2020 TRI-VALLEY
MUNICIPAL AND INDUSTRIAL WATER DEMAND STUDY

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2020 TRI-VALLEY MUNICIPAL AND INDUSTRIAL WATER DEMAND STUDY

Final Report

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ACRONYMS

Acronym [A]	Definition
ac	acre
AF	acre-foot
AFY	acre-feet per year
AMI	Advanced Metering Infrastructure
APN	assessor's parcel number
AWWA	American Water Works Association
BART	Bay Area Rapid Transit
CDD	Community Development Department
CII	Commercial, Industrial, and Institutional
CIMIS	California Irrigation Management Information System
CPI	Consumer Price Index
DERWA	DSRSD-EBMUD Recycled Water Authority
DOF	Department of Finance
DSRSD	Dublin-San Ramon Services District
DU	dwelling unit
DWR	Department of Water Resources
EBMUD	East Bay Municipal Utility District
FCI	Federal Correction Institution
GIS	Geographic Information System
GPCD	gallons per capita per day
mgd	million gallons per day
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
R-GPCD	residential gallons per capita per day
SWRCB	State Water Resources Control Board
TDC	Transferable Development Credits
GPQ	Groundwater Pumping Quota
WMP	Water Master Plan

Note:

A. *Numerous additional acronyms for land use codes are described in tables throughout the report and are not included in this report-wide acronym summary.*

EXECUTIVE SUMMARY

Background

The Tri-Valley Water Agencies consist of Zone 7 Water Agency (Zone 7), a wholesale water supply agency, and four water retail agencies or retailers (Dublin San Ramon Services District [DSRSD], City of Pleasanton, City of Livermore, and California Water Service Livermore District). They share a common goal of working together to better align planning efforts so that the water future of the Tri-Valley is secure.

The primary goal of the 2020 Tri-Valley Municipal and Industrial Water Demand Study was to develop a regional, land-use based water demand forecasting model (Model) for Zone 7 that produces key inputs to its 2020 Urban Water Management Plan, 2021 Water Supply Evaluation Update, water conservation program, and other planning efforts. Historically, the retailers have conducted independent demand forecasting, with Zone 7 using those forecasts to develop a regional forecast, with some adjustment. This study serves to develop a consistent method for estimating demands across the Tri-Valley region, while still considering the unique characteristics of each of the four retail agencies served by Zone 7, including demographic data, historical water use, demand hardening patterns, and future projections for land use and population. The Model can be used for future planning and is easily updated with new information as it becomes available. The Model provides demand forecasts by parcel, allowing Zone 7 and its retailers to easily analyze how current and near future developments may trigger changes in demand forecasts, as well as how changes in land use or unique demand management approaches may change the outcomes.

The Model is the center of the projection methodology and was designed in Microsoft Excel without the use of macros in an effort to increase transparency and allow the agencies to easily update inputs in the future as conditions change, new information is available, or as there is interest in running additional scenarios. The Model is supported by two additional components: (1) a GIS Tool that processes the spatial data for parcels and assigns land uses as well as (2) a fixture saturation model that calculates the potential water savings from passive conservation due to plumbing code future fixture replacements.

Data Sources

The Model is primarily driven by the land use projected for buildout in the respective general plans for each city in Zone 7's service area. However, some water agencies or their respective city planning departments track future known proposed developments that are being permitted or constructed. In these cases, the Model provides flexibility for updating the year in which a parcel's demand comes online or changing assumptions about land use type associated with the development. The Model will be updated regularly with new development information as it becomes available. Finally, the water demand projection methodology for each parcel is driven by historical water consumption specific to each agency. Meter data was collected from each agency and tied to parcels to calculate either area-specific water demand factors or per-capita water demand factors.

Projection Methodology

The model calculates demands for four sectors as described below:

Residential Indoor demands are calculated by first projecting population based on parcel area multiplied by the expected dwelling unit density (number of dwelling units per acre) and the average number of people per dwelling unit. Population is then multiplied by indoor residential per capita use (gallons per person per day of indoor use).

Residential Outdoor demands are calculated by multiplying area of residential land by an outdoor water demand factor (AF/ac). The outdoor water demand factor was calculated using historic water consumption reported by each agency. Historic residential water consumption was disaggregated into estimates of indoor and outdoor water use per property.

Commercial, Industrial, and Institutional (CII) demands are calculated by multiplying area of CII land by a CII water demand factor (AF/ac). The CII water demand factor was calculated using historic water consumption reported by each agency. CII parcels were sorted in various land use categories according to county assessor data.

Water losses are calculated by multiplying number of service connections by “real losses per connection per day” and "apparent losses per connection per day" which are both volumetric units calculated by agencies as part of annual water loss reporting requirements.

Unmetered Consumption is authorized consumption from unmetered uses like firefighting or construction meters that is calculated by multiplying total potable demands by an estimated percent unmetered.

The Model also makes the following adjustments to the projected demands:

- **Climate Change** – increases in outdoor water demands are expected as a result of increasing temperatures, more frequent and more intense droughts and heat waves, and increasing variability in precipitation due to ongoing climate change.
- **Recycled Water (as a supply; not demand reduction)** – the Model calculates water demands per parcel for each sector using the same methodology, regardless of the water supply. This section of the Model allocates that water demand between potable and recycled water sources depending on where the parcel is located within a recycled water service area.

Results

Table ES-1 shows the total projected demands by sector in five-year increments from 2020 through the 2045 planning horizon. Total potable demands are estimated at approximately 39,000 AF in 2020[1] and peak at approximately 50,225 AF before holding constant beginning in 2040 (an approximate 11,200 AF increase). After subtracting out a Groundwater Pumping Quota (GPQ) of 6,569 AF, the total retailer demand on Zone 7 at buildout (2040) is approximately 43,700 AF compared to approximately 32,500 AF in 2020.

[1] At the time of publishing, actual 2020 demands were noted to be somewhat higher than projected. This is expected to be partly due to the impact of the COVID-19 pandemic and shelter-in-place orders that were in effect for most of the year and a corresponding increase in residential consumption. The Model is designed as a long-term planning tool and does not account for near-term impacts such as COVID-19. Estimated 2020 consumption is based on recent trends and lines up very closely with actual 2019 demands.

Table ES-1: Projected Total Retailer Demands (Baseline Scenario)

Year	Population	Residential Indoor (AF)	Residential Outdoor (AF)	CII (AF)	Unmetered Consumption (AF)	Water Loss (AF)	Total Potable (AF) B	GPQ (AF) A	Retailer Demands on Zone 7 (AF) B
2020	265,811	12,852	13,076	9,910	365	2,837	**39,039**	6,569	**32,470**
2025	283,964	14,576	14,332	11,129	412	3,163	**43,612**	6,569	**37,043**
2030	299,121	15,331	15,568	11,435	432	3,348	**46,114**	6,569	**39,545**
2035	311,887	15,963	16,718	11,575	442	3,517	**48,216**	6,569	**41,647**
2040	322,742	16,495	17,845	11,754	450	3,683	**50,225**	6,569	**43,656**
2045	322,742	16,495	17,845	11,754	450	3,683	**50,225**	6,569	**43,656**
Change from 2020-2045	56,931	3,643	4,769	1,844	85	846	**11,186**	0	**11,186**

Notes:

A. *645 AF GPQ for DSRSD is pumped by Zone 7 and not included in GPQ column.*

B. *Development information was updated in May 2021, resulting in a net increase of 42 AF and 1,117 people at buildout (2045). These net increases are not reflected in the table.*

Scenarios

The Model can be configured to run many different scenarios based on custom adjustments to the inputs. For the purposes of this study, five scenarios (plus baseline) were run to represent a range of potential future conditions that could impact water demands. These are listed below with their 2045 total retailer potable demand on Zone 7 for reference:

1. Baseline (43,656 AF)
   - Based on recent consumption patterns and expected growth.
2. New Normal (34,920 AF)
   - Low bound with the modeled effects of passive conservation (water savings from regulatory drivers, typically due to the replacement of inefficient water fixtures) and price elasticity (water savings associated with the long-term increase in water rates).
3. Drought & Economic Rebound (47,024 AF)
   - High bound assuming some level of rebound post-drought.
4. Economic Slowdown (35,912 AF)
   - Several sources of water reductions with slower pace of development, including passive conservation and price elasticity described in #2 above.
5. Growth Cycling (43,656 AF)
   - Different growth rate pattern (with the same endpoint) mimicking alternate growth assumptions from Zone 7's Connection Fee Program Update.
6. Recycled Water Expansion (42,251 AF)
   - Recycled water served to all "potential" recycled water parcels to offset additional potable demands.

1. INTRODUCTION & BACKGROUND

1.1 Purpose

The primary goal of the 2020 Tri-Valley Municipal and Industrial Water Demand Study was to develop a regional, land-use based water demand forecasting model (Model) for Zone 7 Water Agency (Zone 7) that produces key inputs to its 2020 Urban Water Management Plan, its 2021 Water Supply Evaluation Update, its water conservation program, and potentially other planning efforts. This study serves to develop a consistent method for estimating demands across the Tri-Valley region, while still considering the unique characteristics of each of the four retail agencies served by Zone 7, including demographic data, historical water use, demand hardening patterns, and future projections for land use and population. The Model can be used for future planning and is easily updated with new information as it becomes available. The Model provides demand forecasts by parcel, allowing Zone 7 and its retailers to easily analyze how current and near future developments (and their timing) may trigger changes in demand forecasts, as well as how other changes in land use or unique demand management approaches may change the outcomes.

1.2 Document Organization

This document provides an overview of the Tri-Valley Water Agencies (Section 1), the data sources used in the Model (Section 2), the demand projection methodologies (Section 3), adjustment factors used to modify the projections (Section 4), and Model results and scenarios (Section 5).

Two companion documents provide additional technical information about the Model. Appendix A is an Excel Model User Guide that provides user information for updating assumptions, adding or editing development or recycled water parcel information, viewing outputs, and running scenarios. Appendix B is a GIS Tool Update Guide that provides information on how the GIS Tool runs to generate input data for the Excel Model and how to update the inputs of the GIS Tool.

The Model makes use of three geographic terms that are described below and used throughout this report:

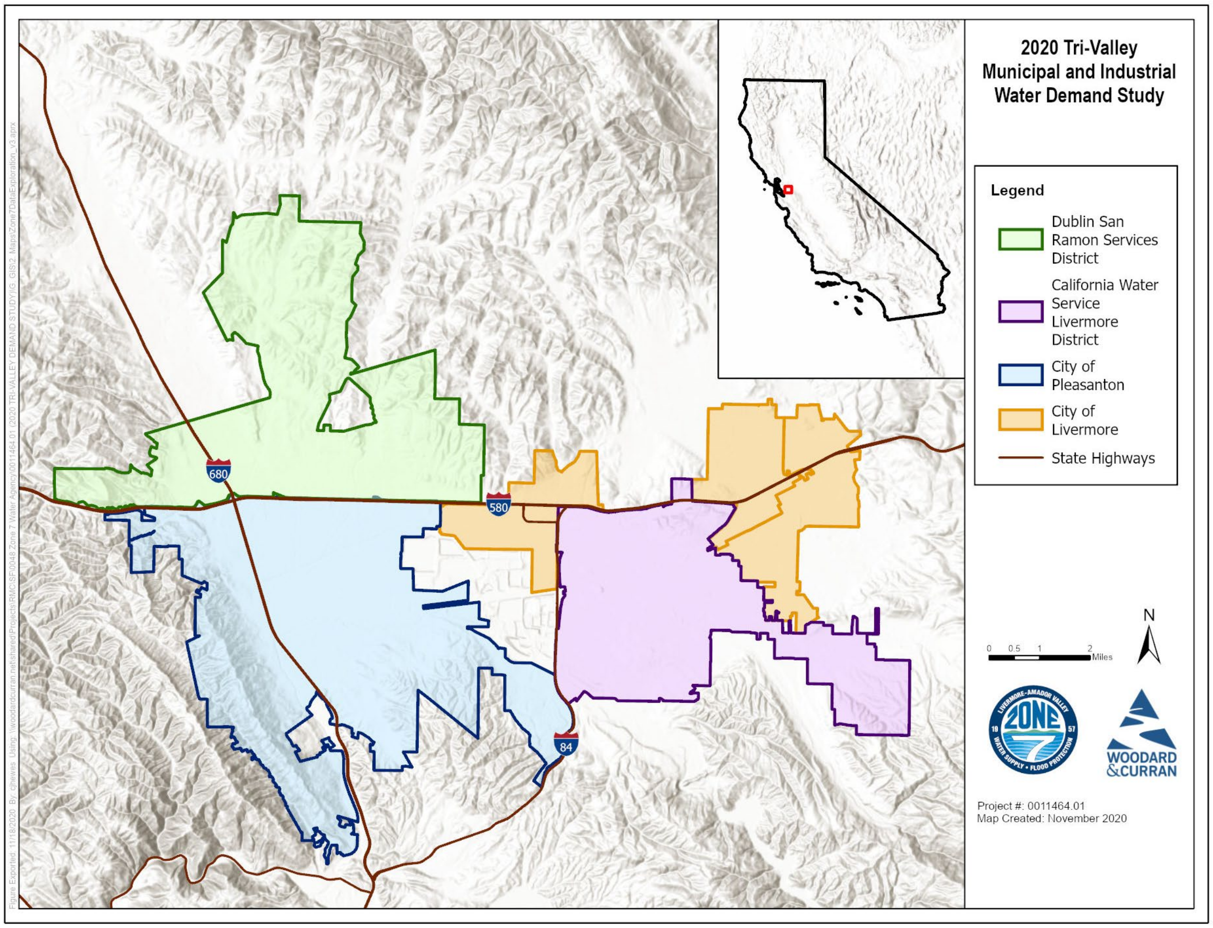
- **Region** - smallest unit of area with unique characteristics in the model - primarily used to separate Dublin from San Ramon in Dublin San Ramon Services District.
- **Agency** - Corresponds with the unique agencies that provide water to each Region.
- **General Plan City** - City associated with the General Plan used for future land use type lookups (e.g., "Livermore" General Plan is used for projecting land uses for both City of Livermore and Cal Water Livermore).

1.3 Description of Agencies

Zone 7 Water Agency is primarily a wholesaler that provides treated water to Dublin San Ramon Services District (DSRSD), the City of Livermore, the City of Pleasanton, and California Water Service Company – Livermore District (Cal Water Livermore) (Zone 7 Water Agency, 2016). **Figure 1-1** shows the service area boundaries of the four retailers. Zone 7 also provides treated water to six direct retail customers, including commercial and institutional water users, as well as raw or untreated water for agricultural purposes to 3,500 acres (Zone 7 Water Agency, 2016). The six direct retail customers are not included in Model projections. Note that this does not include Zone 7's untreated water customers.

The sections below describe each of the retailers.

Figure 1-1: Regional Map



1.3.1 Dublin San Ramon Services District (DSRSD)

DSRSD provides potable and recycled water service to the entirety of the City of Dublin as well as the Dougherty Valley Area of the City of San Ramon in Contra Costa County (DSRSD, 2016). DSRSD serves two notable customers with large demands: the Federal Correctional Institution (FCI) and Alameda County's Santa Rita Jail. All of DSRSD's potable water supply is sourced from Zone 7 Water Agency (DSRSD, 2016). DSRSD currently serves a population of 92,640 (DSRSD, 2020) through 25,521 service connections (DSRSD, 2019). DSRSD also serves as a wastewater service provider to the City of Dublin, City of Pleasanton, U.S. Army Reserve's Parks Reserve Forces Training Area (Parks RFTA), Federal Bureau of Prison's Federal Correctional Institution at Dublin (FCI), Santa Rita Jail, and the southern portion of San Ramon.

DSRSD and East Bay Municipal Utility District (EBMUD) formed the DSRSD – EBMUD Recycled Water Authority (DERWA) to produce recycled water for the two agencies as well as supply a portion of it to the City of Pleasanton. In 2019, DERWA facilities produced roughly 4,300 acre-feet (AF) of recycled water that was delivered to DSRSD, EBMUD, and City of Pleasanton (DSRSD, 2020). Additional information about recycled water projections can be found in Section 4.4.

1.3.2 City of Pleasanton

The City of Pleasanton provides potable water service to the entirety of the City of Pleasanton as well as approximately 250 customers in unincorporated Alameda County (City of Pleasanton, 2016)[2]. Approximately 80 percent of the City of Pleasanton's potable water supply is sourced from Zone 7, with the remaining 20 percent coming from local groundwater supplies (City of Pleasanton, 2016). The City of Pleasanton currently serves a population of 80,492 (SWRCB, 2020) through 25,521 service connections (City of Pleasanton, 2019).

Since 2014, the City of Pleasanton has distributed water produced by DERWA facilities as well as some recycled water supplies produced by the City of Livermore (City of Pleasanton, 2016). DERWA serves the western portion of Pleasanton's recycled water distribution system and Livermore serves new development in the eastern portion of Pleasanton. City of Pleasanton recycled water customers used roughly 1,070 AF of recycled water in 2019 (City of Pleasanton, 2020). Additional information about recycled water projections can be found in Section 4.4.

