercial	21.1	319,754	66	0.60
Industrial	7.8	87,314	89	0.80
Institutional	7.3	114,221	64	0.58
Office/Storage	3.9	129,846	30	0.27
Public/Other	0.7	11,306	59	0.53
Landscape meters (non-building parcel area)				
Commercial	4.5	275,922	16	0.15
Industrial	0.4	47,014	9	0.08
Institutional	4.0	171,651	23	0.21
Office/Storage	1.7	40,559	41	0.37
Public/Other	0.2	38,253	5	0.04

Note: The EDU factors above are post-adjustment (multiplied by the 2.61 adjustment factor).

Source: Keen Independent analysis of City of Phoenix CII water use data, April 2013 through March 2023.

Commercial, Institutional and Industrial (CII) Water Use

16. Trends in Commercial, Industrial and Institutional gallons per day per thousand square feet (April 2013–March 2023)



Note: Years range from April through March of the following year to correspond to significant disruptions in consumer behavior due to the implementation and later relaxation of pandemic restrictions and safety guidelines.

Source: Keen Independent analysis of City of Phoenix non-residential water use data, April 2013 through March 2023.

Commercial, Institutional and Industrial (CII) Water Use

Property Use Codes

The Keen Independent study team repeated the analyses above for each of the 44 aggregated PUCs (APUCs) in the CII categories.⁴ APUCs with fewer than 20 unique properties after SP-APN aggregation were not included in APUC-specific analyses. In total, there were 23 APUC categories analyzed.

Figure 17 presents the EDU factors for 13 different APUCs in the Commercial/Retail category. Several APUCs had much higher water use than the single-family EDU. Car washes (10.68), Laundries (5.70), Restaurants (4.16), Mortuaries and Crematoriums (2.59) and Vehicle Repair (1.55) each had EDU factors above the SF average demand.

The post-adjustment EDU factor for Storage was 0.06, substantially lower than the SF average demand. Other low-use APUCs included Vacant Land (0.14), general Commercial (0.27), Mixed Use properties (0.30) and Warehouses (0.35).

17. Commercial and retail EDU factors by APUC (April 2013–March 2023)

	Gal/day (millions)	Area (ksf)	Avg. annual g/day/ksf	EDU factor
COMMERCIAL/RETAIL				
Commercial	4.72	160,750	29	0.27
Fitness/Recreation Centers	0.15	1,772	85	0.77
Hotels/Motels/Resorts	3.40	46,043	74	0.67
Laundries	0.41	649	631	5.70
Mixed Use (Residential)	0.12	4,021	34	0.30
Mortuaries or Crematoriums	0.04	154	287	2.59
Restaurants/Food Services/Bars	1.84	4,006	461	4.16
Stores, Shopping Centers, Malls	6.25	81,974	76	0.69
Vehicle/Equipment Sales	0.53	8,368	63	0.57
Storage	0.11	16,672	7	0.06
Vacant Land - Commercial	0.07	166	14	0.13
Vehicle Fuel/Service/Repair	0.98	5,704	172	1.55
Vehicle/Car/Truck Washes	0.54	450	1,183	10.68
Warehouses	5.69	145,178	39	0.35

Note: The EDU factors above are post-adjustment (multiplied by the 2.61 adjustment factor).

Source: Keen Independent analysis of City of Phoenix CII water use data, April 2013 through March 2023.

⁴ PUCs with fewer than 20 unique service points after SP-APN aggregation were not included in PUC-specific analyses.

Commercial, Institutional and Industrial (CII) Water Use

Figure 18 presents the APUC EDU factors for industrial, institutional, office and public buildings. There were several low-use APUCs in these categories, relative to the SF average demand. These include Medical Facilities in the Industrial category (0.23, or about 23 percent of the SF average demand), Office Buildings (0.22), Vacant Land (0.18) and Parking Lots in Public/Other (0.12).

When comparing average water use of Banks and Financial Institutions, the average water use was higher than the average water use of a SF home, resulting in an EDU of 1.41 (i.e., 41 percent higher on average). Data Centers (1.13) and Manufacturing (0.94) also had high EDU factors compared to other CII categories.

18. Industrial and institutional EDU factors by APUC (April 2013–March 2023)

	Gal/day (millions)	Area (ksf)	Avg. annual g/day/ksf	EDU factor
INDUSTRIAL				
Data Centers	0.70	5,094	136	1.23
Industrial	1.61	27,288	59	0.53
Manufacturing	3.78	33,613	112	1.02
Medical Facilities	2.53	90,808	28	0.25
INSTITUTIONAL				
Government	1.94	38,928	50	0.45
Institutions	2.53	36,330	70	0.63
Schools/Day Care	6.86	117,401	58	0.53
OFFICE				
Bank/Financial Institutions	0.30	1,944	156	1.41
Office Buildings	5.21	197,348	26	0.24
PUBLIC/OTHER				
Parking Lots	0.10	7,204	14	0.13
Police/Fire/Military Facilities	0.62	9,348	66	0.60
Utilities	0.06	1,053	58	0.52
Vacant Land - Government	0.07	3,304	22	0.20

Note: The EDU factors above are post-adjustment (multiplied by the 2.49 adjustment factor).

Source: Keen Independent analysis of City of Phoenix CII water use data, April 2010 through March 2023.

Commercial, Institutional and Industrial (CII) Water Use

COVID-19 Impact by PUC

The study team analyzed monthly water use (per day per thousand square feet) by APUC. Figure 19 shows the average gallons per day per thousand square feet for restaurants within City of Phoenix boundaries. The figure includes a solid black line to indicate water use for 2020, during the COVID-19 pandemic lockdowns.

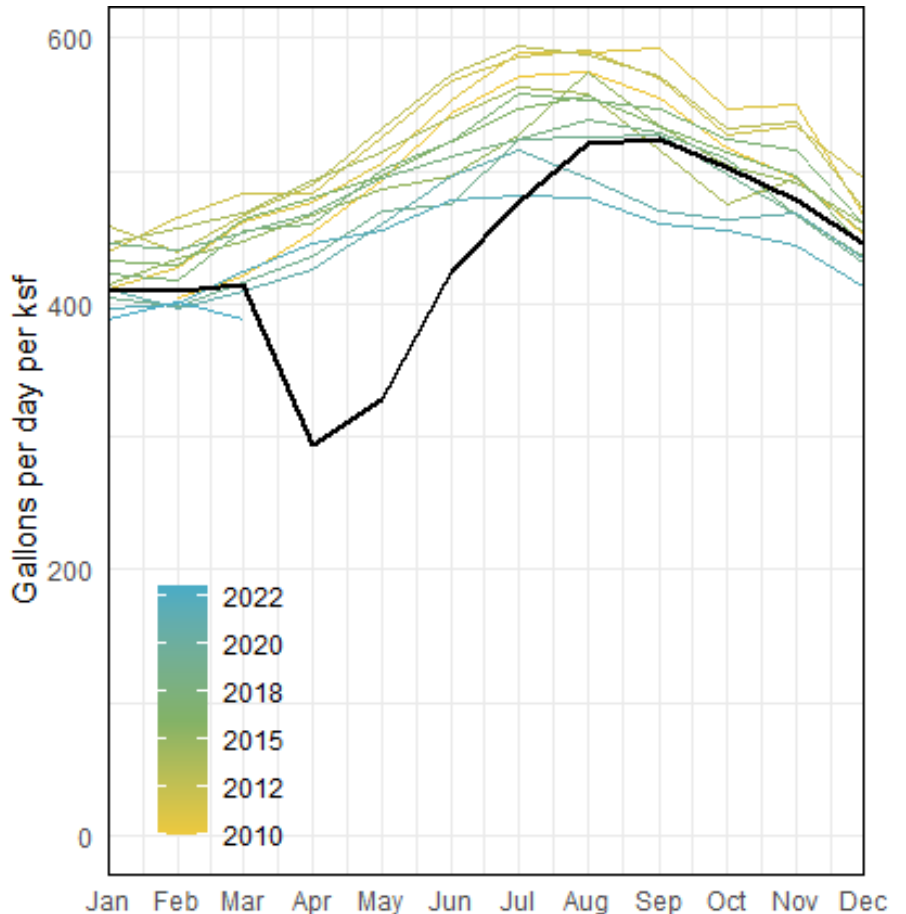
Figure 19 illustrates that the average g/day/ksf for restaurants was decreasing over time (as seen from the gradient from yellow to green to blue). The pandemic impacted restaurants especially, as water use dropped substantially in April and May of 2020. However, restaurant water use was on par with previous years by September of 2020.