In the near term, the City of Pleasanton does not expect to expand delivery of recycled water significantly beyond the currently constructed recycled water distribution systems set of targeted recycled water customers. There is a relatively small number of customers that are pending conversions from potable to recycled water along a recently installed recycled water line expansion (City of Pleasanton, 2020), but no other expansions are currently planned.

1.3.3 City of Livermore

The City of Livermore provides potable and recycled water service to a portion of the City of Livermore, with the remainder of the City served by Cal Water Livermore. All of the City of Livermore's potable water supply is sourced from Zone 7 (City of Livermore, 2016). The City of Livermore currently serves a population of 30,003 (SWRCB, 2020) through 10,404 service connections (City of Livermore, 2018).

The City of Livermore owns and operates a wastewater treatment facility and produces recycled water. The average dry weather wastewater inflow is 6.5 million gallons per day (mgd) (7,281 AFY) (City of Livermore, 2020) and approximately 2.0 mgd (2,240 AF/year) of recycled water is produced and delivered within the City of Livermore (City of Livermore, 2016) as well as in the City of Pleasanton (as mentioned above). Based on current limitations of the ultraviolet disinfection system, capacity is currently limited to 6 mgd (6,721 AFY), which represents significant potential for expanding recycled water use above 2 mgd if feasible projects can be identified (City of Livermore, 2016). The proposed Isabel Neighborhood Plan (described further in Section 2.2.3) would use some of the recycled water capacity for both residential and non-residential landscape irrigation. Additional information about the recycled water projections can be found in Section 4.4.

1.3.4 Cal Water Livermore

Cal Water Livermore provides potable water service to a portion of the City of Livermore, with the remainder of the City served by the City of Livermore. Cal Water Livermore serves 48 percent of the City's incorporated area and 69 percent of its population. Approximately 70 percent of Cal Water Livermore's potable water supply is sourced from Zone 7 while the remainder is from local groundwater sources (California Water Service, 2016). Cal Water Livermore currently serves a population of 58,612 (SWRCB, 2020) through 18,905 service connections (California Water Service, 2019). Cal Water Livermore does not distribute recycled water.

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2 The City of Pleasanton has a contract to distribute water to the Castlewood Country Club which is outside the City's water service area. Water supplied to this neighborhood is not supplied by City of Pleasanton nor Zone 7. The Castlewood Country Club is built into the GIS Tool and Model if it needs to be included in the future, but all assumptions in the Model have been set to 0 so no water demands are generated.

2. DATA SOURCES

This section is organized by the major sources of data used as Model inputs, with subsections describing the specific data for each retail agency:

- Section 2.1 - General Plans
- Section 2.2 - Known Proposed Developments/Specific Plans
- Section 2.3 - Matching Water Consumption to Parcels

2.1 General Plans

2.1.1 City of Dublin

The City of Dublin's General Plan was last amended in 2017 and projects growth and development through an expected buildout by or before 2035 (City of Dublin, 2017). The City of Dublin's General Plan was used to project land uses within the portion of DSRSD's service area that is located within the City of Dublin.

2.1.2 City of San Ramon

The City of San Ramon's General Plan was adopted in 2015 and projects growth and development through an expected buildout by or before 2035 (City of San Ramon, 2015). The City of San Ramon's General Plan was used to project land uses within the portion of DSRSD's service area that is located within the City of San Ramon, the portion of San Ramon known as Dougherty Valley. The balance of demand in the City of San Ramon is served by EBMUD.

2.1.3 City of Pleasanton

The City of Pleasanton's General Plan was last updated in 2005, adopted in 2009, and amended several times between 2010 and 2019. The General Plan projects growth and development through 2025 (City of Pleasanton, 2005). The land use element of the General Plan breaks the City of Pleasanton into relatively large units by land use type, typically without defining individual parcels. The City of Pleasanton's General Plan was used to project land uses within the City of Pleasanton.

2.1.4 City of Livermore

The City of Livermore's General Plan was adopted in 2003 and has been amended several times between 2005 and 2014. The General Plan projects growth and development through an expected buildout by or before 2035 (City of Livermore, 2014). The City of Livermore General Plan was used for land use projections for two retailers: the City of Livermore and Cal Water Livermore.

2.2 Known Proposed Developments/Specific Plans

In the Tri-Valley, water agencies and the respective city planning departments in the region track future known proposed developments that are being permitted or constructed. The sections below describe for each agency how this information was incorporated into the Model to allow flexibility in (1) updating the year in which a particular project will come online (i.e., start using water) and (2) overwriting the land use type or residential dwelling unit density if the default general plan assumptions for that parcel are not up to date (or have been superseded). Overwriting the default land use leads to a more "current" water demand projection when a more recent specific plan is available that changes the character of expected development or if a development has been approved for an alternate land use that does not match the general plan, and that land use has a different water demand pattern than the default land use.

2.2.1 DSRSD

DSRSD maintains a list of development projects for the purposes of projecting future water demand. Each of the projects is tracked for information such as project name, description, estimated start and end dates for construction, land use designation, number of dwelling units, etc. A "development projects" shapefile (see **Figure 2-1**) showing the spatial boundary of each project is also maintained with a Site No (site number) field link.

The GIS Tool that processes the input data for the Excel Model compares the current parcels within DSRSD's service area against the development projects shapefile and assigns a Site No if the parcel is located within the boundary of a development project.

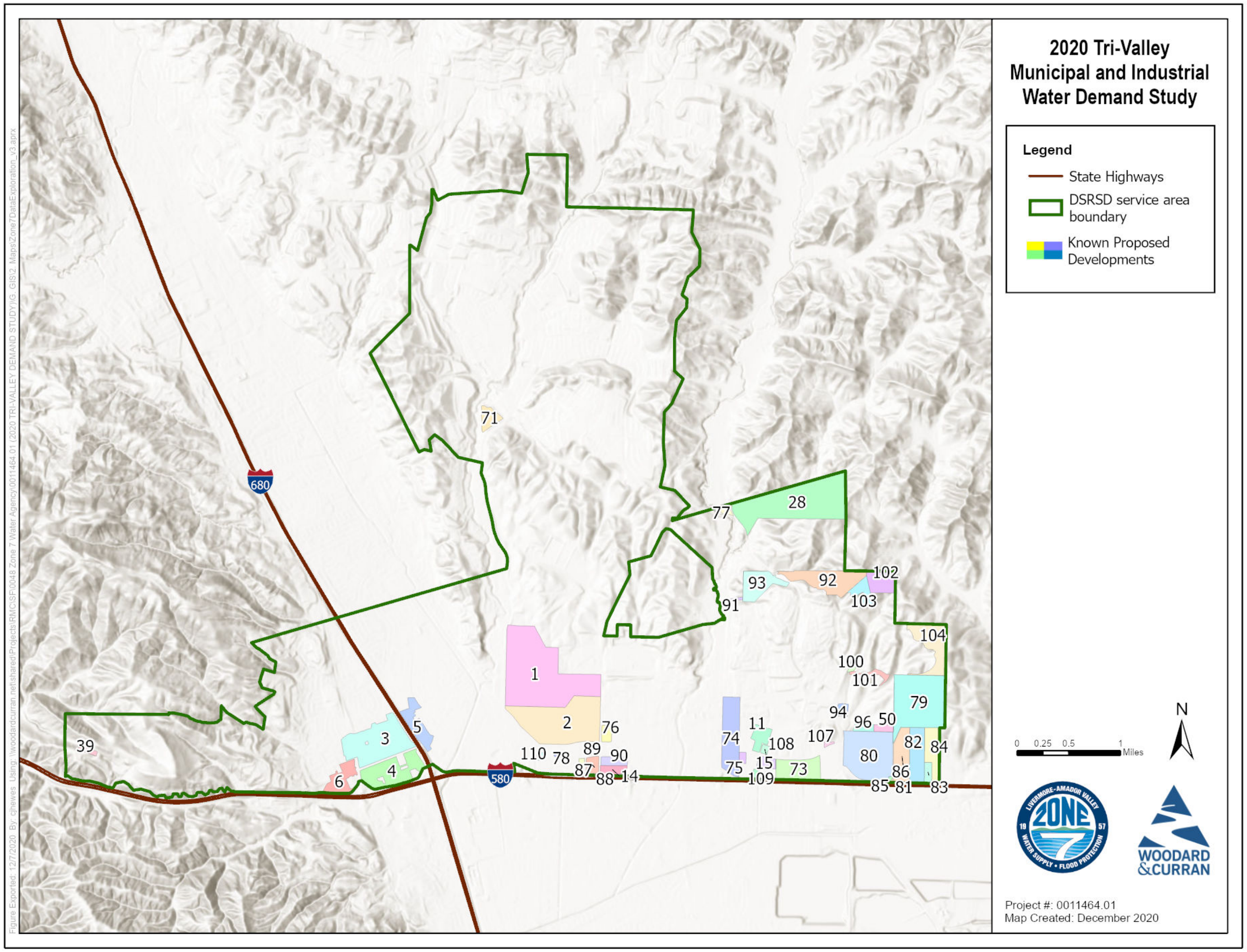
Projects with an online date of 2020 or earlier were not populated with a date since they are assumed to be part of the base year consumption.

Table 2-1 provides a list of known proposed developments where the existing General Plan land use was overwritten with a new land use type after a review of the development type.

Table 2-1: DSRSD Developments with Land Use Type Overrides

Development Name	Site Number	Development Type	General Plan Land Use Type	Land Use Type Override
The Green	14	Mixed Use	General Commercial	Mixed Use
Fountainhead Montessori	19	Elementary School	Downtown Dublin Transit-Oriented District	Public and Semipublic
Persimmon Place	20	Shopping Center	Campus/Office	Retail/Office
Community Center	69	Community Center	Single Family Medium Density	Public and Semipublic
Village Center – South	71	Commercial	Mixed Use	General Commercial
School/Park	72	School/Park	Single Family Medium Density	Public and Semipublic
Jordan--Mixed Use	94	Mixed Use	Open Space	Mixed Use

Figure 2-1: DSRSD Known Proposed Developments



For development projects where the number of dwelling units that will be constructed is known and the default General Plan land uses results in a vast over- or under-estimation of projected dwelling units, the Model overwrites any residential land use types within that specific development with a custom land use code that applies a dwelling unit density calculated based on the formula below:

$$\frac{Known\ number\ of\ dwelling\ units\ to\ be\ constructed}{Sum\ of\ area\ of\ residential\ land\ use\ types\ within\ known\ development\ area}$$

The General Plan provides a wide range of allowable densities per land use category. If known proposed developments have a planned density that is different than the average value projected for the General Plan land use category, it is necessary to make an adjustment based on best available information.

For any developments that projected both the number of housing units and the square footage of non-residential space (typically for mixed use developments,) non-residential water use demands of a similar land use category (based on project description) were also applied in the overriding custom land use code.

Custom calculated residential dwelling unit densities are described later in Section 3.1 in **Table 3-2**.

2.2.2 City of Pleasanton

The City of Pleasanton's Community Development Department (CDD) publishes a bi-monthly CDD Update that provides a summary of proposed development projects within Pleasanton. The CDD Update contains information such as project address, type of development, status, and the project's next steps.

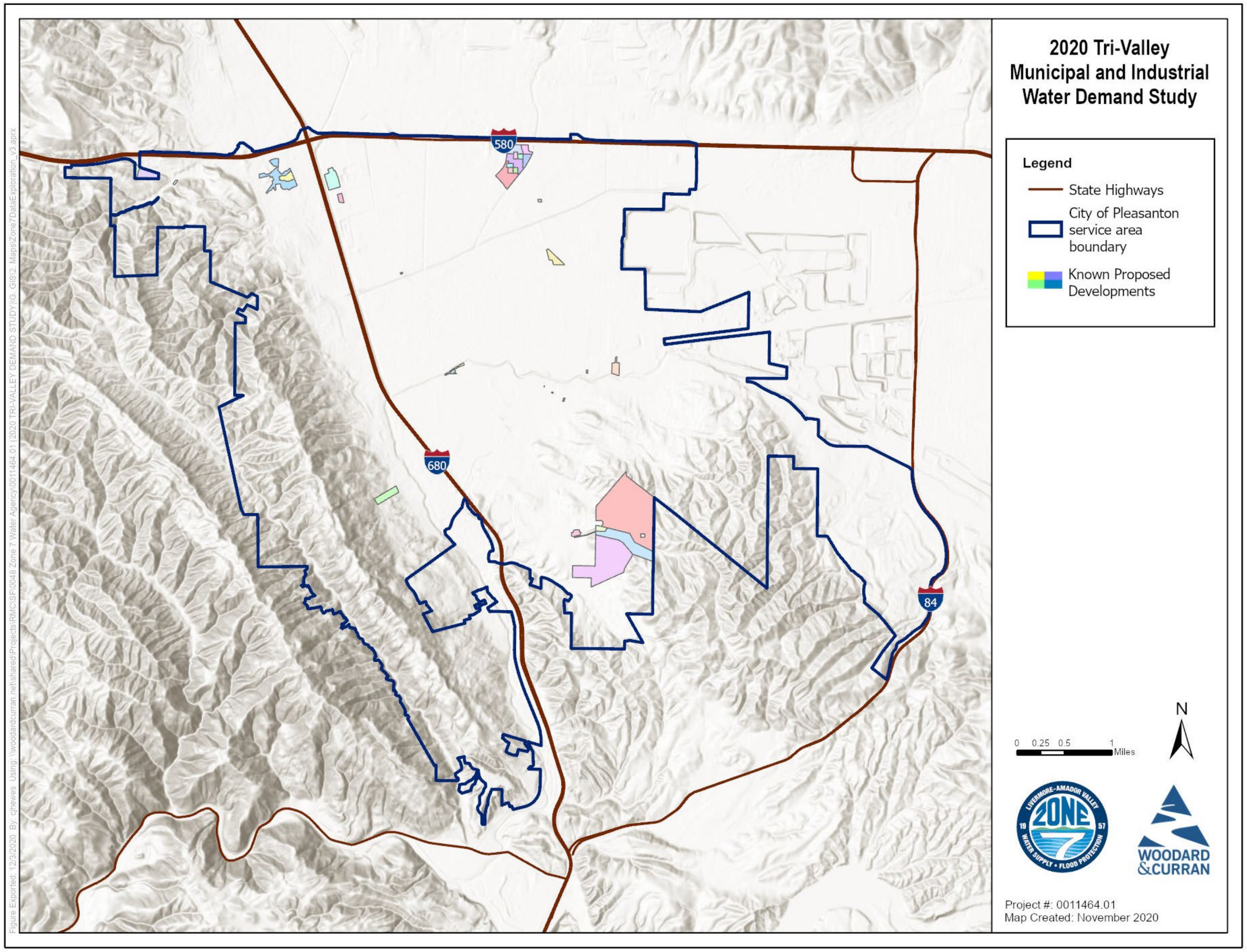
Because parcel numbers were not identified for any of the development projects, parcel numbers were assigned based on the address column for a handful of projects by referencing the tabular Assessor's parcel dataset. For the 10 out of 29 projects where locations could not be determined, the information associated with these projects (online year and land use type) do not factor into Model projections. See **Figure 2-2** for a map of the assigned locations. A list of the specific projects can be found in the Model's "Development-Lookup" tab (the CDD update dated February 2020 was used to generate this report).

The project online date was estimated based on a review of the project description, status, and other notes accordingly:

- If "construction expected to complete ______" or similar, then populated with year provided.
- If "currently under construction," then entered 2021 or 2022, depending on available info on when construction started.
- If project "approved" but not yet under construction, then entered 2024.
- If project "under review," then entered 2026.
- Projects that already had a status of "completed" were assumed to be online already and no year was populated.

Projects with Development Type of "Transportation/Traffic Project" or most projects with Development Type of "Other" were not assumed to have any future water demands.

Figure 2-2: City of Pleasanton Known Proposed Developments



Note - Map does not include a small number of additional developments identified during May 2021 discussions with the City Community Development Department.

The nine development projects in **Table 2-2** were overwritten with a new General Plan land use code to match the description of the project if the project differed from the existing General Plan use type.