This pattern of a substantial drop in water use during the early months of the COVID-19 pandemic followed by a return to pre-pandemic levels later in the year was observed for several other APUCs. (See Figure 20 for APUCs matching this pattern.)

Many other APUCs appeared to respond less severely to pandemic lockdowns. Figure 21 illustrates four APUCs that had lower than average water use in April of 2020 which quickly returned to pre-pandemic levels.

Of all APUCs analyzed, office buildings appear to be the only type of property with lasting impacts of the COVID-19 pandemic. While most other types of properties returned to pre-pandemic levels, office buildings have used less water than pre-pandemic levels, particularly in the summer months. (See Figure 21.)

19. Monthly restaurant g/day/ksf (January 2013–March 2023)

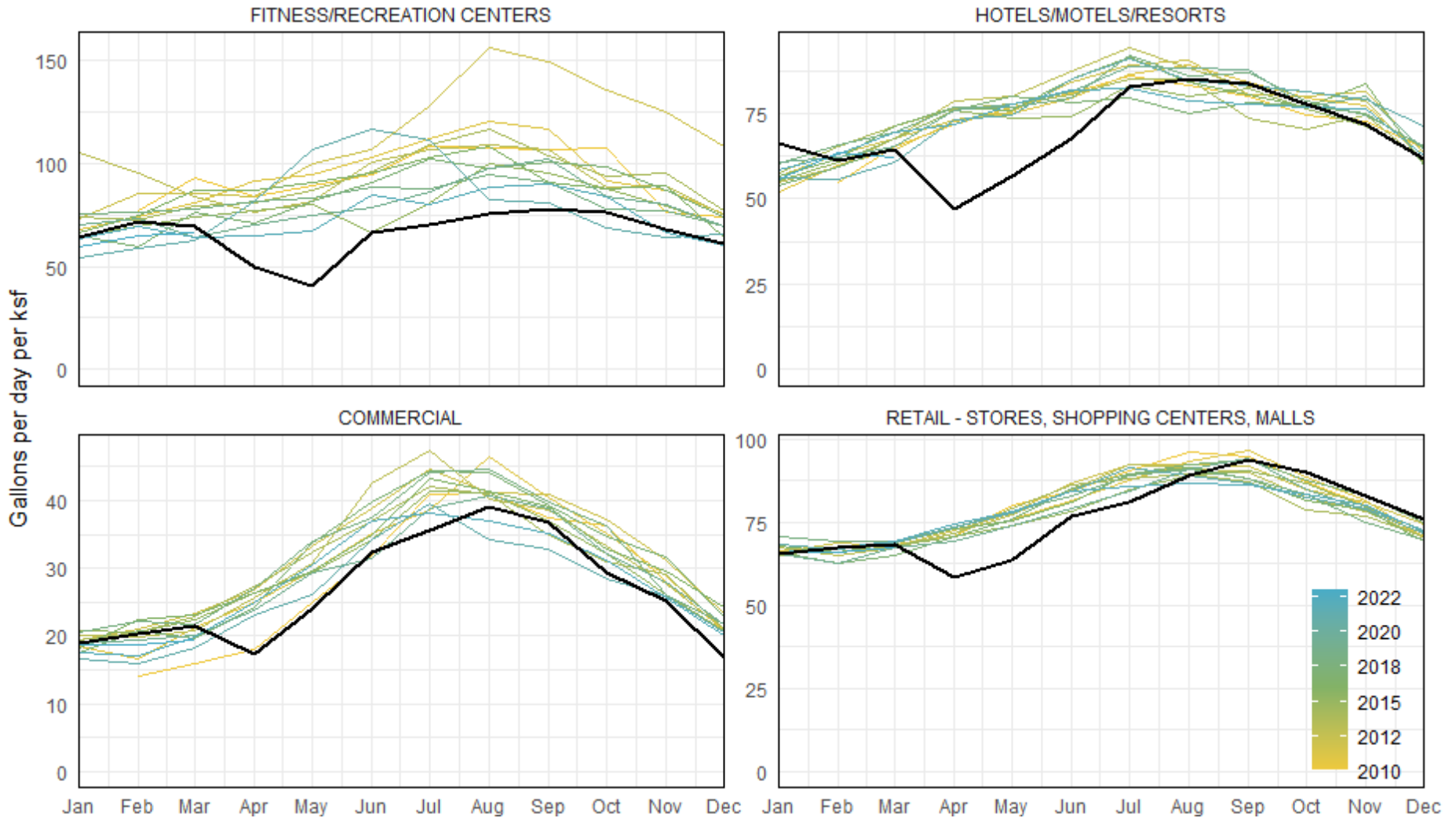


Source: Keen Independent analysis of City of Phoenix CII water use data, April 2013 through March 2023.

Commercial, Institutional and Industrial (CII) Water Use

20. Monthly Commercial/Retail APUC g/day/ksf (January 2013–March 2023)

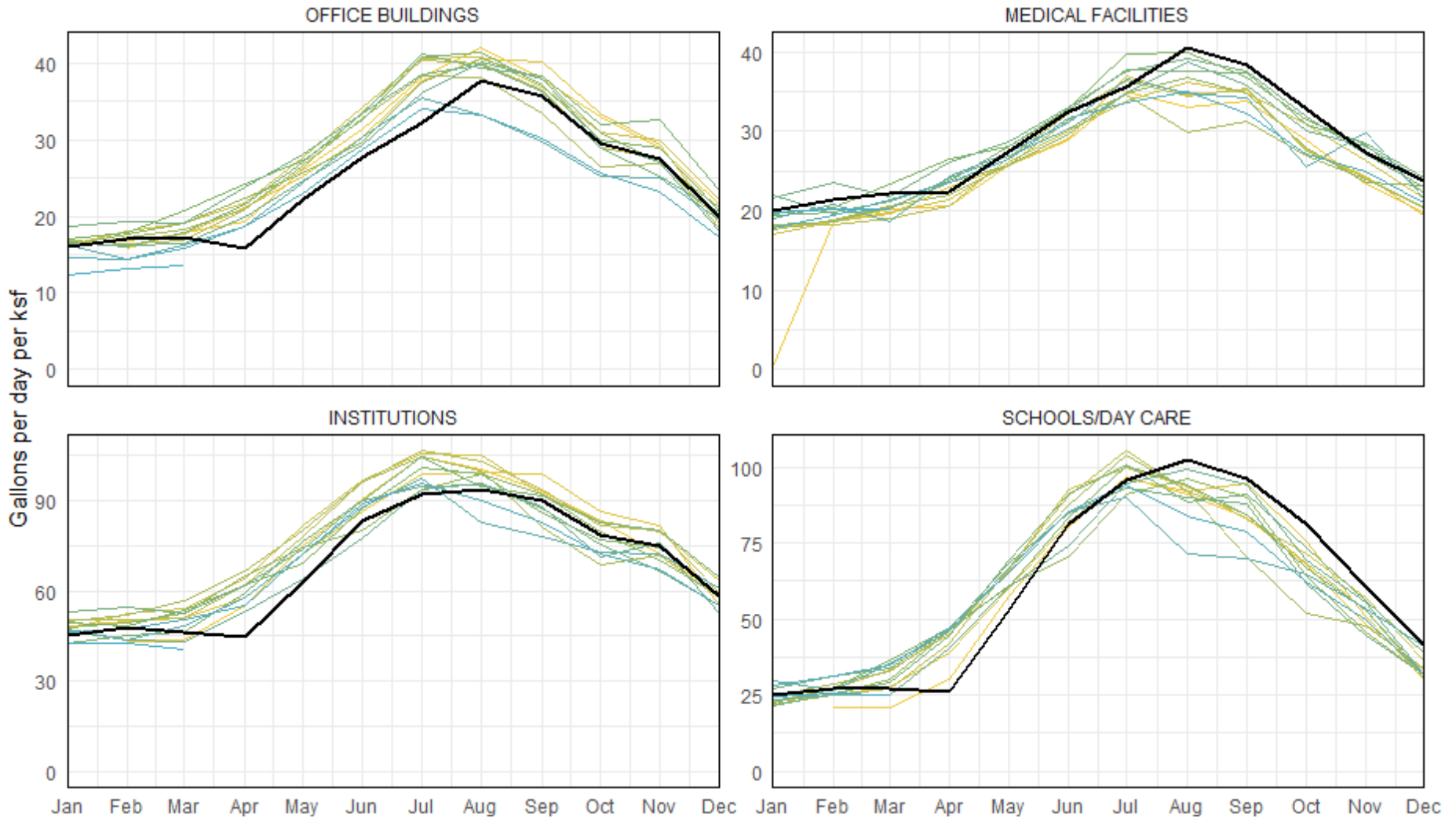
Source: Keen Independent analysis of City of Phoenix non-residential water use data, April 2010 through March 2023.



Note: The black line indicates 2020 to highlight changes in monthly use due to the COVID-19 pandemic.

Commercial, Institutional and Industrial (CII) Water Use

21. Monthly Institutional and Public Office APUC g/day/ksf (January 2013–March 2023)



Note: The black line indicates 2020 to highlight changes in monthly use due to the COVID-19 pandemic.

Source: Keen Independent analysis of City of Phoenix non-residential water use data, April 2010 through March 2023.

Wastewater Analysis

Keen Independent analyzed each water using sector’s contribution to wastewater flows in the City of Phoenix. Using observed water use values and estimates of indoor single-family water use, the study team estimated wastewater return flow rates for multifamily and non-residential properties.

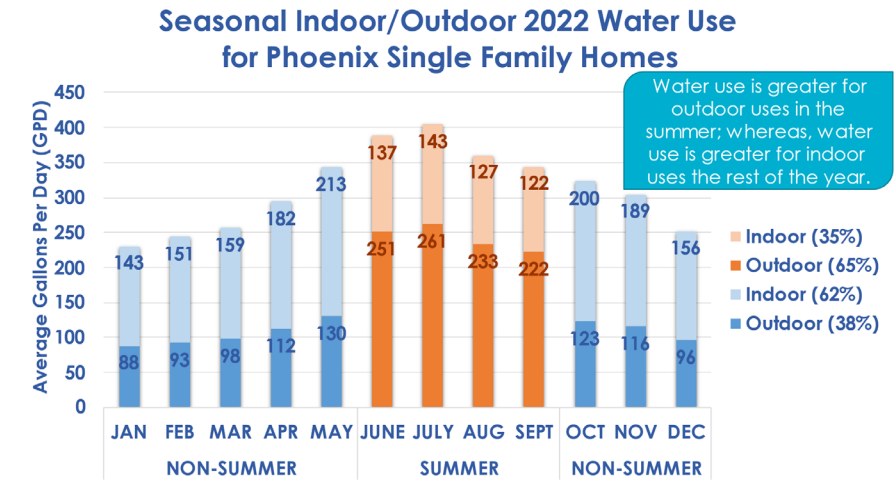
Wastewater Data and Methods

WSD provided Keen Independent with data on citywide monthly wastewater generation. The study team used the total millions of gallons of wastewater generated per day in 2022 (127) as a baseline for the sum of indoor residential and non-residential water use.

The study team relied on past research for estimates of the proportion of single-family water use that is indoor versus outdoor. The *2019 Phoenix Subdivision Water and Sewer Monitoring Project* analyzed residential water use and estimated that about 53 percent of annual single-family water use was used indoors and 67 percent of multifamily water use was used indoors. This research was supported by the *2019 Phoenix Metro Area Multi-City Water Use Study*. (See Figure 22.)

Using the total gallons of water used per day in 2022 (215 million), the study team was able to estimate the share of wastewater generated by single family homes as well as non-single-family properties.

22. Estimated seasonal indoor/outdoor 2022 water use



Non-Summer Reference: 2019 Phoenix Subdivision Water and Sewer Monitoring Project Final Report by Hazen & Sawyer
 Summer Reference: 2019 Phoenix Metropolitan Area Multi-City Water Use Study: Single Family Executive Report City of Phoenix

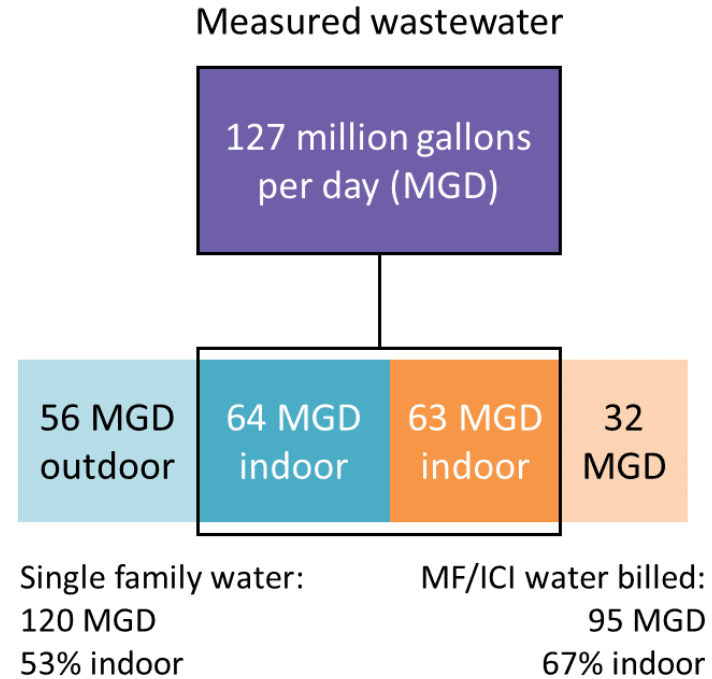
Wastewater Analysis

Results

About 127 million gallons of wastewater were generated per day in 2022. Total water use (billed) was 215 million gallons for the same period. SF water use accounted for about 120 million gallons per day (MGD) while MF and non-residential together accounted for about 95 MGD.