Table 2-2: City of Pleasanton Developments with Land Use Type Overrides

Development Name	Address	Development Type	General Plan Land Use Type	Land Use Type Override
N/A	124/126 Spring Street	Mixed-Use Development	Commercial	MixedUse
Rose Avenue Estates	1851 Rose Ave.	Residential- Single-Family	PublicHealthandSafety	Medium Density
Spotorno Ranch Project	1000 Minnie St	Residential- Single-Family	Medium Density	Low Density (1 Dwelling unit per 2 acres) for APN 948 001500201 only
Lester/Hidden Valley Project [A]	10807, 11033 and the two western parcels on Dublin Canyon Road	Residential- Single-Family	PublicHealthandSafety	Low Density
Stoneridge Mall Housing Project	1008 Stoneridge Mall Road	Residential- Multi-Family/Apartments	MixedUse	High Density
The Homestead at Irby Ranch and Sunflower Hill at Irby Ranch	3988 First St. and 3878 and 3780 Stanley Blvd. *and* 3780 Stanley Blvd., future 3701 Nevada St.	Residential- Single-Family	Commercial and PublicHealthAndSafety	IR-COP (custom DU density residential land use type)
1701 Springdale Drive 10X Genomics	1701 Springdale Dr	Commercial/Master Planned Campus	Commercial	BusinessPark
Meadowlark	3459 Old Foothill Rd.	Residential- Single-Family	Low Density (residential)	(custom DU density residential land use type)
Ponderosa Homes	6900 Valley Trails Dr.	Residential- Single-Family	Elementary School	(custom DU density residential land use type)

Note:

A. *Part of the estimated Lester/Hidden Valley Project falls outside of Pleasanton's potential service area boundary. Thus, the part of the project that falls outside of the boundary was not included in Model projections, although this would need to be updated if the project is approved and eventually annexed.*

The City also publishes a GIS layer with the boundaries of 11 unique Specific Plans that overlay the existing General Plan. The land uses defined in the Specific Plans may not match the General Plan land uses for the same areas. No assumptions for Specific Plans were updated for the version of the Model described in this report, but the flexibility exists to quickly apply alternate assumptions in these geographic boundaries in the future without needing to re-run the GIS Tool.

Parcels that fall within the boundary of a Specific Plan were tagged in GIS and loaded into the "Development-Lookup" tab but were not assigned an online date or General Plan land use type override beyond what the General Plan specified.

2.2.3 City of Livermore

The City of Livermore last updated its Water Master Plan in 2017. Through this process the City developed a list of parcels called "Reasonably Foreseeable Development Projects" based on information from the City Planning Department about proposed developments across the City of Livermore (City of Livermore, 2017). A parcel shapefile was developed as part of this process whereby all parcels across the service area were tagged as "planned," "vacant," "developed," or one of several other statuses. This shapefile was used to bring in the project or planning area number for "planned" projects as well as the General Plan land use code associated with each project in the Water Master Plan. See **Figure 2-3** for a map of the planning areas, with adjustments made in the Isabel Neighborhood area (described below). The following changes were made from the Master Plan Assumptions:

- Project 17b (titled "Open Space," paired with Project 17a "BART Site: 300 SF Homes") was changed from the Water Master Plan land use type of "Neighborhood Mixed High Density" to "Park, Trail Way, Recreation Corridor, and Protection Areas." Separately, assumptions for the parcel were adjusted to match the Water Master Plan estimate of 7 MG/yr (21.5 AFY) that are associated with the 1.02 AF/ac water demand factor developed for "Park, Trail Way, Recreation Corridor, and Protection Areas." The General Plan residential designation for this land use was contingent on development of a BART station that is no longer planned (City of Livermore, 2020). The development for this area is expected to shift to the Isabel Neighborhood, described further below.

An August 2020 update provided directly by staff at the City of Livermore Planning Department confirmed that many of the "reasonably foreseeable development projects" from the 2017 Water Master Plan have already been constructed (City of Livermore, 2020). No "online date" was provided for any of the remaining proposed developments, with the exception of the existing Las Positas College that is expected to grow by 2025. For development projects where the number of dwelling units that have or will be constructed is known and the default General Plan land uses results in a vast over- or under-estimation of projected dwelling units, the Model overwrites any residential land use types within that specific development with a custom land use code that applies a calculated dwelling unit density similar to what was done for DSRSD (see Section 2.2.1).

The Isabel Neighborhood is a 1,138 acre area in the City's western water service area for which a Specific Plan was approved by the Livermore City Council on November 9, 2020 (Dyett & Bhatia, 2020). The Specific Plan was incorporated as a "known proposed development" for the purpose of this study. A copy of the most recent land use shapefile for this Specific Plan was obtained from the City's Planning Department and was merged with the "Reasonably Foreseeable Development Projects" file described above. The following Reasonably Foreseeable Development Projects overlapped with and were superseded by the land uses defined in the Isabel Neighborhood Specific Plan:

- 7a – Livermore Valley Charter School: K-8
- 7b – Livermore Valley Charter School: Athletics
- 7c – Livermore Valley Charter School: High School
- 8 – Las Positas College
- 9 – Shea Homes, Sage

Land use types in the Isabel Neighborhood Specific Plan were assigned a City of Livermore General Plan Land Use Type according to **Table 2-3**. A map of the Isabel Neighborhood Specific Plan land uses can be found in **Figure 2-4**.

The Isabel Neighborhood Specific Plan includes 220.2 acres of parks, exclusive of sports fields on the Las Positas College campus. For the purpose of the Model, 197.7 acres are designated Scenic Open Space (Dyett & Bhatia, 2020) and are assumed to have no water demand. Scenic Open Space parcels were identified by referencing the Specific Plan's Figure 4-1 (Parks and Open Space) and added to the Parcel Override tab in the Model as having no water demand (Parcel Overrides are described further in Section 4.5).

All landscape irrigation (both residential and non-residential) is assumed to be met with recycled water supplies (West Yost Associates, 2017).

Table 2-3: Isabel Neighborhood Specific Plan Land Use Reassignments

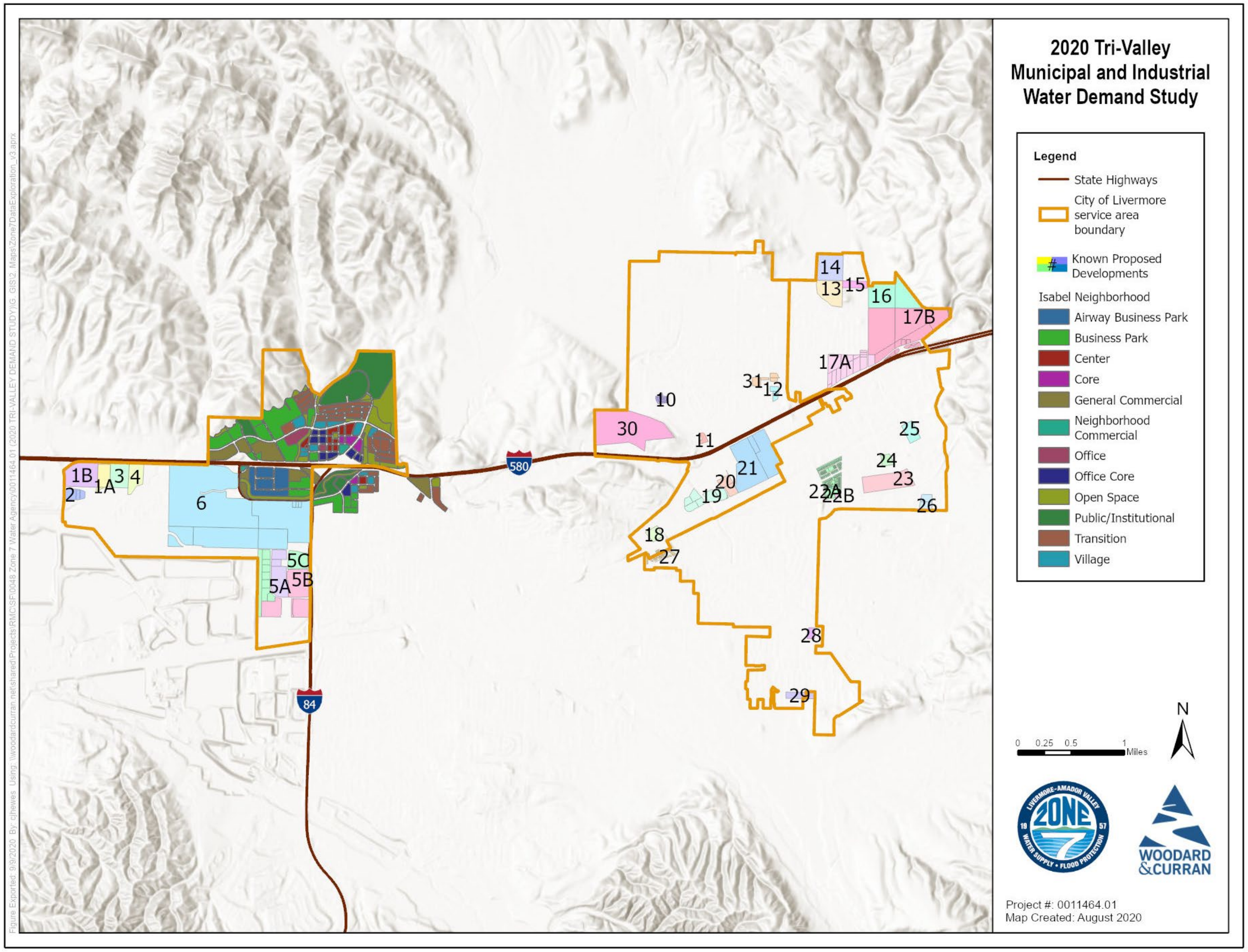
Isabel Neighborhood Specific Plan Land Use Description	Land Use Code Assigned [A]	General Plan Land Use Description	Notes
Airway Business Park	BCP	Business and Commercial Park	
Parking [B]	BART	BART Station and Parking	
Business Park	BCP	Business and Commercial Park	
Center	ISABEL_CENTER	-	Custom land use code added for 40-60 du/ac
Core	ISABEL_CORE	-	Custom land use code added for 60-100 du/ac
General Commercial	SC	Service Commercial	
Ground Floor Retail - Flex [B]	SC	Service Commercial	
K-12 School Overlay [B]	CF-S		
Neighborhood Commercial	NC	Neighborhood Commercial	
Office	LOC	Large Office Commercial	
Office Core	LOC	Large Office Commercial	
Open Space	OSP	Park, Trail Way, Recreation Corridor, and Protection Areas	
Educational/Institutional	CF-S	School-General	
Transition	ISBAEL_TRANSITION	-	Custom land use code added for 15-25 du/ac
Village	ISABEL_VILLAGE	-	Custom land use code added for 25-40 du/ac

Notes:

A. *Land use code assigned from General Plan, unless otherwise noted.*

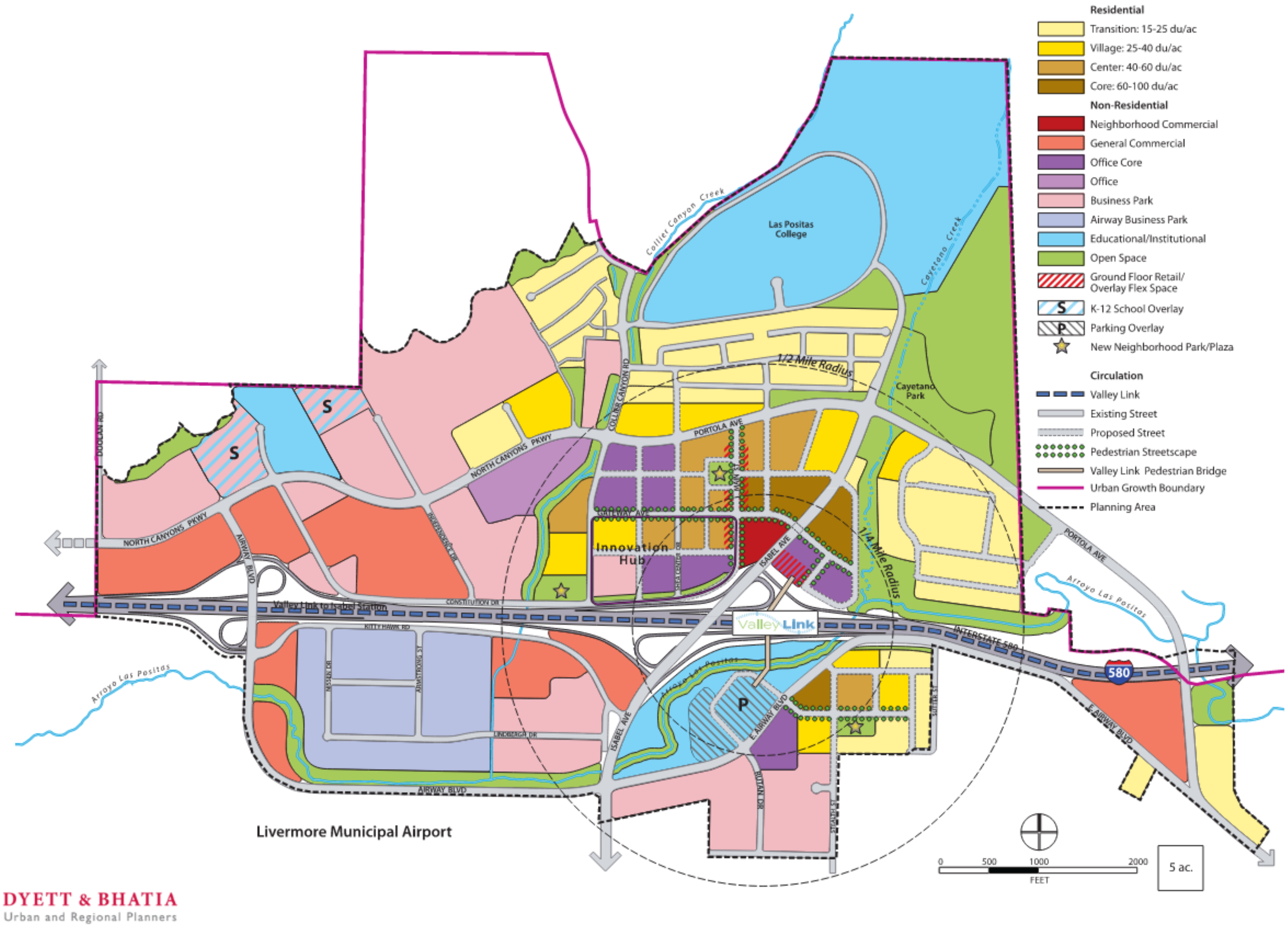
B. *K-12 School Overlay, Ground Floor Retail – Flex, and Parking were found to be overlays that caused issues with duplicate parcels in the GIS Tool and were removed from current calculations to avoid double-counting water demands. If they are added back in, the Model will use the land uses in this table to assign demands. The existing "BART" category is not assigned any water demands.*

Figure 2-3: City of Livermore Known Proposed Developments



Note - Map does not include a small number of additional developments identified during May 2021 discussions with the City Planning Department.

Figure 2-4: Isabel Neighborhood Specific Plan Land Use Map



Source: (Dyett & Bhatia, 2020) *Figure 2-1: Land Use Diagram*

2.2.4 Cal Water Livermore

The only information available for future developments in the Cal Water Livermore service area was for the portion of the Isabel Neighborhood Specific Plan located within the northwest corner of Cal Water Livermore's service area. The same land use assumptions apply from **Table 2-3**.[3]

2.3 Matching Water Consumption to Parcels

Historical water consumption from each agency was tied to parcels to develop water demand factors used in Sections 3.2 (Residential Outdoor) and 3.3 (Commercial, Industrial, Institutional). Each agency provided an export of unique meter numbers or accounts, along with location information, such as APN (if known) and street address. An attempt was made to assign an APN to every unique meter. **Table 2-4** provides a summary of the consumption data provided by each agency. Average annual consumption was summed for each unique APN; if multiple meters served one APN, their consumption was combined. Area per APN was determined from parcel shapefiles provided by the Alameda County and Contra Costa County Assessors' Offices by an automated area calculation tool in the ArcGIS mapping software.

Table 2-4: Consumption Data Provided

Agency	Frequency of Consumption Data	Years of Water Consumption Provided
DSRSD	Hourly	2018-2019
DSRSD	Bimonthly	2013-2019
City of Pleasanton	Bimonthly	2017-2019
City of Livermore	Hourly	2017-2019
City of Livermore	Monthly	2017-2019
Cal Water Livermore	Monthly	2011-2019

2.3.1 Dublin San Ramon Services District (DSRSD)

DSRSD serves parcels located in two different counties. Parcels from the City of Dublin are located in Alameda County and parcels from the City of San Ramon are located in Contra Costa County. Each county maintains a separate parcel numbering database. Whenever "assessor data" is mentioned in the text below, it refers to assessor data from both counties as it applies to each respective city.

DSRSD provided tabular lists of all unique potable and recycled water meters along with address location information. DSRSD also provided separate GIS point shapefiles with locations of water meters for various sectors (e.g., residential, commercial, potable irrigation, and recycled). Most (but not all) non-irrigation meters had an APN assigned in the GIS file. For potable irrigation meters, an APN was not included so it was assigned to a parcel by performing a spatial join against assessor data of parcel polygons, where the meter needed to be located within a parcel boundary to be matched to that parcel. Recycled water irrigation meter location matching is described separately in Section 4.4.1. All GIS shapefile information was exported to Excel and merged into a single lookup file using Meter ID as the unique record ID.

[3] In May 2021, discussions with the City of Livermore Planning Department resulted in the identification of a small number of known development projects in the Cal Water Livermore service area which were added to the Model but are not reflected in the results tables of this report. This change has a minimal impact on total water demands (approximately +4 AF at buildout).

An additional approximately 1,200 Meter IDs were identified in the consumption data extract that were not included in the initial tabular list of Meter IDs. This means consumption data was available but could not immediately be associated with a parcel. The consumption data extract included address information that was used in the same process described below to assign APNs if possible.