If 53 percent of SF water use is indoor water use (refer to Figure 22 on the previous page) and assuming that all of that water goes into wastewater treatment plants, then single-family customers generate 64 MGD of wastewater flows. The remainder of the 127 MGD of wastewater flows is 63 MGD, or about 67 percent of the water used by MF/non-residential properties in 2022. (This implies that 67 percent of the combined multifamily/non-residential use is indoor use and 33 percent is outdoor use.)

23. Wastewater analysis results (2022)



Source: Keen Independent analysis of City of Phoenix water use data and wastewater generation data (2022).

Wastewater Analysis

The wastewater estimates for residential properties are therefore 153 gpd for single family homes (289 gpd of water use × 53%) and 103 gpd per multifamily unit (162 gpd of water use × 67%).

To calculate the non-residential EDU factors, the wastewater estimate (g/day/ksf multiplied by the percent indoor estimate) was divided by the SF average wastewater estimate (153 g/unit/day). The result was then multiplied by the 2.61 adjustment factor for the EDU factor.

Note that these estimates are highly dependent on the assumption concerning the share of single-family water use that is indoor and outdoor. If indoor use was a smaller share than the 53 percent assumed here, then the wastewater generation per SF unit would be lower than 153 gpd and the wastewater generation related to MF/non-residential would be higher.

24. Wastewater analysis results and EDU factors (2022)

Property type	Avg. annual g/day	Percent indoor	Wastewater estimate	EDU factor
Residential (per unit)				
SF per unit	289	53 %	153	1.00
MF (any build year)	162	67	103	0.67
CII (per 1,000 sqft)				
Commercial and retail	52	67 %	35	0.59
Industrial	57	67	38	0.65
Institutional	59	67	39	0.67
Office	28	67	19	0.32
Public and other	41	67	27	0.47

Source: Keen Independent analysis of City of Phoenix water use data and wastewater generation data (2022) and City of Phoenix CII water use data, April 2013 through March 2023.

APPENDIX A. Methodology and Assumptions

Appendix A provides additional information about study methodology.

Water Year

Keen Independent received data through March 2023. COVID lockdown period was from March 2020 through March 2021. Keen Independent measured annual water use from April through March of the following year.

Thresholds

The study team identified outliers for omission from estimation of the single-family EDU. WSD reviewed a sample of the water users with the highest daily consumption and verified that the top 1 percent of water users were likely due to data entry error.

- **Single Family.** 1,737 gallons per day or more;
- **Multifamily.** 22,200 gallons per day;
- **Retail/Commercial.** 21,308 gallons per day; and
- **Public/Other.** 28,470 gallons per day;
- **Industrial.** 347,560 gallons per day;
- **Office/Storage.** 33,404 gallons per day.

Single Family

WSD supplied data on billed monthly water use for about 367,000 unique Service Points for single-family properties. Following data processing, single-family EDU analyses were based on water use patterns for 23,007 single-family properties.

Data selection. Keen Independent analyzed single-family water users with the following characteristics.

- Categorized as a single-family home according to a property use category variable.
- The property was built in 2010 or later according to Assessor data.
- The water meter size was typical for a single-family home (3/4", 5/8" or 1"). The study team and WSD confirmed that these meter sizes were typical for single-family homes. A near-zero proportion of homes built in 2010 or later had meters sizes larger than 1."
- The number of days in a billing period was non-zero.

Water use. WSD tracks water use in hundreds of cubic feet (CCF). The study team converted CCF to gallons by multiplying the CCF by 100 and then multiplying by the cubic feet to gallons conversion rate, 7.48052 gallons per cubic foot.

Single-family units. Single-family water demand was calculated per unit. The study team assumed a single-family home had one unit where number of units was missing, which was more than 99 percent of observations.

A. Methodology and Assumptions

Multifamily

Keen Independent analyzed the water use of about 6,100 multifamily residences from April 2013 through March 2023. Multifamily water users include apartment complexes, condominiums, duplexes, triplexes and other types of multifamily residential units.

Data selection. Keen Independent analyzed multifamily water users with the following characteristics.

- Categorized as a multifamily residence according to a property use category variable; and
- Contained valid number of units.

Third-party data supplement. Not all WSD multifamily data included number of units or number of stories. Keen Independent purchased third-party (Reonomy) data to supplement units and stories where possible. As WSD data were anonymized and Reonomy data were not, Keen Independent sent WSD the Reonomy data to merge with water use data and return to the study team with anonymized identifiers.

Water demand. Multifamily water demand was measured as the average daily water use per unit per year.

A. Methodology and Assumptions

Non-Residential Properties

Non-residential properties were categorized according to Maricopa County Assessor Property Use Code (PUC) definitions. WSD provided a relationship table between PUCs and non-residential property categories. The relationship table provided a hierarchical structure of 558 distinct PUCs, 44 simplified or “aggregated” PUC categories, and five CII categories (see Appendix B)

Data selection. Keen Independent analyzed non-residential water users with the following characteristics.

- Not categorized as single-family or multifamily residences according to a MASTER PLAN CATEGORY variable;
- Had a floor area of 500 square feet or more; and
- Contained valid number of stories.

Floor area. Assessor floor area data did not account for multiple stories. To calculate the total square footage of non-residential properties, the study team multiplied the number of stories by the floor area variable.

Water demand. Non-residential water demand was measured as the total gallons per day per user type divided by the total floor area per user type.

A. Methodology and Assumptions

Property type classification. WSD maintains water use data per water meter, each of which is classified according to the building's Property Use Code (PUC). However, characteristics required to scale water demand for comparison to average single-family demand, such as floor area and number of stories, existed only at the parcel level (which may contain several water meters). In some cases, there were several meters per parcel; applying parcel-level data to the meter-level underestimates non-residential EDU factors, as floor area for the parcel would be multiplied as many times as there are meters for that parcel.

To address the multiple meters per parcel data structure, the study team totaled water use per parcel, classifying all meters in a parcel according to the largest water using type on the parcel. For example, if there were two meters on a parcel – one Office/Warehouse and on Data Center – and the Data Center meter accounted for more than 50 percent of the water used by both properties, the whole parcel (and water used by meters on that parcel) would be classified as a Data Center. The data were aggregated at the parcel level by totaling the gallons used per day by all meters on that parcel.