An attempt was made to define an APN for every unique meter and then sum monthly consumption by APN (aggregated from hourly consumption). APN was determined in the following priority order:

1. APN was already recorded for many meters in the GIS files (non-irrigation meters) or was assigned via a spatial join (irrigation meters).
    a. If the matched APN did not exist in the latest parcel exports from the assessors, an attempt was made to re-assign a new APN using the methods below.
2. APN was determined by matching street number and street name to the assessor data.
3. APN was determined by matching street number with an alternate or adjusted street name to the assessor data (e.g., changing suffixes from LANE to LN).

Out of 26,181 accounts, 1,310 accounts (5 percent) could not be matched with a valid parcel number for the reasons described below. The consumption from these accounts was excluded from the analysis of water demand factors.

- 226 accounts had no street number and could not be matched against the assessor database.
- 1,084 accounts had an existing APN that was not found in the assessor database.

451 (about 34 percent) of the 1,310 unmatched accounts had an account type of condo (condominium) that may not have a unique parcel number and may instead be associated with a larger grouped parcel that would require manual review to identify.

2.3.2 City of Pleasanton

An attempt was made to define an APN for every account and then sum bimonthly consumption by APN. APN was determined in the following priority order:

1. APN was already recorded for many accounts.
2. APN was determined by matching street number and street name to the Alameda County Assessor Parcel Database.
3. APN was determined by matching street number with an alternate or adjusted street name to the Alameda County Assessor Parcel Database.

Out of 22,590 accounts, 1,011 accounts (4 percent) could not be matched with a valid parcel number for the reasons described below. The consumption from these accounts was excluded from the analysis of water demand factors.

- 116 accounts had an existing APN that was not found in the Alameda County Assessor Parcel Database.
- 548 accounts had no APN and no street number and could not be matched against the Alameda County Assessor Parcel Database.

- 347 accounts had a street number and street name that did not match to a known parcel in the Alameda County Assessor Parcel Database.

495 (about 50 percent) of the unmatched accounts had an account type of Irrigation (potable). It is possible that these unmatched accounts represent irrigation at CII or large multi-family residential parcels that is missed in the calculation of water demand factors for these sectors in Section 3.

2.3.3 City of Livermore

An attempt was made to define an APN for every account and then sum monthly consumption (aggregated from hourly consumption) by APN. City of Livermore records location information in one "Service Address" field. The Service Address was decomposed into a street number and street name, stripping out suffixes contained in parentheses (such as "(IRR)" or "(FL)"). APN was determined in the following priority order:

1. APN was determined by matching the street number and street name to the Alameda County Assessor Parcel Database.
2. APN was determined by matching street number with an alternate or adjusted street name to the Alameda County Assessor Parcel Database (e.g., adjusting suffixes like "COMMON" to "CMN" or "AVE" to "AV").

Out of 10,602 accounts, 1,001 accounts (9 percent) could not be matched with a valid parcel number for the reasons described below. The consumption from these accounts was excluded from the analysis of water demand factors.

- 156 accounts had no street number and could not be matched against the Alameda County Assessor Parcel Database.
- 845 accounts had a street number and street name that did not match to a known parcel in the Alameda County Assessor Parcel Database.

303 (about 30 percent) of the unmatched accounts had an account type of Irrigation (potable). It is possible that these unmatched accounts represent irrigation at CII or large multi-family residential parcels that is missed in the calculation of water demand factors for these sectors in Section 3.

An additional 557 unique meter IDs were provided in the hourly consumption dataset for which there was no matching address or account type. Consumption from these meters was not included in the analysis of water demand factors.

2.3.4 Cal Water Livermore

Cal Water Livermore has already performed extensive analysis on the locations of its water meters and provided APNs for most meters. Monthly consumption was summed by APN. Out of 19,008 meters, 991 meters (5 percent) did not have an APN provided. Fewer than 1 percent (62 meters) had APNs that were not found in the latest Alameda County Assessor's parcel database. The consumption from the unmatched meters was excluded from the analysis of water demand factors.

3. DEMAND PROJECTION METHODOLOGY

This chapter describes how demands are calculated for each demand sector, including residential indoor (Section 3.1), residential outdoor (Section 3.2), commercial, industrial, and institutional (Section 3.3), water loss (Section 3.4), and unmetered consumption (Section 3.5). It also describes service connection projections (Section 3.6) and Model interpolation calculations (Section 3.7).

3.1 Residential Indoor

The Model calculates residential indoor water demands using the following calculation:

$$Area\ (ac) * Dwelling\ Unit\ Density\left(\frac{DU}{ac}\right) * Persons\ per\ dwelling\ unit * (1 - Vacancy\ Rate) * Indoor\ R\text{-}GPCD$$

where:

- “Area” is supplied by the shapefiles contained in the GIS of General Plan land use types;
- “Dwelling Unit Density” is defined primarily by the land use descriptions in each respective general plan, but may vary based on more recent assumptions contained in Water Master Plan documents (see **Table 3-1** for land use codes from the general plans and **Table 3-2** for custom land use codes from reviews of known proposed developments);
- “Persons per dwelling unit” is based on California Department of Finance data defined for each city (see **Table 3-3**);
- “Vacancy Rate” is based on California Department of Finance data defined for each city (see **Table 3-4**) and describes the percent of households that are empty and not generating indoor water demands. In the Model, the vacancy rate is only applied to increases in future population and not existing population; and
- “Indoor R-GPCD,” or residential gallons per capita per day of indoor use, was calculated based on dividing estimated base year indoor use by service area population (see **Table 3-5** for 2020 and **Table 3-6** for 2025-2045).

3.1.1 Dwelling Unit Density

Most general plans define a range of densities for each residential land use category. The median of this range of dwelling unit densities was used as a default input to the Model for each residential land use category. However, for all agencies, it was observed in the current GIS parcel data that some residential land use categories did not accurately reflect the densities of currently developed residential neighborhoods. Most medians under-represented existing residential densities, which would result in artificially low water demands.

For each agency, a review of existing residential areas was conducted to calculate the count of unique parcel numbers per land use category from the respective general plan. An average dwelling unit density was calculated for each major residential land use category by dividing a count of unique parcel numbers per land use category by total analyzed parcel area. Unique parcel numbers were assumed to represent one dwelling unit. For most land use categories, a small number of parcels of over 1 or 2 acres were excluded from this analysis as they were assumed to represent anomalous parcels or currently undeveloped areas zoned for future subdivision. For each general plan, dwelling unit densities were adjusted to match the average calculated density. These are noted in **Table 3-1** in the Notes column like "updated to # after a review of current APNs and area."

For example, in the City of Dublin, the "Single Family Residential" land use category allows densities of 0.9 – 6 dwelling units per acre (DU/ac), which yields an average of 3.5 DU/ac. A total of 5,734 unique parcel numbers within this land use category were observed with a total area of 982 acres, which results in an average corrected density of 5.5 DU/ac. Similarly, in the Cal Water Livermore service area, the "Urban High Residential (UH-2)" land use category allows densities of 8 – 14 DU/ac (average 11 DU/ac). A total of 971 unique parcel numbers within this land use category were observed with a total area of 82 acres, which results in an average corrected density of 11.9 DU/ac.

3.1.2 Indoor R-GPCD

Future projections of indoor R-GPCD could be defined by the indoor water use objective proposed by the California Department of Water Resources (DWR) in response to Senate Bill 606 and Assembly Bill 1686 (2018), which directed DWR to develop urban water use efficiency standards. DWR has recommended a standard for indoor residential use of 55 gpcd that transitions to 52.5 gpcd in 2025 and 50 gpcd in 2030. While agencies do not need to meet this indoor standard directly, it will be used to calculate one piece of a total water use objective and may be considered a good future goal if indoor per-capita water use is currently estimated to be higher than the standard.

However, based on the disaggregation of indoor and outdoor water use described later in Section 3.2.1, all agencies were found to have existing indoor R-GPCD values under 50 GPCD, both for 2019 only and when averaged across several earlier years. For most agencies (see description of Cal Water Livermore below), it is assumed that this level of R-GPCD will remain consistent in the future. The Model has the option to separately calculate reductions in indoor residential and CII water use on a per-capita basis as a result of passive conservation (described in detail in Section 4.1).

At the request of Cal Water Livermore, their portion of the Model includes an estimation of indoor demand rebound post-drought. While demands were observed to decrease during the recent drought, it is assumed that those demands will rebound to below pre-drought levels, with some portion of the agency's conservation efforts remaining permanent. The assumption from Cal Water Livermore is that 20 percent of conservation realized during the drought will remain permanent. The formulas below describe how Cal Water Livermore's rebounded R-GPCD of 52.3 gpcd was calculated:

$$(Pre\text{-}drought\ R\text{-}GPCD) - 20\% * (Pre\text{-}drought\ R\text{-}GPCD - Drought\ R\text{-}GPCD\ )$$

$$(2013\ R\text{-}GPCD) - 20\% * (\ 2013\ R\text{-}GPCD - 2014\text{-}2017\ Average\ R\text{-}GPCD\ )$$

$$(54.2) - 20\% * (54.2 - 44.8) = 52.3\ gpcd$$

More details on the 2013 and 2014-2017 average period indoor R-GPCDs for Cal Water Livermore are described in Section 3.2.1.2.

3.1.3 General Plan Land Use Category Maps

Maps of general plan land uses with residential components can be found in **Figure 3-1** for DSRSD, **Figure 3-2** for City of Pleasanton, **Figure 3-3** for City of Livermore, and **Figure 3-4** for Cal Water Livermore. Note that these maps do not reflect general plan land use overrides for case-by-case edits, developments, or in most cases, for specific plans. These are tracked in the Model's "Development-Lookup" tab (described further in Appendix A). These maps are intended to provide a general reference for the spatial distribution of the various general plan land use categories.

Table 3-1: Residential Dwelling Unit Densities from General Plans

City	Source	General Plan Land Use Code	Description	Modeled Residential DU/acre	Residential Type	Notes
Dublin	Downtown Dublin Specific Plan 2019	DDRD	Downtown Dublin Retail District	22.0	Multiple	
		DDTOD	Downtown Dublin Transit-Oriented District	30.0	Multiple	
		DDVPD	Downtown Dublin Village Parkway District	35.0	Multiple	Assumed to be same as High Density
	DSRSD Water Master Plan 2016 (based on Dublin General Plan)	ER	Estate Rural	0.01	Single	Assumed same as RRA
		HDR	High Density Residential	35.0	Multiple	
		LDSF	Low Density Single Family	6.0	Single	4.7 DU/ac; updated to 6 after a review of current APNs and area
		MDR	Medium Density Residential	10.5	Single	10 du/ac; updated to 10.5 after a review of current APNs and area
		MHDR	Medium High Density Residential	20	Multiple	
		MU	Mixed Use	7.4	Multiple	Average of original values for Medium and Medium-High density
		RRA	Rural Residential/Agriculture	0.01	Single	
	Dublin General Plan 2017	MHRRO	Medium High Density Residential and Retail Office	19.6	Multiple	Average of range 14.1-25.0 DU/ac
		MU2CO	Mixed Use 2/Campus Office	7.4	Multiple	Assumed average of Medium and Medium-High density
		SFR	Single Family Residential	5.5	Single	0.9-6 units/acre; updated to 5.5 after review of current APNs and area
	Dublin General Plan 2017 (GIS only, not specifically in plan)	EMHDR	Estate medium High Density Residential	8.4	Single	Medium-High Density is 14.1-25 DU/ac; updated to 8.4 after review of current APNs and areas

City	Source	General Plan Land Use Code	Description	Modeled Residential DU/acre	Residential Type	Notes
San Ramon	DSRSD Water Master Plan 2016 (based on San Ramon General Plan)	MFH	Multi-Family High Density	31.6	Multiple	14-30 units per acre (WMP said 31.6 DU/ac)
		SFL	Single Family Low Density	5.7	Single	0.2-3 units per acre (WMP said 5.7 DU/ac)
		SFLM	Single Family Low Medium Density	6.9	Single	3-6 units per acre (WMP said 6.9 DU/ac)
	San Ramon General Plan 2015	HR	Hillside Residential	1.1	Single	Average of 0.2-2 DU/ac
		MFVH	Multi-Family Very High Density	40.0	Multiple	Average of 30-50 DU/ac
		MU	Mixed Used	22.0	Multiple	Average of 14-30 DU/acre
		MUCC	Mixed Used City Center	36.0	Multiple	Average of 22-50 DU/ac
		RC	Rural Conservation	0.2	Single	1 unit per 5 gross acres
		SF M	Single Family Medium Density	10	Single	6-14 DU/ac; updated to 10 based on review of current APNs and area
Livermore	Livermore General Plan, Land Use Element Chapter Amended 2013	AGVT	Agriculture/Viticulture	0.01	N/A [B]	Average of 1.0-5.0 DU/100 ac
		AGVT (SV7-TDR)		0.01	N/A [B]	Assumed to be same as AGVT
		BCP/UH-4	Business and Commercial Park/Urban HD Residential	10.0	Multiple	TDC average of 0 DU/ac and 14-22 DU/ac
		DA	Downtown Area Specific Plan	13.3	Multiple	Maximum 3,600 DU over 270 acres
		HII/UH-3	High Intensity Industrial/Urban High Density Residential	8.0	Multiple	TDC average of 0 DU/ac and 14-18 DU/ac
		HII/UH-5b	High Intensity Industrial/Urban High Density Residential	17.0	Multiple	TDC average of 0 DU/ac and 30-38 DU/ac
		HLCN	Hillside Conservation	0.03	Single	Average of 1.0 DU/20 ac - 1.0 DU/100 ac
		LII/UH-3	Low Intensity Industrial/Urban HD Residential	8.0	Multiple	TDC average of 0 DU/ac and 14-18 DU/ac
		LII/UH-5b	Low Intensity Industrial/Urban High Residential	15.0	Multiple	TDC average of 0 DU/ac and 22-38 DU/ac

City	Source	General Plan Land Use Code	Description	Modeled Residential DU/acre	Residential Type	Notes
		LII/ULM	Low Intensity Industrial/Urban Low-Medium Residential	1.3	Multiple	TDC average of 0 DU/ac and 2-3 DU/ac
		LII/UM	Low Intensity Industrial/Urban Medium Density Res	1.9	Multiple	TDC average of 0 DU/ac and 3-4.5 DU/ac
		NC/UH-3	Neighborhood Commercial/Urban HD Residential	8.0	Multiple	TDC average of 0 DU/ac and 14-18 DU/ac
		NMH	Neighborhood Mixed High Density	19.0	Multiple	TDC average of 6-8 and 24 - 38 DU/ac
		NML	Neighborhood Mixed Low Density	8.0	Single	TDC average of 2-3 and 12 - 15 DU/ac
		NMM	Neighborhood Mixed Medium Density	11.0	Multiple	TDC average of 3-4.5 and 15 - 24 DU/ac
		RR	Rural Residential	0.5	Single	1-5 ac Site; updated to 0.5 based on review of current APNs and area for RR
		RR/UM	Rural Residential/Urban Medium Residential	2.1	Single	TDC average of 0.5 (custom override for RR) and 3-4.5 DU/ac
		SC/UH-2	Service Commercial/Urban High	11.0	Multiple	Average of 8 - 14 DU/ac for UH-2; looks like TDC but not defined as such in GP
		SV-RDA	South Livermore Valley Residential Developed Area	0.1	Single	Assumed to be 1 DU/20 acres
		UH-1	Urban High Residential	8.0	Single	6 - 8 DU/ac; updated to 8 based on review of current APNs and area
		UH-2	Urban High Residential	12.0	Single	8 - 14 DU/ac; updated to 12 based on review of current APNs and area
		UH-2/OC	Urban High Residential/Office Commercial	5.5	Single	TDC average of 0 DU/ac and 8-14 DU/ac
		UH-3	Urban High Residential	18.0	Multiple	14 - 18 DU/ac; updated to 18 based on review of current APNs and area
		UH-4	Urban High Residential	20.0	Multiple	Average of 18 - 22 DU/ac

City	Source	General Plan Land Use Code	Description	Modeled Residential DU/acre	Residential Type	Notes
		UH-5b	Urban High Residential	34.0	Multiple	Average of 30 - 38 DU/ac
		UL-1	Urban Low Residential	3.0	Single	1.0-1.5 DU/ac; updated to 3 based on review of current APNs and area
		UL-2	Urban Low Residential	2.5	Single	1.5-2.0 DU/ac; updated based to 2.5 based on review of current APN and area
		ULM	Urban Low-Medium Residential	4.0	Single	2.0-3.0 DU/ac; updated to 4 based no review of current APNs and area
		ULM/UH-2	Urban Low Medium Residential/High Density	6.8	Single	TDC average of 2.0-3.0 DU/ac or 8-14 DU/ac
		ULM/UH-3	Urban Low Medium Residential/High Density	9.3	Multiple	TDC average of 2.0-3.0 DU/ac or 14-18 DU/ac
		ULM/UH-4	Urban Low Medium Residential/High	11.3	Multiple	TDC average of 2.0-3.0 DU/ac or 18-22 DU/ac
		UM	Urban Medium Residential	5.7	Single	3.0-4.5 DU/ac; updated to 5.7 based on review of current APNs and area
		UMH	Urban Medium-High Residential	6.8	Single	4.5-6.0 DU/acre; updated to 6.8 based on review of current APNs and area
		UMH/UH-2	Urban Medium High Residential/High Density	7.4	Single	TDC average of 3.0-4.5 DU/ac or 8-14 DU/ac
Pleasanton	Pleasanton General Plan, Adopted 2009	101	RuralDensity	0.2	Single	
		102	LowDensity	2.0	Single	1.0 DU/acre (average); updated to 2 based on review of current APNs and area
		103	LowDensity1Dwelling/2acs	0.5	Single	
		104	MediumDensity	6.0	Single	5.0 DU/acre (average); updated to 6 based on review of current APNs and area
		105	MediumandHighDensity	10.0	Multiple	Assumed average of medium and high density