APPENDIX B. Master Plan Categories and Property Use Codes

The City of Phoenix Water Services Department (WSD) provided Keen Independent with a relationship table of Maricopa County Assessor property use codes (PUCs) and how these codes are used to define property categories. Figure B-1 illustrates the hierarchical relationship between PUCs and WSD-defined aggregated PUCs and master plan categories.

Keen Independent analyzed property use codes by their aggregated PUC to examine the impact of the COVID-19 pandemic by specific types of non-residential properties. To estimate EDU factors and wastewater EDUs, Commercial, Institutional and Industrial (CII) categories were defined using the PUC relationships below.

Figure B-1. Property Use Code and Master Plan Category relationship table

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Retail/Commercial			
2210	Race Tracks Horses	2	Amusement Facilities/Theaters/Race Tracks
2520	Movie Theaters Walk- In	2	Amusement Facilities/Theaters/Race Tracks
2540	Bowling Alleys	2	Amusement Facilities/Theaters/Race Tracks
2570	Amusement Facilities	2	Amusement Facilities/Theaters/Race Tracks
0920	Salvage Commercial	5	Commercial
1040	Miscellaneous Commercial	5	Commercial
1040	Miscellaneous Commercial	5	Commercial
1040	Miscellaneous Commercial	5	Commercial
1074	Associated Commercial Parcels	5	Commercial
8801	Retention Basin with Cm Properties	5	Commercial
8804	Orphan Parcels with Cm Zoning	5	Commercial
9420	Federal Commercial Property	5	Commercial
9520	State Commercial Property	5	Commercial
9528	State Commercial Prop, lpr	5	Commercial
9620	County Commercial Property	5	Commercial
9720	Municipal Commercial Property	5	Commercial
9726	Municipal Commercial Prop - (GPLET)	5	Commercial
9728	Municipal Commercial Property, lpr	5	Commercial
9820	Indian Tribal Government Commercial Property	5	Commercial

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Retail/Commercial (continued)			
0212	Clubhouse/Rec Center - Not Qualified	7	Fitness/Recreation Centers
2730	Health and Fitness Club	7	Fitness/Recreation Centers
2461	Golf Maintenance Building, Separately Parceled	8	Golf Course/Driving Ranges
0410	Hotel	10	Hotels/Motels/Resorts
0411	Hotel 2 To 4 Stories	10	Hotels/Motels/Resorts
0412	Hotel 5 or More Stories	10	Hotels/Motels/Resorts
0422	Hotel 5 or More Stories Over 200 Rooms	10	Hotels/Motels/Resorts
0510	Motel	10	Hotels/Motels/Resorts
0512	Motel Over 200 Rooms	10	Hotels/Motels/Resorts
0520	Motel with Restaurant/Lounge Facilities	10	Hotels/Motels/Resorts
0522	Motel with Rest/Lounge Over 200 Rooms	10	Hotels/Motels/Resorts
0610	Resort	10	Hotels/Motels/Resorts
2804	Part Comp Hotels	10	Hotels/Motels/Resorts
1020	Laundromat	13	Laundries - Industrial/Commercial/Coin-Op
2120	Medical Clinic	15	Medical Facilities
2126	Medical Clinic Common Area Not Parceled	15	Medical Facilities
2130	Medical Clinic No Pharmacy	15	Medical Facilities
2140	Medical, Dental Service	15	Medical Facilities
2146	Medical, Dental Service, Com Area Not Parceled	15	Medical Facilities
2150	Medical, Dental Service No Lab or X- Ray	15	Medical Facilities
2170	Veterinarian Clinic/Hospital	15	Medical Facilities
2821	Part Comp Medical, Dental, Veterinarian	15	Medical Facilities
9020	Property Tax Expert, Medical, Dentist/Other Services	15	Medical Facilities
3070	Mining, Quarrying and Processing	16	Mines & Quarries
6800	Mineral Rights Only	16	Mines & Quarries
2320	Mortuary or Crematorium For Profit	17	Mortuaries Or Crematoriums

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Retail/Commercial (continued)			
2320	Mortuary or Crematorium For Profit	17	Mortuaries Or Crematoriums
0190	Miscellaneous Res Improvement Status Unknown	25	Residential - Mixed Use
0191	Miscellaneous Res Improvement Urban Subdivided	25	Residential - Mixed Use
0191	Miscellaneous Res Improvement Urban Subdivided	25	Residential - Mixed Use
0192	Miscellaneous Res Improvement Urban Non- Subdivided	25	Residential - Mixed Use
1210	Store and Office or Store and Apt Combo	25	Residential - Mixed Use
1220	Store and SF residence, 2/3/Fourplex, or MF Combo	25	Residential - Mixed Use
2897	Part Comp Municipal Property Imp	25	Residential - Mixed Use
8770	Mixed Res Any Combo >5 AC	25	Residential - Mixed Use
8772	Mixed Res Any Combo> 5 AC, Urban Nons	25	Residential - Mixed Use
8772	Mixed Res Any Combo> 5 AC, Urban Nons	25	Residential - Mixed Use
9510	State Residential Property	25	Residential - Mixed Use
9510	State Residential Property	25	Residential - Mixed Use
2010	Restaurant Sit Down	29	Restaurants/Food Svc/Bars
2010	Restaurant Sit Down	29	Restaurants/Food Svc/Bars
2020	Restaurant Sit Down with Cocktail Lounge	29	Restaurants/Food Svc/Bars
2028	Restaurant Sit Down with Cocktail Lounge	29	Restaurants/Food Svc/Bars
2030	Restaurant Fast Food	29	Restaurants/Food Svc/Bars
2031	Restaurant Fast Food, No Inside Eating	29	Restaurants/Food Svc/Bars
2040	Nightclub	29	Restaurants/Food Svc/Bars
2041	Nightclub, No Inside Eating	29	Restaurants/Food Svc/Bars
2050	Bar or Tavern	29	Restaurants/Food Svc/Bars
2060	Beverages/Prepared Food/No Kitchen	29	Restaurants/Food Svc/Bars
2820	Part Comp Restaurant, Night Club, Bar	29	Restaurants/Food Svc/Bars
8903	SF/Condo Conversion To Resturant Use	29	Restaurants/Food Svc/Bars
8987	Warehouse Conversion To MiscellaneousUse	30	Retail - Services/Miscellaneous

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Retail/Commercial (continued)			
1110	Convenience Store	31	Retail - Stores, Shopping Centers, Malls
1120	Store Front Commercial Building	31	Retail - Stores, Shopping Centers, Malls
1120	Store Front Commercial Building	31	Retail - Stores, Shopping Centers, Malls
1122	Store Front Commercial Building Two Story	31	Retail - Stores, Shopping Centers, Malls
1125	Retail Condo	31	Retail - Stores, Shopping Centers, Malls
1126	Retail Condo - Common Area	31	Retail - Stores, Shopping Centers, Malls
1128	Store Front Commercial Building	31	Retail - Stores, Shopping Centers, Malls
1130	Retail Strip Center	31	Retail - Stores, Shopping Centers, Malls
1132	Retail Strip Center Two Story	31	Retail - Stores, Shopping Centers, Malls
1140	Supermarket Groceries	31	Retail - Stores, Shopping Centers, Malls
1141	Supermarket Groceries with Fuel Dispense	31	Retail - Stores, Shopping Centers, Malls
1150	Warehouse Type Store	31	Retail - Stores, Shopping Centers, Malls
1151	Warehouse Type Store with Fuel Dispense	31	Retail - Stores, Shopping Centers, Malls
1153	Mega Warehouse Retail	31	Retail - Stores, Shopping Centers, Malls
1160	Store Building - Commercial without Store Front	31	Retail - Stores, Shopping Centers, Malls
1170	Freestanding Drug Store	31	Retail - Stores, Shopping Centers, Malls
1230	Store and Repair Garage Combo	31	Retail - Stores, Shopping Centers, Malls
1240	Store and Lumberyard Combo	31	Retail - Stores, Shopping Centers, Malls
1320	Jr Dept or Discount Store or Equiv	31	Retail - Stores, Shopping Centers, Malls
1410	Neighborhood Shopping Center	31	Retail - Stores, Shopping Centers, Malls
1416	Neighborhood Shop Ctr, Parcel Exc Lan	31	Retail - Stores, Shopping Centers, Malls
1417	Neighborhood Shop Ctr Nonqualifying	31	Retail - Stores, Shopping Centers, Malls
1420	Community Shopping Center Enclosed Mall	31	Retail - Stores, Shopping Centers, Malls
1430	Community Shop Ctr Open Air	31	Retail - Stores, Shopping Centers, Malls
1434	Community Shop Ctr Open Air, Parking	31	Retail - Stores, Shopping Centers, Malls
1440	Regional Shopping Center Enclosed Mal	31	Retail - Stores, Shopping Centers, Malls

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Retail/Commercial (continued)			
1444	Regional Shop Ctr Enclosed Mall, Parking	31	Retail - Stores, Shopping Centers, Malls
1450	Regional Shop Ctr Open Air	31	Retail - Stores, Shopping Centers, Malls
1460	Super Regional Shop Ctr Enclosed Mall	31	Retail - Stores, Shopping Centers, Malls
1480	Power Center	31	Retail - Stores, Shopping Centers, Malls
2811	Part Comp Conv/Strip Stores, Supermarket	31	Retail - Stores, Shopping Centers, Malls
8902	SF/Condo Conversion To Retail Use	31	Retail - Stores, Shopping Centers, Malls
1810	Motorcycle and All Terrain Vehicle	32	Retail - Vehicle/Equipment Sales
1820	Auto/Light Truck Dealership	32	Retail - Vehicle/Equipment Sales
1821	Auto/Light Truck Dealership, Auto Mall	32	Retail - Vehicle/Equipment Sales
1830	Auto/Light Truck Lot- Lease or Sale	32	Retail - Vehicle/Equipment Sales
1840	Heavy Equipment/Truck Lease or Sale	32	Retail - Vehicle/Equipment Sales
1841	Heavy Equip/Truck Lease or Sale- Auto Mall	32	Retail - Vehicle/Equipment Sales
1860	Sale/Rental/Repair Light Equip/Trucks	32	Retail - Vehicle/Equipment Sales
1870	Mh/Motor Home/Rv Sales/Rent/Repair	32	Retail - Vehicle/Equipment Sales
1890	Auto Wrecking and/or Salvage Yard	32	Retail - Vehicle/Equipment Sales
1041	Contractors' and Landscapers' Storage Yard	35	Storage
3730	Mini-Storage	35	Storage
3731	Mini-Storage, Planned Industrial Park	35	Storage
3734	Mini-Storage Common Area with Imp	35	Storage
3736	Mini-Storage, Off/Ret Interior Finish - 26% To 60%	35	Storage
3739	Mini-Storage Condominium	35	Storage
0021	Vacant Commercial Urban Subdivided	38	Vacant Land - Commercial
0022	Vacant Commercial Urban Non- Subdivided	38	Vacant Land - Commercial
0023	Vacant Commercial Rural Subdivided	38	Vacant Land - Commercial
1111	Convenience Store With Fuel Dispensing	42	Vehicle Fuel/Service/Repair Stations
1131	Retail Strip Center With Fuel Dispens	42	Vehicle Fuel/Service/Repair Stations

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Retail/Commercial (continued)			
1710	Full-Service Service Station	42	Vehicle Fuel/Service/Repair Stations
1720	Self-Service Service Station	42	Vehicle Fuel/Service/Repair Stations
1724	Self-Service Station, Car/Truck Self	42	Vehicle Fuel/Service/Repair Stations
1725	Self-Service Station with Retail Sales	42	Vehicle Fuel/Service/Repair Stations
1726	Self-Service Station with Rest Facilities	42	Vehicle Fuel/Service/Repair Stations
1742	Truck Stop, Car/Truck Full Service	42	Vehicle Fuel/Service/Repair Stations
1745	Truck Stop with Retail Sales	42	Vehicle Fuel/Service/Repair Stations
1760	Auto Service, Fast Oil/Lube, and/or Tune- Up	42	Vehicle Fuel/Service/Repair Stations
1762	Auto Service/Car/Truck Full Service	42	Vehicle Fuel/Service/Repair Stations
1765	Auto Service Fast Oil/Lube, Tune- Up	42	Vehicle Fuel/Service/Repair Stations
1770	Auto Repair Garage, Autos/Light Truck	42	Vehicle Fuel/Service/Repair Stations
1771	Auto Repair Garage with Lodging	42	Vehicle Fuel/Service/Repair Stations
1772	Auto Repair Garage with Full Service	42	Vehicle Fuel/Service/Repair Stations
1773	Auto Repair Garage with Fuel Facilities	42	Vehicle Fuel/Service/Repair Stations
1775	Auto Repair Garage W Retail	42	Vehicle Fuel/Service/Repair Stations
1778	Auto Repair Garage, Autos/Light Truck	42	Vehicle Fuel/Service/Repair Stations
1780	Truck or Heavy Equipment Repair	42	Vehicle Fuel/Service/Repair Stations
1782	Truck or Heavy Equip Repair- Full Service	42	Vehicle Fuel/Service/Repair Stations
1783	Truck or Heavy Equip Repair- Fuel Facilities	42	Vehicle Fuel/Service/Repair Stations
1880	Auto/Truck Tires, Parts Sales and Service	42	Vehicle Fuel/Service/Repair Stations
1750	Car/Truck Wash	43	Vehicle/Car/Truck Washes
1752	Car/Truck Wash, Full Service	43	Vehicle/Car/Truck Washes
1753	Car/Truck Wash, Full Service with Fuel	43	Vehicle/Car/Truck Washes
1754	Car/Truck Wash, Self Service.	43	Vehicle/Car/Truck Washes
1755	Car/Truck Wash with Retail Sales	43	Vehicle/Car/Truck Washes
2837	Part Comp Industrial Warehouses	44	Warehouses