City	Source	General Plan Land Use Code	Description	Modeled Residential DU/acre	Residential Type	Notes
		106	HighDensity	15.0	Multiple	
		501	MixedUse	20.0	Multiple	20+ DU/acre
		502	MixedUseBusinessPark	3.2	Multiple	At Hacienda (the only use for this land use type), 6,400 projected residents/2.8919 persons per household/700 acres = 3.16 DU/ac; population projection from https://www.hacienda.org/po-location/location-hacienda

Notes:

A. *The City of Livermore General Plan has certain land use categories that indicate a Transferable Development Credits (TDC) Program whereby multiple residential densities are possible. These land uses are identified with a slash ("/") in the land use code, though not all land use codes with slashes are involved with the TDC Program. Developers of parcels subject to the TDC Program may pay a fee to exceed a baseline density or original land use designation* (City of Livermore, 2014). *To account for TDC parcels with two possible residential density scenarios, an average was calculated between the two ranges. To account for TDC parcels with a baseline CII use and a maximum residential option, an average residential density between 0 DU/ac and the average of the maximum density range was assumed.*

B. *AGVT (Agriculture/Viticulture) in the City of Livermore General Plan accounts for a large number of acres in the Tri-Valley relative to a small number of expected dwelling units due to a very low dwelling unit density. For this reason, this land use type is assumed to not have outdoor residential irrigation as it would result in a likely over-estimation of demand if assigned the default agency-specific single or multiple family outdoor water demand factor. Per the City of Livermore, some properties within this land use type may be used for viticultural purposes and/or could include winery and wine production facilities. However, agricultural uses are largely served with untreated water supplies which are outside of the scope of the Model. Information about potable use at specific existing properties or planned developed properties can be updated in future iterations of the Model's Development-Lookup tab.*

Table 3-2: Residential Dwelling Unit Densities from Known Proposed Developments

City	Source	Assigned Land Use Code	Modeled Residential DUs/acre	Type	Notes
Livermore	Isabel Neighborhood Specific Plan Public Draft June 2020	ISABEL_CENTER	50.0	Multiple	40-60 DU/ac
		ISABEL_CORE	80.0	Multiple	60-100 DU/ac
		ISBAEL_TRANSITION	20.0	Multiple	15-25 DU/ac
		ISABEL_VILLAGE	32.5	Multiple	25-40 DU/ac
	Livermore Water Master Plan, 2017	9-COL	N/A	N/A	(overwritten by Isabel Neighborhood)
		10-COL	5.7	Single	26 DU across 4.5 ac dedicated residential acreage
		11-COL	17.4	Multiple	58 DU across 3.3 ac dedicated residential acreage
		12-COL	9.7	Single	49 DU across 5 ac dedicated residential acreage
		13-COL	1.3	Single	42 DU across 31.7 ac dedicated residential acreage
		15-COL	1.2	Single	12 DU across 9.7 ac dedicated residential acreage
		17a-COL	5.4	Single	300 DU across 55.5 ac dedicated residential acreage
		19-COL	17.0	Multiple	495 DU across 29.1 ac dedicated residential acreage
		20-COL	34.0	Multiple	436 DU across 12.8 ac dedicated residential acreage
		22a-COL	13.9	Single	465 DU across 33.5 ac dedicated residential acreage
		22b-COL	33.8	Multiple	46 DU across 1.4 ac dedicated residential acreage
		27-COL	4.9	Single	58 DU across 11.8 ac dedicated residential acreage
		28-COL	11.0	Single	49 DU across 4.4 ac dedicated residential acreage
		29-COL	2.8	Single	20 DU across 7.1 ac dedicated residential acreage
		31-COL	3.7	Single	32 DU across 8.5 ac dedicated residential acreage
	City of Livermore 2020 Annual Housing Element Progress Report	LASSEN-186	186	Multiple	186 DU across 1.2 ac dedicated residential acreage
		THIRDST-8	8	Multiple	8 DU across 0.1 ac dedicated residential acreage
		ISABEL_TRANSITION_200	200	Multiple	Numerous small parcels in Isabel Transition neighborhood identified with 4 DU each - existing general density in "Transition" was too small so they

City	Source	Assigned Land Use Code	Modeled Residential DUs/acre	Type	Notes
					were assigned an average 200 DU/ac to calculate closer to 4.
Dublin	Dublin Crossing Specific Plan, October 2013	2-DSRSD	10.6	Multiple	1,995 housing units in 189 gross acres; 32.2 acres of mixed/commercial; 30 acres of park
	DSRSD Future Developments Tracker, received May 2020 & Downtown Dublin Specific Plan December 2019	3-DSRSD	3.5	Single	400 DUs across 112.9 ac dedicated residential acreage
	DSRSD Future Developments Tracker, received May 2020 [A]	4-DSRSD	16.3	Multiple	1157 DUs across 71.1 ac dedicated residential acreage
		5-DSRSD	6.4	Multiple	200 DUs across 31.2 ac dedicated residential acreage
		6-DSRSD	6.4	Single	54 DUs across 8.4 ac dedicated residential acreage
		15-DSRSD	29.2	Multiple	357 DUs across 12.2 ac dedicated residential acreage
		22-DSRSD	6.1	Multiple	122 DUs across 20 ac dedicated residential acreage
		23-DSRSD	16.1	Multiple	68 DUs across 4.2 ac dedicated residential acreage
		24-DSRSD	25.2	Single	95 DUs across 3.8 ac dedicated residential acreage
		25-DSRSD	9.0	Multiple	806 DUs across 89.7 ac dedicated residential acreage
		26-DSRSD	1.3	Single	105 DUs across 80.3 ac dedicated residential acreage
		27-DSRSD	10.0	Multiple	103 DU across 10.3 ac dedicated residential acreage
		28-DSRSD	2.3	Single	370 DU across 161.3 ac dedicated residential acreage
		30-DSRSD	26.5	Multiple	105 DUs across 4 ac dedicated residential acreage
		31-DSRSD	35.1	Multiple	252 DU across 7.2 ac dedicated residential acreage
		32-DSRSD	6.0	Single	48 DUs across 8 ac dedicated residential acreage
		34-DSRSD	0.1	Single	4 DUs across 30.5 ac dedicated residential acreage
		35-DSRSD	7.8	Single	252 DUs across 32.3 ac dedicated residential acreage
		36-DSRSD	11.4	Single	140 DUs across 12.3 ac dedicated residential acreage

City	Source	Assigned Land Use Code	Modeled Residential DUs/acre	Type	Notes
		37-DSRSD	53.0	Multiple	72 DU across 1.4 ac dedicated residential acreage
		38-DSRSD	64.0	Multiple	314 DU across 4.9 ac dedicated residential acreage
		39-DSRSD	5.9	Single	26 DUs across 4.4 ac dedicated residential acreage
		41-DSRSD	9.3	Single	85 DUs across 9.1 ac dedicated residential acreage
		42-DSRSD	7.4	Single	30 DUs across 4.1 ac dedicated residential acreage
		43-DSRSD	12.4	Single	134 DUs across 10.8 ac dedicated residential acreage
		44-DSRSD	32.4	Multiple	43 DUs across 1.3 ac dedicated residential acreage
		45-DSRSD	701.8	Multiple	341 DUs across 0.5 ac dedicated residential acreage
		47-DSRSD	17.9	Multiple	126 DUs across 7 ac dedicated residential acreage
		48-DSRSD	80.8	Single	54 DUs across 0.7 ac dedicated residential acreage
		50-DSRSD	21.3	Multiple	109 DUs across 5.1 ac dedicated residential acreage
		51-DSRSD	18.2	Multiple	52 DUs across 2.8 ac dedicated residential acreage
		52-DSRSD	17.8	Multiple	437 DUs across 24.5 ac dedicated residential acreage
		53-DSRSD	26.3	Multiple	111 DUs across 4.2 ac dedicated residential acreage
		78-DSRSD	80.7	Multiple	190 DUs across 2.4 ac dedicated residential acreage
		79-DSRSD-LDSF	4.2	Single	469 DU across 110.4 ac dedicated residential acreage
		79-DSRSD-MDR	11.5	Single	104 DU across 9 ac dedicated residential acreage
		80-DSRSD	20.2	Multiple	130 DU across 6.4 ac dedicated residential acreage
		81-DSRSD	15.4	Multiple	108 DU across 7 ac dedicated residential acreage
		112-DSRSD	6.5	Single	136 DUs across 20.9 ac dedicated residential acreage
San Ramon	DSRSD Future Developments Tracker, received May 2020 [A]	54-DSRSD	4.8	Single	60 DUs across 12.5 ac dedicated residential acreage
		55-DSRSD	14.9	Single	111 DUs across 7.5 ac dedicated residential acreage
		56-DSRSD	11.9	Single	121 DUs across 10.1 ac dedicated residential acreage
		57-DSRSD	8.7	Single	96 DUs across 11 ac dedicated residential acreage
		58-DSRSD	10.3	Single	90 DUs across 8.7 ac dedicated residential acreage

City	Source	Assigned Land Use Code	Modeled Residential DUs/acre	Type	Notes
		59-DSRSD	12.0	Single	36 DUs across 3 ac dedicated residential acreage
		60-DSRSD	13.5	Single	87 DUs across 6.4 ac dedicated residential acreage
		61-DSRSD	9.9	Single	82 DUs across 8.2 ac dedicated residential acreage
		62-DSRSD	14.0	Single	113 DUs across 8.1 ac dedicated residential acreage
		63-DSRSD	20.8	Multiple	136 DUs across 6.5 ac dedicated residential acreage
		64-DSRSD	9.9	Single	105 DUs across 10.6 ac dedicated residential acreage
		65-DSRSD	8.3	Single	143 DUs across 17.3 ac dedicated residential acreage
		66-DSRSD	4.8	Single	101 DUs across 20.9 ac dedicated residential acreage
		67-DSRSD	5.7	Single	162 DUs across 28.2 ac dedicated residential acreage
		70-DSRSD	57.6	Multiple	449 DUs across 7.8 ac dedicated residential acreage

Note:

A. *This list may include some existing/built developments in DSRSD's service area as of May 2020. These were still included in the Model to reflect a known number of constructed dwelling units for more accurate projected consumption calculations.*

Figure 3-1: DSRSD Residential Land Use Categories from General Plans

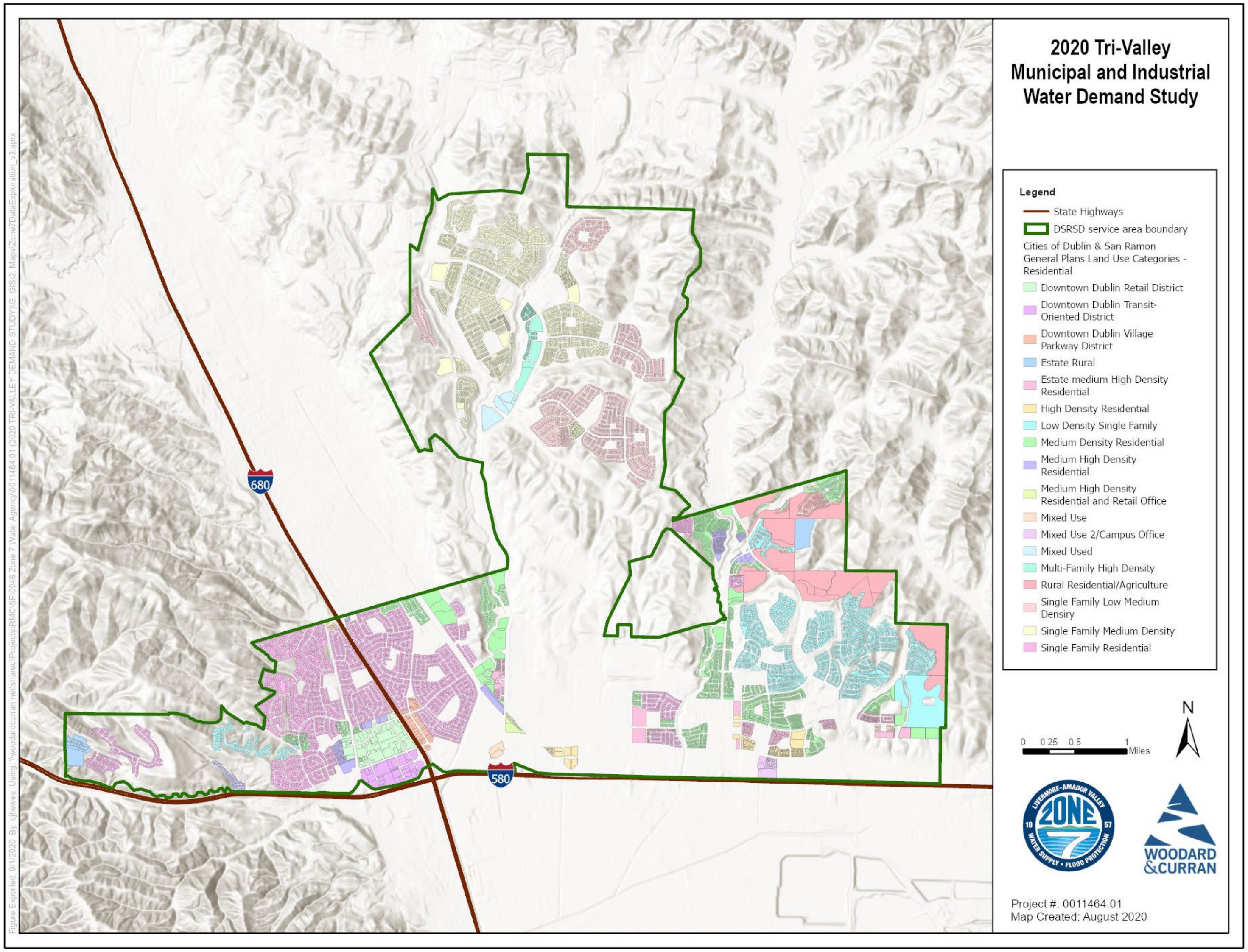


Figure 3-2: City of Pleasanton Residential Land Use Categories from General Plan

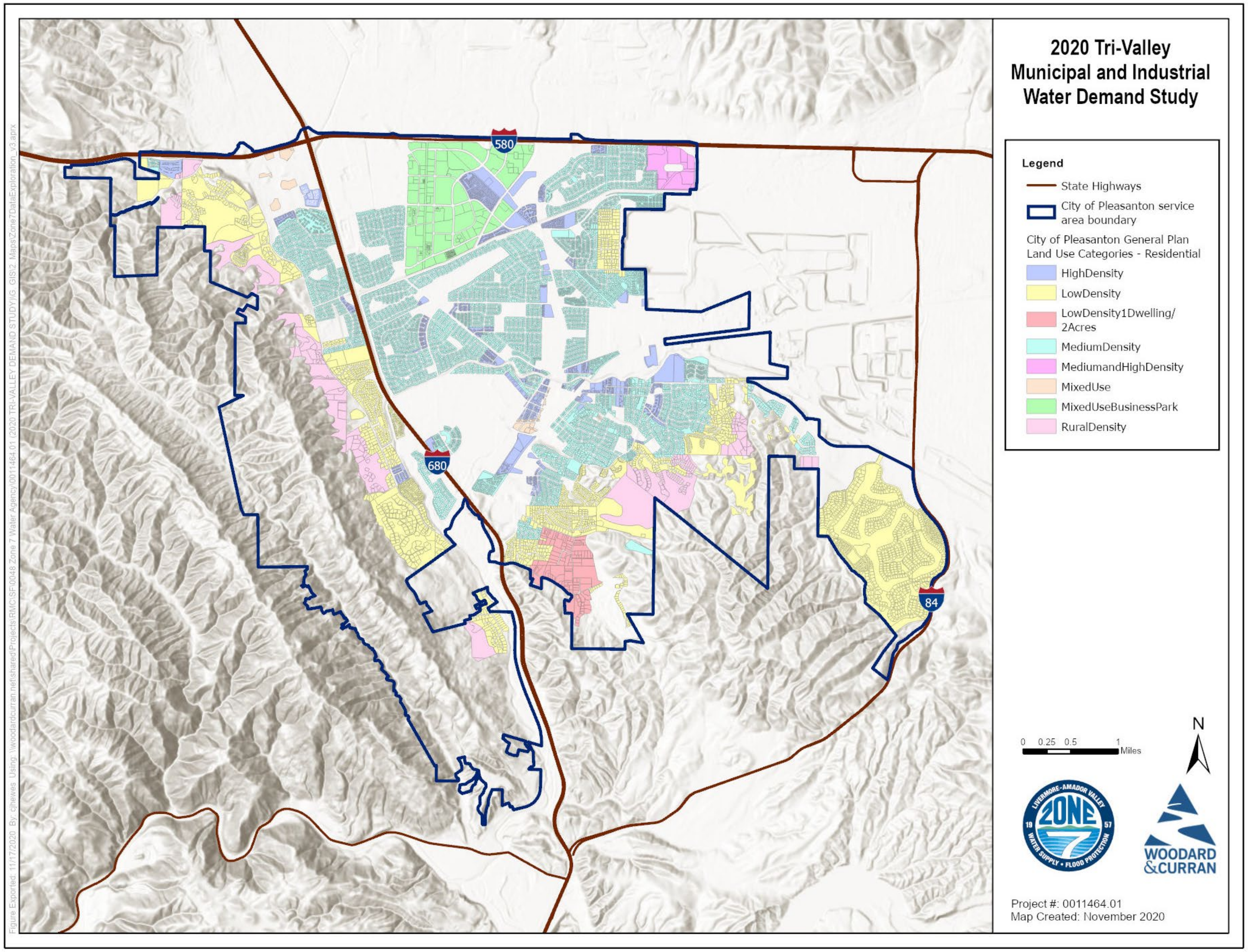


Figure 3-3: City of Livermore Residential Land Use Categories from General Plan

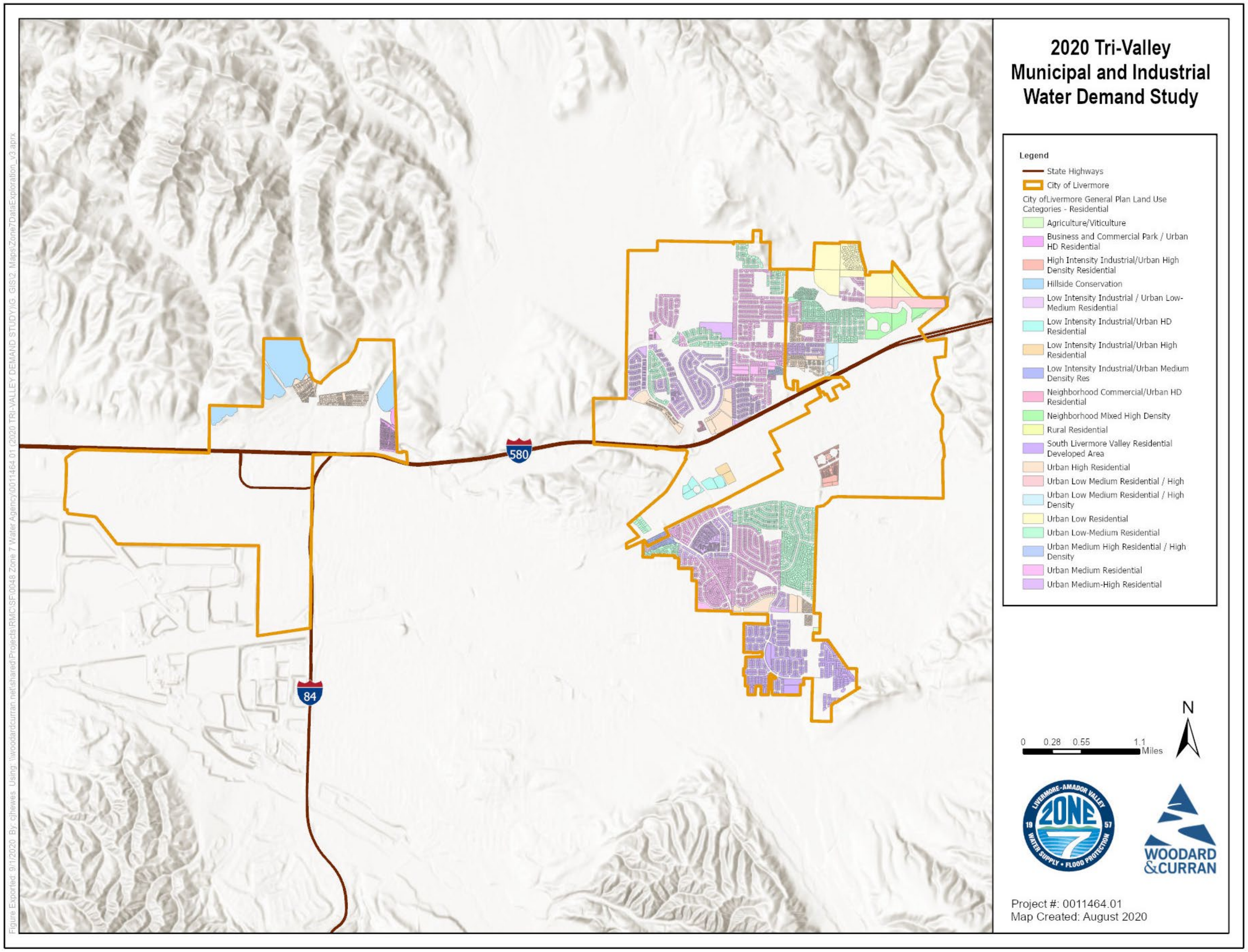
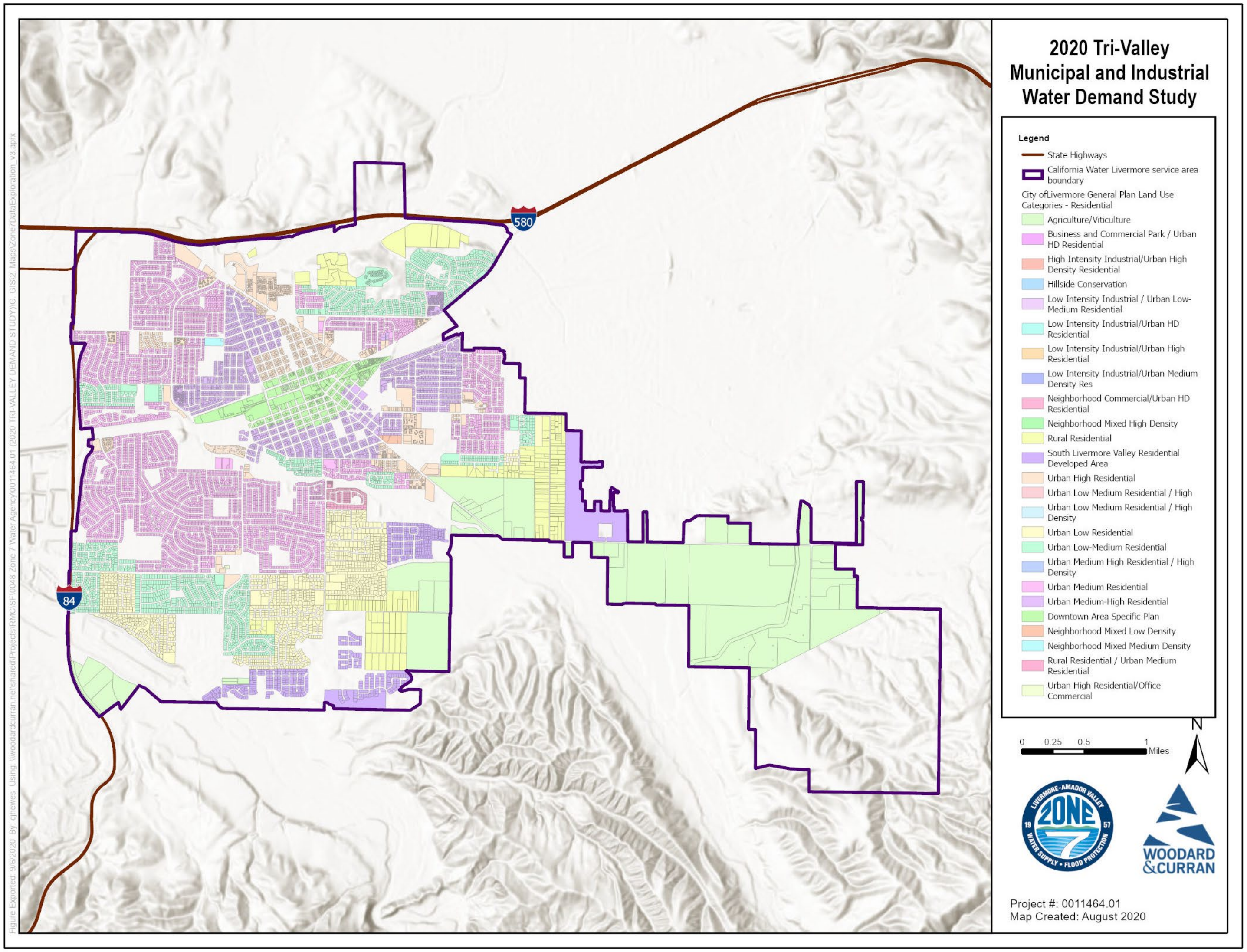


Figure 3-4: Cal Water Livermore Residential Land Use Categories from General Plan



Note: the southwest corner of Cal Water Livermore's service area boundary is located outside of the City of Livermore General Plan. Land use types for this area were manually assigned separately based on current Alameda County Assessor land use codes.

Table 3-3: Persons per Household

City	Persons per Household
Dublin	2.811
San Ramon	2.965
Livermore	2.882
Pleasanton	2.892

Source: (CA DOF (a), 2020)

Table 3-4: Vacancy Rate

City	Vacancy Rate
Dublin	6.6%
San Ramon	4.3%
Livermore	3.2%
Pleasanton	4.3%

Source: (CA DOF (a), 2020)

Table 3-5: Indoor R-GPCD (for 2020 based on 2019 data)

Agency	Total Indoor Residential Consumption (AF) [A]	Residential Indoor Consumption Data Source	Service Area Population [B]	Indoor R-GPCD
DSRSD	4,930	2019 monthly data	92,640	47.5
City of Livermore	1,446	2019 monthly data	30,003	43.0
Cal Water Livermore	2,637	2019 monthly data	59,612	39.5
City of Pleasanton	3,690	2019 bimonthly data	80,492	40.9

Notes:

A. *Additional information about disaggregation of indoor and outdoor residential demand can be found in Section 3.2.1.*

B. *Service area population source:* (SWRCB, 2020)*, with the exception of DSRSD that provided an updated population value based on updated service area information.*

Table 3-6: Indoor R-GPCD for 2025-2045

Agency	Total Indoor Residential Consumption (AF) [A]	Residential Indoor Consumption Data Source	Service Area Population	Indoor R-GPCD
DSRSD	4,666	2016-2019 bimonthly data	89,082	46.7
City of Livermore	1,410	2017-2019 average monthly data	30,003	42.0
Cal Water Livermore	*(Calculated in Section 3.1.2 as 52.3 gpcd using assumptions about drought rebound)*			
City of Pleasanton	3,761	2017-2019 average bimonthly data	80,492	41.7

Note:

A. *Additional information about disaggregation of indoor and outdoor residential demand can be found in Section 3.2.1.*

3.2 Residential Outdoor

The Model calculates residential outdoor water demands using the following calculation:

$$Area\ (ac) * Outdoor\ Water\ Demand\ Factor\ \left(\frac{AF}{ac}\right)$$

For single family homes, the outdoor water demand factor is multiplied by an adjustment factor that considers density (dwelling units per acre) and percent impervious area (an estimate for non-irrigable area) using the formula below:

$$(\%\ change\ from\ Average\ Dwelling\ Unit\ Density * 100) * -0.14\% * (\%\ change\ from\ Average\ \%\ impervious\ area * 100) * -0.01\%$$

$$= [1 + \left(\frac{Density_{Predict} - Density_{Avg}}{Density_{Avg}} * 100\right) * -0.14\%] * [1 + \left(\frac{Impervious_{Predict} - Impervious_{Avg}}{Impervious_{Avg}} * 100\right) * -0.01\%]$$

$where:$

$Density_{Predict} = Predicted\ future\ {}^{DUs}/_{ac}\ (from\ general\ plan)$

$Density_{Avg} = Average\ {}^{DUs}/_{ac}\ of\ current\ parcels\ based\ on\ land\ use\ categories\ from\ general\ plan$

$Impervious_{Predict} = Predicted\ future\ \%\ impervious\ area\ (generally\ estimated\ to\ be\ higher)$

$Impervious_{Avg} = Average\ current\ \%\ impervious\ area$

Historical outdoor water use was analyzed in conjunction with parcel area and residential sector type (single- vs multi-family) to develop outdoor water demand factors (i.e., volume of water used per acre of land). **Table 3-7** (single family) and **Table 3-8** (multi-family) provide a summary of the final outdoor residential water demand factors for each agency. Section 3.2.1 describes how these were calculated using monthly data (City of Pleasanton and Cal Water Livermore), while Section 3.2.2 describes how these were calculated using hourly Advanced Metering Infrastructure (AMI) data (DSRSD and City of Livermore).

For future single-family residential parcels, the Model makes an adjustment to the base year outdoor water demand factor based on dwelling unit density and percent impervious area compared to base year (current conditions). **Table 3-7** describes the base year average density and percent impervious area for the existing data. For every 1 percent increase in density (DU/ac) for future parcels, the single-family outdoor water demand factor is decreased by 0.14

percent. For every 1 percent increase in percent impervious area for future parcels, the single-family water demand factor is decreased by 0.01 percent. For instance, the base year density for DSRSD is 7.88 DUs/ac and 55 percent impervious area with an outdoor water demand factor of 0.61 AF/ac. A parcel with 10.3 DUs/ac and 58 percent impervious area (55% * (100%+5%) = ~58%) would have a water demand factor 4.3 percent lower due to density and an additional 0.05 percent lower due to impervious area than base year, or 0.58 AF/ac as shown in the example calculation below. Section 3.2.4 describes how these factors were calculated using a random effects panel statistical model.

$$\left[1+\left(\frac{10.3-7.88}{7.88}*100\right)*-0.0014\right]*\left[1+\left(\frac{0.58-0.55}{0.55}*100\right)*-0.0001\right]$$
$$=[1+\ 0.043]*[1+\ 0.0005]=[0.957]*[0.9995]=0.956$$

$$95.6\%*0.61\frac{AF}{ac}=0.58\frac{\mathrm{AF}}{\mathrm{ac}}$$

While DWR has not published a methodology for calculating the outdoor residential portion of the water use objective (as a result of the conservation legislation enacted by AB 1668 and SB 606), it is expected that a dataset of irrigated and irrigable land area per unique parcel will be made available to urban water suppliers in 2021. In future iterations of the Model, this data could be used to replace the percent impervious area estimate used in the adjustment factor described above for a more fine-tuned projection. The existing impervious area estimate comes from a national dataset that is significantly lower resolution than the forthcoming DWR landscape dataset. Section 3.2.4 describes more about the random effects panel statistical model that used the impervious area data.

To account for known variations in single-family residential outdoor water demand for existing parcels where AMI data was available and could be matched to a residential single-family parcel, custom parcel-specific water demand factors were used in the Model. For a subset of current residential single-family meters where a parcel could not be identified or for any future single-family parcels, the outdoor water demand factors described in **Table 3-7** are used.

Table 3-7: Single Family Residential Outdoor Water Demand Factors

Agency	Base Year Water Demand Factor (AF/ac)	Source/Notes	Base Year Average Density (DU/ac)	Base Year % Impervious Area
DSRSD [A]	0.61	Calculated based on hourly data analysis of single-family (2018-2019 average) with drought rebound adjustment (see Section 3.2.1.4).	7.88	55%
City of Livermore	0.84	Calculated based on hourly data analysis of single-family (2017-2019 average).	5.27	50%
City of Pleasanton	1.00	Calculated based on minimum month with seasonal range adjustment data analysis of single-family (2017-2019 average).	5.65	47%
Cal Water Livermore	1.26	Calculated based on minimum month with seasonal range adjustment data analysis of single-family with drought rebound adjustment (2013 vs 2014-2017 comparison – see more details in Section 3.2.1.2).	5.10	54%

Note:

A. *While the Model region field distinguishes between Dublin and San Ramon for General Plan land use type purposes, outdoor residential demand factors were calculated for the agency as a whole and the same result was applied to each city.*

Table 3-8: Multi-Family Residential Outdoor Water Demand Factors

Agency	Base Year Water Demand Factor (AF/ac)	Source/Notes
DSRSD [A]	0.61	Equal to base year single-family estimation – complexities of multi-family irrigation meters and data meant that consumption from multi-family meters could not be matched sufficiently with irrigated parcels.
City of Livermore	0.84	Equal to base year single-family estimation - not enough valid data for separate multi-family analysis.
City of Pleasanton	1.00	Equal to base year single-family estimation – high variability of consumption and acreage for the relatively small number of multi-family meters meant an average representative value could not be calculated with confidence.
Cal Water Livermore	0.99	Calculated based on minimum month with seasonal range adjustment data analysis of multi-family with drought rebound adjustment (2013 vs 2014-2017 comparison – see more details in Section 3.2.1.2).