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Retail/Commercial (continued)			
3710	Warehousing	44	Warehouses
3711	Warehousing, Planned Industrial Park	44	Warehouses
3712	Warehouse - Industrial Complex, Non Subdivided	44	Warehouses
3713	Warehousing - Rail Spur, Privately Owned	44	Warehouses
3716	Warehouse - Off and/or Retail Interior Finish - 26% To 60%	44	Warehouses
3717	Warehouse - Off and/or Ret Interior Finish - 61% To 100%	44	Warehouses
3740	Office/Retail Warehouse	44	Warehouses
3741	Warehouse with Office/Retail, Planned Par	44	Warehouses
3742	Warehouse with Office/Retail, Nonsubdivided	44	Warehouses
3746	Warehouse with 26%- 60% Interior Finish	44	Warehouses
3747	Warehouse with 61%- 100% Interior Finish	44	Warehouses
3760	Warehouse Agricultural Commodities	44	Warehouses
3766	Warehouse Ag with 26% To 60% Interior Finish	44	Warehouses
3770	Cold-Storage Warehouse	44	Warehouses
3780	Office/Retail Warehouse with Aircraft Hangar	44	Warehouses
3784	Office/Retail Warehouse with Aircraft, C/A with Imps	44	Warehouses
3786	Office/Retail Warehouse with Hangar, Interior Finish 26% To 60%	44	Warehouses
3799	Warehouse Not To Be Market Modeled	44	Warehouses
Industrial			
1507	Data Centers	6	Data Centers
2830	Part Comp Industrial Properties	11	Industrial
3010	Multiuse or Miscellaneous Industrial	11	Industrial
3011	Multiuse/Miscellaneous Indust Planned Park	11	Industrial
3050	Lumbering, Saw Mills, Planing Mills	11	Industrial
3099	Industrial Prop Not To Be Market Modeled	11	Industrial

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Industrial (continued)			
3720	Truck Terminal	11	Industrial
3721	Truck Terminal, Planned Industrial Park	11	Industrial
9530	State Industrial Property	11	Industrial
9531	Taxable Industrial Leased To State Go	11	Industrial
9538	State Industrial Prop, Ipr	11	Industrial
9630	County Industrial Property	11	Industrial
9730	Municipal Industrial Property	11	Industrial
9738	Municipal Indust Prop, Ipr	11	Industrial
1030	Commercial Laundry	13	Laundries - Industrial/Commercial/Coin-Op
3020	Manufacture Durable/Nondurable Goods	14	Manufacturing
3021	Manuf Dur/Nondurable, Planned Park	14	Manufacturing
3023	Manuf Dur/Nondurable Complex Nonsubdivided	14	Manufacturing
3028	Manuf Durable/Nondurable Goods, Ipr	14	Manufacturing
3030	Special Purpose Manufacturing Plant	14	Manufacturing
3031	Spec Purpose Manuf, Planned Park	14	Manufacturing
3040	Manufacture Food Products	14	Manufacturing
2110	Hospital	15	Medical Facilities
2160	Emergency Care	15	Medical Facilities
9010	Prop Tax Ex, Hospital	15	Medical Facilities
1730	Petroleum Bulk Plant	21	Petroleum Bulk Plants
3022	Manuf Dur/Nondurable Private Rail Spur	24	Rail Spurs
3042	Manuf Food Products Private Rail Spur	24	Rail Spurs
3723	Truck Terminal Private Rail Spur	24	Rail Spurs
0031	Vacant Industrial Urban Subdivided	40	Vacant Land - Industrial
0032	Vacant Industrial Urban Non- Subdivided	40	Vacant Land - Industrial
0033	Vacant Industrial Rural Subdivided	40	Vacant Land - Industrial

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Institutional			
8806	Restricted By A Municipality	9	Government - Miscellaneous
9364	Government Property Lease Excise Tax (GPLET) Associated Parcel	9	Government - Miscellaneous
9374	Exempt Associated Parcel	9	Government - Miscellaneous
9374	Exempt Associated Parcel	9	Government - Miscellaneous
9374	Exempt Associated Parcel	9	Government - Miscellaneous
9480	Federal Miscellaneous Improved Prop	9	Government - Miscellaneous
9580	State Miscellaneous Improved Prop	9	Government - Miscellaneous
9588	State Miscellaneous Property, Ipr	9	Government - Miscellaneous
9680	County Miscellaneous Improved Property	9	Government - Miscellaneous
9780	Municipal Miscellaneous Improved Property	9	Government - Miscellaneous
9780	Municipal Miscellaneous Improved Property	9	Government - Miscellaneous
9786	Municipal Miscellaneous Improved Prop (GPLET)	9	Government - Miscellaneous
2720	Club, Lodge, Fraternal Non Profit	12	Institutions
9050	Prop Tax Ex, Charitable Institution	12	Institutions
9060	Prop Tax Ex, Housing	12	Institutions
9060	Prop Tax Ex, Housing	12	Institutions
9070	Prop Tax Ex, Community Service Organ	12	Institutions
9070	Prop Tax Ex, Community Service Organ	12	Institutions
9110	Prop Tax Ex, Prop Musical, Drama, Dance..	12	Institutions
9150	Prop Tax Ex, Animal Shelter	12	Institutions
9150	Prop Tax Ex, Animal Shelter	12	Institutions
9160	Prop Tax Ex, Club, Lodge/Fraternal Org	12	Institutions
9162	Prop Tax Ex, Club, Lodge., Vet Org	12	Institutions
9200	Vacant Land, Religious Use	12	Institutions
9210	Residence (Not Parsonage) Religious Use	12	Institutions
9210	Residence (Not Parsonage) Religious Use	12	Institutions

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Institutional (continued)			
9210	Residence (Not Parsonage) Religious Use	12	Institutions
9220	Commercial, Religious Use	12	Institutions
9250	Office, Religious Use	12	Institutions
9250	Office, Religious Use	12	Institutions
9270	Worship Fac, Religious Use	12	Institutions
9270	Worship Fac, Religious Use	12	Institutions
9271	Worship Facility, Tax Prop Leased To Religious Group	12	Institutions
9277	Worship Facility (Condo)	12	Institutions
9280	Parsonage Religious Use	12	Institutions
9280	Parsonage Religious Use	12	Institutions
9287	Parsonage (Condo)	12	Institutions
2910	Day Care and Pre- School Center	34	Schools/Day Care
2911	Day Care and Pre- School, Children	34	Schools/Day Care
2920	Academic School Private	34	Schools/Day Care
2921	Academic School Private, Children	34	Schools/Day Care
2922	Academic School Private, Adults	34	Schools/Day Care
2923	Academic School Private, Charter School	34	Schools/Day Care
2930	Vocational School Private	34	Schools/Day Care
2931	Vocational Sch Private, Children	34	Schools/Day Care
2932	Vocational School Private, Adults	34	Schools/Day Care
9120	Prop Tax Ex, Schools/Libraries	34	Schools/Day Care
9120	Prop Tax Ex, Schools/Libraries	34	Schools/Day Care
9121	Prop Tax Ex, Sch/Libraries, Charter School	34	Schools/Day Care
9290	School, Religious Owned, Religious Use	34	Schools/Day Care
9590	State School Property	34	Schools/Day Care
9598	State School Prop, lpr	34	Schools/Day Care