Note:

A. While the Model region field distinguishes between Dublin and San Ramon for General Plan land use type purposes, outdoor residential demand factors were calculated for the agency as a whole and the same result was applied to each city.

3.2.1 Minimum Monthly Use Method

A common method used to estimate outdoor water use from monthly residential consumption data is to assume that the winter month with the least amount of water use is entirely dedicated to indoor use. This simple "minimum month" method typically under-estimates the volume of outdoor use because there is generally a low level of ongoing irrigation throughout the winter in most parts of urban California.

The minimum month method can be modified using a "seasonal range" (difference between peak month and minimum month) adjustment based on the patterns of consumption in dedicated irrigation meters. By comparing the relative water use of dedicated irrigation meters in winter against summer seasons, an adjustment factor can be applied to the residential sector to help estimate outdoor use more accurately. This seasonal range method assumes that outdoor use patterns are common across sectors.

The minimum month with seasonal range adjustment calculations were performed for two distinct purposes:

(1) **Calculation of residential outdoor water demand factors**

   a. For City of Pleasanton and Cal Water Livermore: to disaggregate indoor and outdoor demands across a multi-year period for calculations of residential outdoor water demand factors (in units of AF/ac).

   b. For DSRSD and City of Livermore: a separate hourly consumption analysis was used for parcel-specific residential outdoor water demand factors (see Section 3.2.2).

(2) **Calculation of total residential indoor and outdoor demands**

   a. For all agencies: to disaggregate indoor and outdoor demands at an agency level for a historical period in order to calculate indoor R-GPCD that will apply to the 2025-2045 forecast period.

b. For all agencies: to disaggregate indoor and outdoor demands at an agency level for 2019 to serve as an input "starting point" for model interpolation calculations beginning in 2020 for total residential outdoor demand.

3.2.1.1 City of Pleasanton

The City of Pleasanton has dedicated potable and recycled water irrigation meters from which a seasonal range adjustment value can be calculated and applied to residential water meters. While the City of Pleasanton has recently installed AMI technology and captures hourly meter reads, bimonthly billing consumption data was chosen as a more complete record for the purpose of developing the Model. In the future, parcel-specific outdoor water demand factors could be calculated using a multi-year record of AMI data which would increase the accuracy and confidence in the outdoor residential water demand forecast. For the seasonal range adjustment calculations described below, consumption was summed across grouped months (e.g., Feb-March through Dec-Jan) and then divided by two to allocate more evenly across 12 months.

2017-2019 Multi-Year Average (for Outdoor Water Demand Factor)

Figure 3-5 shows a graph of the total average annual consumption for all dedicated irrigation meters. The February through March period represents the minimum month (28 AF) while the August through September period is the maximum (448 AF). The seasonal range is 420 AF. The winter irrigation (minimum month) is 6.7 percent of the seasonal range.

Figure 3-5: City of Pleasanton Average 2017-2019 Seasonal Consumption from Dedicated Irrigation (Potable + Recycled) Meters

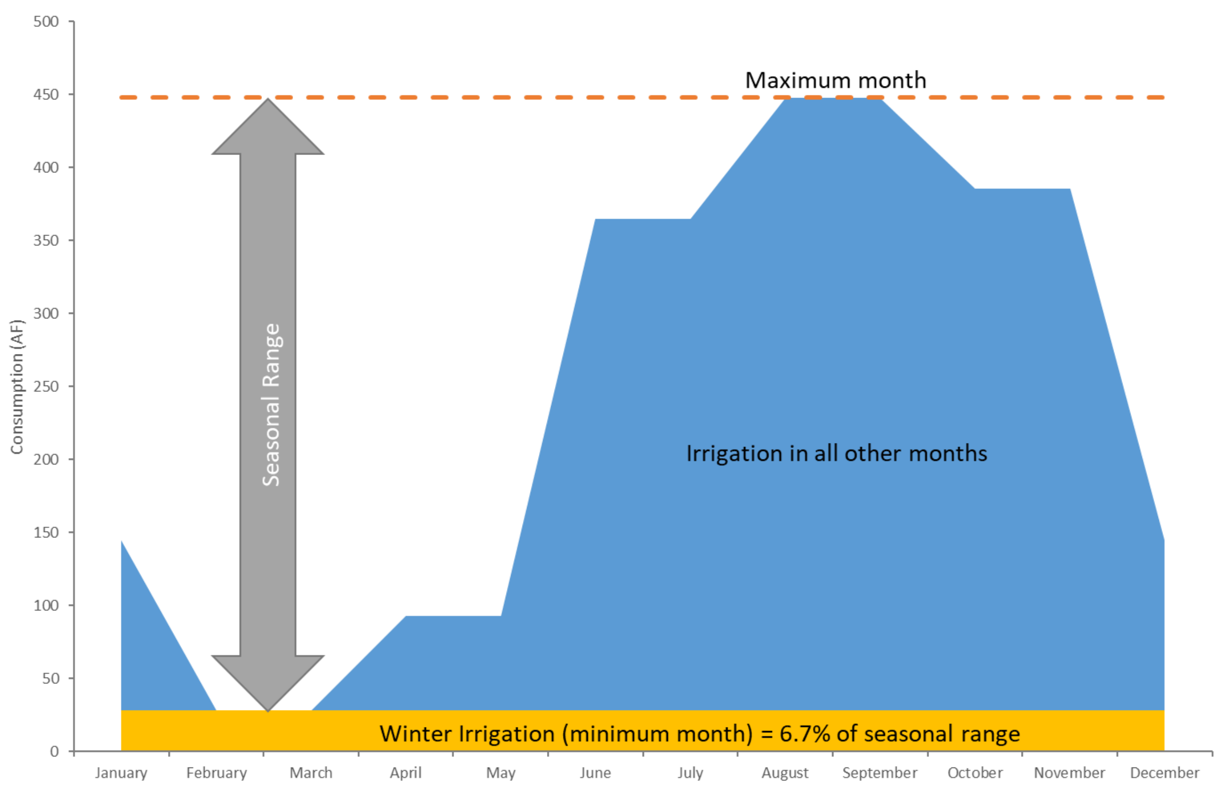
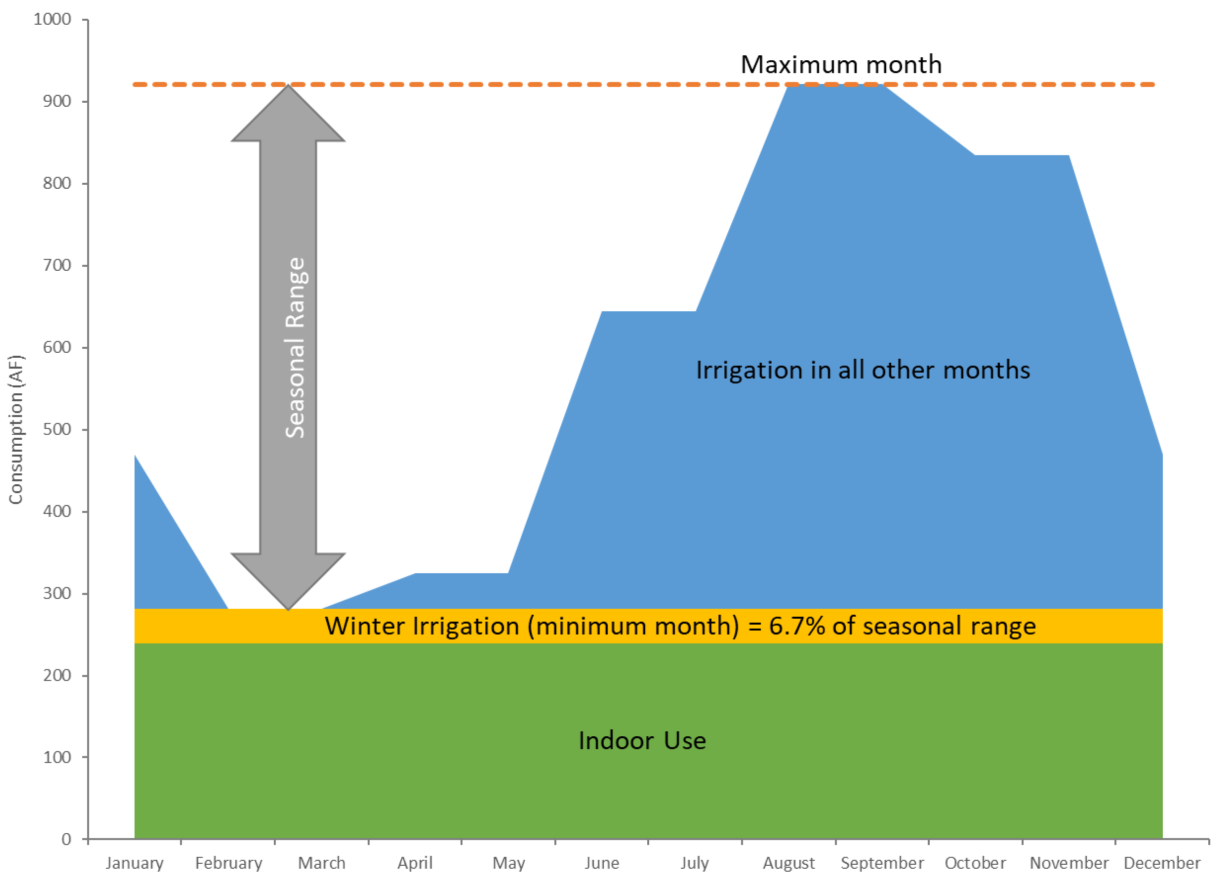


Figure 3-6 shows single-family average monthly consumption from 2017 through 2019 with the seasonal range adjustment. The minimum month of February/March (282 AF) is made up of 43 AF of winter irrigation (seasonal range of 640 AF * 6.7%) and 239 AF (282 AF – 43 AF) of indoor use. Across the entire year, 239 AF * 12 months = 2,867 AF of indoor use. Total outdoor use is a combination of the "irrigation in all other months" plus "winter irrigation" baseline for an annual total of 4,086 AF.

This disaggregation was only performed for accounts for which a valid single-family parcel number was identified (and thus total acreage could be obtained) and after removing suspected outliers[4]. Total outdoor irrigation (4,086 AF) was divided by total acres of single-family homes (4,138 ac) for a 2014-2017 drought period water demand factor of 1.0 AF/ac.

Figure 3-6: City of Pleasanton Disaggregated Indoor/Outdoor Residential Consumption, Single-Family 2017-2019



2017-2019 Multi-Year Average (for Future R-GPCD)

The same disaggregation process described above (exclusive of the outlier filtering and consideration of parcel area) was used at a high level to develop agency-wide estimates of 2017 through 2019 average residential indoor use to calculate an indoor R-GPCD for Model projections of indoor use from 2025 through 2045. For the combined residential

[4] For single-single family accounts, suspected outliers were filtered out of this analysis where parcel size was greater than 5 ac or less than 0.01 ac and average annual consumption was greater than 3 AF or less than 0.01 AF.

data, the minimum month period (February-March, 360 AF) is made up of 47 AF of winter irrigation (seasonal range of 698 AF * 6.7%) and 313 AF (360 AF – 47 AF) of indoor use. 313 AF multiplied by 12 months equals 3,761 AF of indoor use across the entire average representative year. Divided by an average population of 80,492, this results in an indoor R-GPCD of 41.7 (summarized in **Table 3-6**).

2019 Input

The same disaggregation process described above (exclusive of the outlier filtering and consideration of parcel area) was used at a high level to develop agency-wide estimates of 2019 indoor use and outdoor use as inputs to the Model's interpolation calculations that use 2019 as a starting point. The dedicated irrigation meters provided a seasonal range adjustment factor of 5.8 percent. For the combined residential data, the minimum month period (April-May, 357 AF) is made up of 38 AF of winter irrigation (seasonal range of 682 AF * 5.8%) and 318 AF (357 AF – 38 AF) of indoor use. 318 AF multiplied by 12 months equals 3,813 AF of indoor use across the entire year of 2019. Total outdoor use is a combination of the irrigation in all other months plus winter irrigation baseline for an annual total of 4,309 AF.

3.2.1.2 Cal Water Livermore

Cal Water Livermore does not have a significant number of dedicated irrigation meters (nor any recycled water meters) with which to develop a seasonal range adjustment factor specific to the agency's service area. Instead, irrigation consumption from both potable and recycled water meters were combined from DSRSD, City of Livermore, and City of Pleasanton to develop a seasonal range adjustment factor. Because the retail agencies are located in the same geographic region with similar climates, they are expected to have similar seasonal range adjustment factors.

2013 and 2014-2017 Periods with Drought Rebound (for Outdoor Water Demand Factor)

A drought rebound factor for indoor residential water demands for Cal Water Livermore was described in Section 3.1.2. A similar assumption is used in the calculation of the outdoor water demand factor (shortened to as "WDF" in the equations below):

$$(Pre\text{-}drought\ WDF\ ) - 20\% * (Pre\text{-}drought\ WDF - Drought\ WDF)$$

$$(2013\ WDF) - 20\% * (\ 2013\ WDF - 2014\text{-}2017\ Average\ WDF)$$

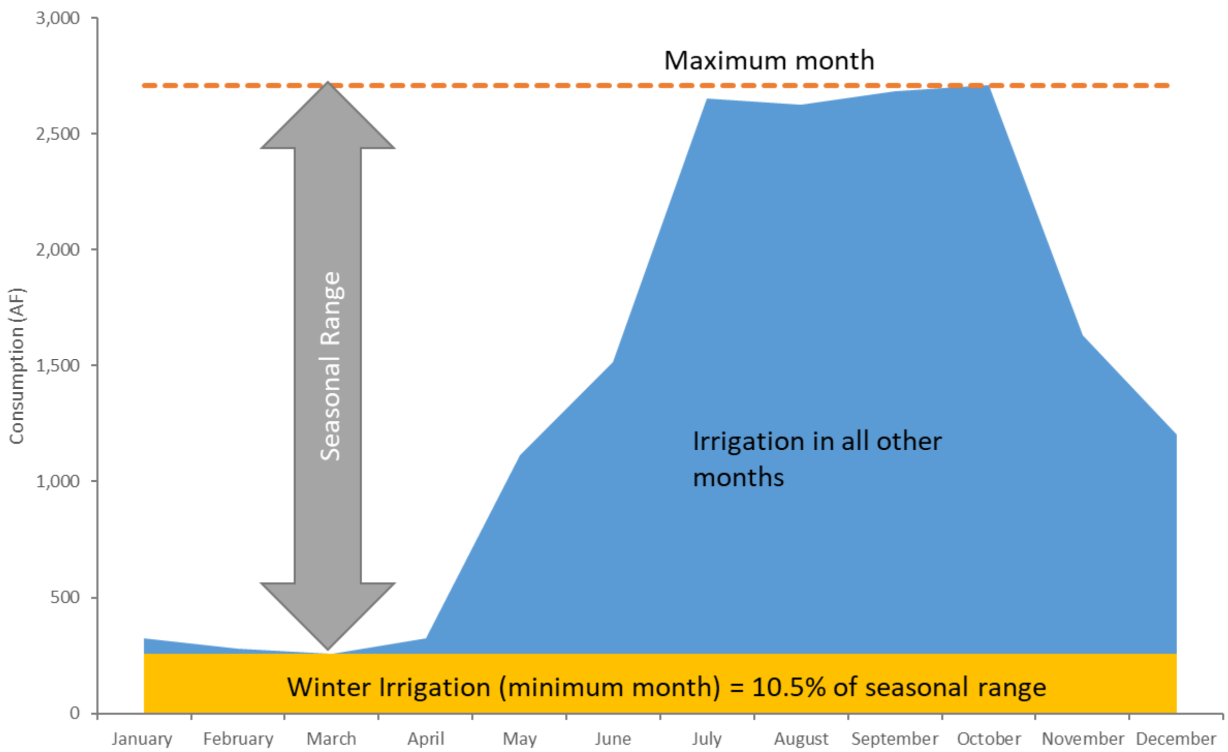
$$Single\text{-}Family: (1.39) - 20\% * (1.39 - 0.73) = 1.26\ AF/ac$$

$$Multi\text{-}Family: (1.08) - 20\% * (1.08 - 0.66) = 0.99\ AF/ac$$

The remainder of this section describes how the WDF was calculated for single-family using an average taken from 2014 through 2017. The same process was used for multi-family and for both residential types in 2013 (summarized in **Table 3-9**).

Figure 3-7 shows the total average monthly consumption of dedicated potable and recycled irrigation meters for the three agencies with these types of connections from 2014 through 2017. The month of March represents the minimum month (257 AF) while October is the maximum (2,710 AF). The seasonal range is 2,453 AF. The winter irrigation (minimum month) is 10.5 percent of the seasonal range.