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Institutional (continued)			
9690	County School Property	34	Schools/Day Care
9690	County School Property	34	Schools/Day Care
9790	Municipal School Property	34	Schools/Day Care
Landscape			
2270	Animal Boarding/Breeding Fac	1	Agricultural
4110	Field Crops	1	Agricultural
4111	Field Crops, Mixed Ag and Non Ag Use	1	Agricultural
4117	Field Crops, Mixed Structures On Site	1	Agricultural
4510	High- Yield Crop or Commodity Production	1	Agricultural
4512	High- Yield Crop/Commodity, with Cm Use	1	Agricultural
4590	Horse Breeding Farm	1	Agricultural
2310	Cemetery or Mausoleum For Profit	4	Cemeteries Or Mausoleums
9030	Cemetery or Mausoleum Non Profit	4	Cemeteries Or Mausoleums
2413	18- 36 Hole Course, Not Qualifying	8	Golf Course/Driving Ranges
2415	18- 36 Hole Course, Private, Open To Public	8	Golf Course/Driving Ranges
2416	18- 36 Hole Course, Private, Membership Only	8	Golf Course/Driving Ranges
2474	Golf Course Associated Parcel	8	Golf Course/Driving Ranges
0261	Open Space Area - Qualified	20	Parks & Recreational Open Spaces
0262	Open Space Area - Not Qualified	20	Parks & Recreational Open Spaces
9450	Federal Parks and Reserve Property	20	Parks & Recreational Open Spaces
9550	State Parks Property	20	Parks & Recreational Open Spaces
9650	County Park/Recreational Properties	20	Parks & Recreational Open Spaces
9750	Municipal Park/Recreational Property	20	Parks & Recreational Open Spaces
1060	Plant Nursery Retail/Wholesale Only	22	Plant Nursery/Greenhouse
4010	Plant Nursery	22	Plant Nursery/Greenhouse

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Landscape (continued)			
4011	Plant Nursery, Mixed Ag and Non Ag Use	22	Plant Nursery/Greenhouse
4012	Plant Nursery, Ag Use and Retail/Wholesale	22	Plant Nursery/Greenhouse
4013	Plant Nursery, with Unsecured Mobile	22	Plant Nursery/Greenhouse
4015	Plant Nursery with SF/Affixed Mobile	22	Plant Nursery/Greenhouse
4017	Plant Nursery, Mixed Structures On Site	22	Plant Nursery/Greenhouse
4017	Plant Nursery, Mixed Structures On Site	22	Plant Nursery/Greenhouse
Office/storage			
1610	Bank	3	Bank/Financial Institutions
1615	Bank Mh or Modular Construct	3	Bank/Financial Institutions
1620	Savings and Loan	3	Bank/Financial Institutions
1630	Credit Union	3	Bank/Financial Institutions
1635	Credit Union Mh or Mod Cons	3	Bank/Financial Institutions
2157	Office - Medical Related Services	15	Medical Facilities
1510	Office Building	18	Office Buildings
1511	Office Building 1 Story	18	Office Buildings
1511	Office Building 1 Story	18	Office Buildings
1512	Office Building 2 Story	18	Office Buildings
1512	Office Building 2 Story	18	Office Buildings
1513	Office Building 3 Story	18	Office Buildings
1514	Office Building 4 or More Story	18	Office Buildings
1521	Office Building 1 Story, Parking Not Separated	18	Office Buildings
1522	Office Building 2 Story, Parking Not Separated	18	Office Buildings
1523	Office Building 3 Story, Parking Not Separated	18	Office Buildings
1524	Office Building 4 Story with Prking Not Separated	18	Office Buildings
1530	Garden Type Office Building	18	Office Buildings
1531	Garden Type Office Building 1 Story	18	Office Buildings

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Office/storage (continued)			
1540	Office Building with Res and/or Mh	18	Office Buildings
1541	Office Building with Res and/or Mh, 1 Story	18	Office Buildings
1542	Office Building with Res and/or Mh, 2 Story	18	Office Buildings
1551	Office Building Store/Off and Apartment 1 Story	18	Office Buildings
1552	Office Building Store/Off and Apartment 2 Story	18	Office Buildings
1560	Office Building/Ind Park	18	Office Buildings
1561	Office Building/Ind Park 1 Story	18	Office Buildings
1570	Office Condominium	18	Office Buildings
1571	Office Condominium 1 Story	18	Office Buildings
1572	Office Condominium 2 Story	18	Office Buildings
1573	Office Condominium 3 Story	18	Office Buildings
1574	Office Condominium 4+ Stories	18	Office Buildings
1576	Common Area Of Office Condominium	18	Office Buildings
1577	Office Condominium (Shell)	18	Office Buildings
1580	Office Building with Aircraft Hangar	18	Office Buildings
1581	Off Building with Aircraft Hangar 1 Story	18	Office Buildings
2815	Part Comp Office Buildings	18	Office Buildings
8901	SF Converted To Office- Use	18	Office Buildings
8911	Multi- Fam Res Conv To Office Use	18	Office Buildings
Public/other			
1850	Auto/Truck Storage Lot	19	Parking Lots
2610	Parking Structure Separately Parceled	19	Parking Lots
2620	Associated Park Structure Separately Parceled	19	Parking Lots
2630	Parking Lot Sep Parc, Private or Pay To Park	19	Parking Lots
2640	Associated Parking Lot Separately Parceled	19	Parking Lots
2641	Associated Park Lot Separately Parceled with Auto Service	19	Parking Lots

B. Master Plan Categories and Property Use Codes

Figure B-1. Property Use Code and Master Plan Category relationship table (continued)

Property Use Code (PUC)	PUC label	Aggregated PUC	Aggregated PUC label
Public/other (continued)			
2650	Parking/Storage Lot	19	Parking Lots
2651	Parking/Storage Lot, with Auto Service	19	Parking Lots
2826	Part Comp Parking Facilities	19	Parking Lots
9470	Federal Military Facilities Property	23	Police/Fire/Military Facilities
9570	State Police/Military Property	23	Police/Fire/Military Facilities
9670	County Police/Fire Department Facility	23	Police/Fire/Military Facilities
9770	Municipal Police/Fire Department Facility	23	Police/Fire/Military Facilities
0251	Private Roadway - Qualified	33	Roadways
0252	Private Roadway - Not Qualified	33	Roadways
8802	Private Roadways Assoc with Cm Properties	33	Roadways
8805	Orphan Parcels with Road Zoning	33	Roadways
2590	Radio, TV, Cable TV, Antenna TV System	37	Utilities
3077	Land Fills	37	Utilities
5100	Railroad Operating Property	37	Utilities
5300	Pipeline Operating Property	37	Utilities
5400	Gas and Electricity Utility Operating Property	37	Utilities
5500	Water Utility Operating Property	37	Utilities
5600	Telecommunications Property	37	Utilities
5700	Municipal Utilities (Electrical)	37	Utilities
8800	Limited Use- Well/Tower Sites, Private Roads	37	Utilities
9910	Tax Exempt Electric District	37	Utilities
9920	Tax Exempt Irrigation District	37	Utilities
9400	Federal Vacant Land	39	Vacant Land - Government
9500	State Vacant Land	39	Vacant Land - Government
9600	County Vacant Land	39	Vacant Land - Government
9700	Municipal Vacant Land	39	Vacant Land - Government