Figure 3-7: Seasonal Consumption of Irrigation (Potable + Recycled) Meters from DSRSD, City of Livermore, and City of Pleasanton 2014-2017 A



Notes:

A. *Includes combined dedicated irrigation data from the following sources and time frames:*
   a. *City of Livermore 2017 potable and recycled water irrigation meters*
   b. *City of Pleasanton 2017 potable and recycled water irrigation meters*
   c. *DSRSD 2014-2017 potable and recycled water irrigation meters*

Figure 3-8 shows the single-family average monthly consumption from 2014 through 2017 with the seasonal range adjustment. The minimum month of March (255 AF) is made up of 38 AF of winter irrigation (seasonal range of 364 AF * 10.5%) and 217 AF (255 AF – 38 AF) of indoor use. 217 AF multiplied by 12 months equals 2,598 AF of indoor use across the entire average year. Total outdoor use is a combination of the “irrigation in all other months” plus “winter irrigation” baseline for an annual total of 2,494 AF.

This disaggregation was only performed for accounts for which a valid parcel number was identified (and thus total acreage could be obtained) and after removing suspected outliers[5]. Thus, the sums for indoor and outdoor use do not represent the entirety of Cal Water Livermore’s residential accounts. Total outdoor irrigation (2,494 AF) was divided by total acres of single-family homes (3,398 ac) for a 2014-2017 drought period water demand factor of 0.73 AF/ac.

[5] For single-single family accounts, suspected outliers were filtered out of this analysis where parcel size was greater than 5 ac and average annual consumption was greater than 2 AF. For separate multi-family analysis, suspected outliers were filtered out of this analysis where parcel size was greater than 10 ac or less than 0.1 ac and average annual consumption was greater than 20 AF.

Table 3-17 shows a summary of the results for both single-family and multi-family for 2013 (pre-drought) and 2014-2017 (post-drought) for purpose of calculating values for outdoor water demand factors with drought rebound.

Figure 3-8: Cal Water Disaggregated Indoor/Outdoor Residential Consumption 2014-2017

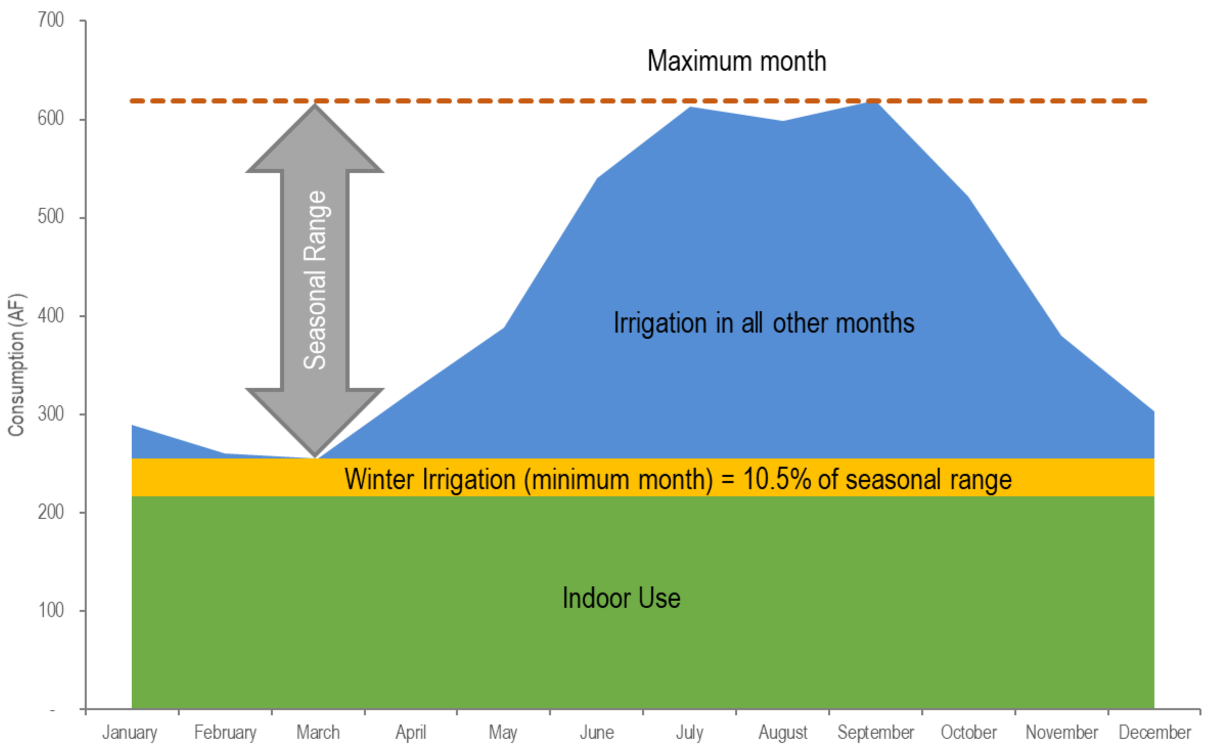


Table 3-9: Cal Water Livermore Outdoor Water Demand Factor Calculation Summary

Time Period	Seasonal Range Adjustment Factor	Residential Type	Outdoor Consumption (AF)	Area (ac)	Outdoor Water Demand Factor (AF/ac)
2013	6.9% A	Single-Family	4,724	3,398	1.39
		Multi-Family	77	72	1.08
2014-2017	10.5%	Single-Family	2,494	3,398	0.73
		Multi-Family	47	72	0.66

Note:

A. The seasonal range adjustment factor for 2013 is based only on DSRSD's potable and recycled dedicated irrigation meters from the same year because other agencies did not provide data for this year.

2013 and 2014-2017 Periods with Drought Rebound (for Future R-GPCD)

The same disaggregation process described above (exclusive of the outlier filtering and consideration of parcel area) was used at a high level to develop agency-wide estimates of 2013 and 2014-2017 residential indoor use to calculate an indoor R-GPCD for Model projections of indoor use from 2025 through 2045. **Table 3-10** describes the calculation of the indoor R-GPCD for each period.

Table 3-10: Cal Water Livermore 2013 and 2014-2017 R-GPCD Calculation Summary

Time Period	Seasonal Range Adjustment Factor	Minimum Month (AF)	Maximum Month (AF)	Seasonal Range (AF)	Indoor Use (AFY)	Population	Indoor R-GPCD
2013	6.9% [A]	340	1,041	701	3,500	57,614 [B]	54.2
2014	17.6%	342	702	360	3,342	57,381	52.0
2015	11.0%	316	598	283	3,413	58,826	51.8
2016	5.4%	229	706	477	2,438	58,939	36.9
2017	2.9%	229	763	535	2,555	59,193	38.5
						2014-2017 Average	44.8

Notes:

A. *The seasonal range adjustment factor for 2013 is based only on DSRSD's potable and recycled dedicated irrigation meters from the same year because other agencies did not provide data for this year.*

B. *2013 population was estimated based on linear trend of population 2014-2019 reported by Cal Water Livermore to SWRCB.*

A drought rebound factor for indoor residential water demands for Cal Water Livermore was described in Section 3.1.2. The formulas below describe how Cal Water Livermore's rebounded indoor R-GPCD of 52.3 gpcd was calculated:

$$(Pre\text{-}drought\ R\text{-}GPCD) - 20\% * (Pre\text{-}drought\ R\text{-}GPCD - Drought\ R\text{-}GPCD\ )$$

$$(2013\ R\text{-}GPCD) - 20\% * (\ 2013\ R\text{-}GPCD - 2014\text{-}2017\ Average\ R\text{-}GPCD\ )$$

$$(54.2) - 20\% * (54.2 - 44.8) = 52.3\ gpcd$$

2019 Input

A similar process was used (exclusive of the outlier filtering and consideration of parcel area) at a high level to develop agency-wide estimates of 2019 residential indoor use and outdoor use as inputs to the Model's interpolation calculations that use 2019 as a starting point. The dedicated irrigation data from the other three agencies provided a seasonal range adjustment factor of 4.7 percent that could be applied to Cal Water Livermore. For the combined residential data, the minimum month (March, 247 AF) is made up of 27 AF of winter irrigation (seasonal range of 579 AF * 4.7%) and 220 AF (247 AF – 27 AF) of indoor use. 220 AF multiplied by 12 months equals 2,637 AF[6] of indoor use across the entire year of 2019. Total outdoor use is a combination of the irrigation in all other months plus winter irrigation baseline for an annual total of 3,687 AF.

[6] Multiplied using unrounded values

3.2.1.3 City of Livermore

Hourly AMI data was used to calculate the parcel-specific area-based outdoor residential demand factors for the City of Livermore (described in Section 3.2.2). However, the minimum month method with seasonal range adjustment was still used to calculate City-wide indoor and outdoor use (for all residential accounts) both as 2019 inputs for current demands in the Model to kick off interpolation calculations as well as to help calculate indoor R-GPCD across a multi-year period from 2017 through 2019. Hourly data from some meters had to be excluded from the analysis for certain reasons[7], so a disaggregation of the AMI data would not represent the entirety of the agency's water demands. However, the percent disaggregation was still found to be similar between indoor and outdoor use via the hourly methodology and via the minimum month methodology.

2017-2019 Multi-Year Average (for Future Indoor R-GPCD)

For City of Livermore, **Figure 3-9** shows the 6.3 percent seasonal range factor from dedicated irrigation meters and **Figure 3-10** shows the combined single- and multi-family average annual consumption from 2017 through 2019 with the seasonal range adjustment. The minimum month of March (134 AF) is made up of 16 AF of winter irrigation (seasonal range of 255 AF * 6.3%) and 118 AF (134 AF – 16 AF) of indoor use. 118 AF multiplied by 12 months equals 1,410 AF of indoor use across the entire average year. Total outdoor use is a combination of the "irrigation in all other months" plus "winter irrigation" baseline for an annual total of 1,562 AF. Monthly data per sector reported in the City's annual water reports was used to calculate these values, rather than summed hourly consumption. Dividing 1,410 AF by an average population of 30,003, this results in an indoor R-GPCD of 42.0 (summarized in **Table 3-6**).

[7] Described in more detail in Section 3.2.2

Figure 3-9: City of Livermore Average 2017-2019 Seasonal Consumption from Dedicated Irrigation (Potable) Meters

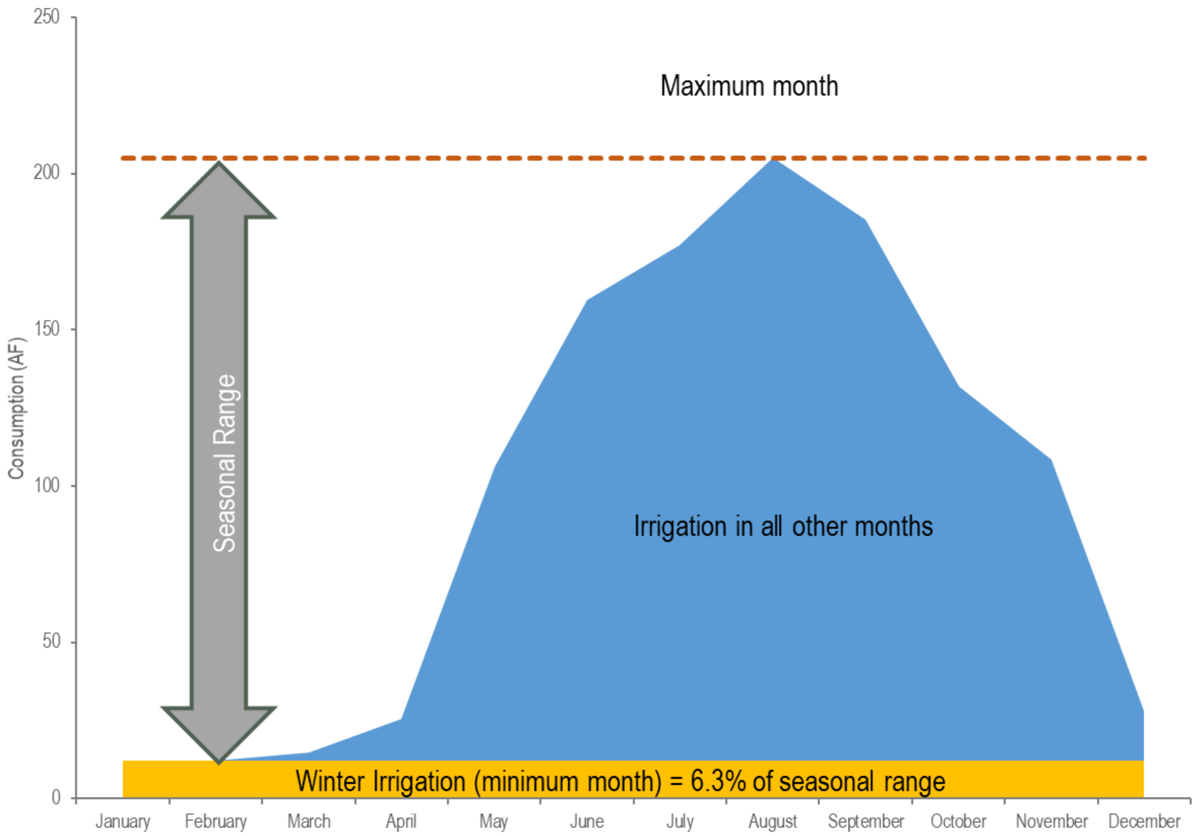
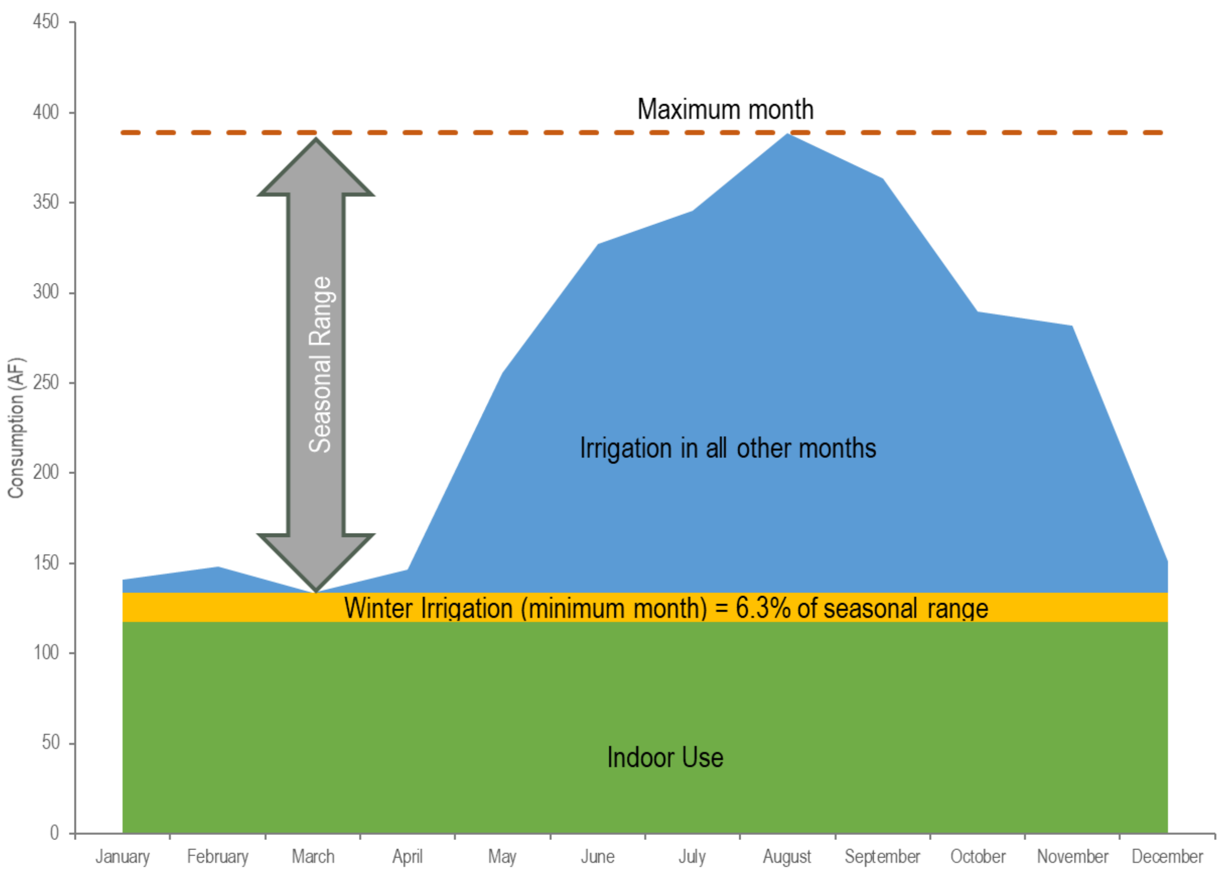


Figure 3-10: City of Livermore Disaggregated Indoor/Outdoor Residential Consumption, 2017-2019



2019 Input

The same process described above was used at a high level to develop agency-wide estimates of 2019 indoor use and outdoor use as inputs to the Model's interpolation calculations that use 2019 as a starting point. For the combined residential data, the minimum month (March, 131 AF) is made up of 10 AF of winter irrigation (seasonal range of 278 AF * 3.7%) and 120 AF (131 AF – 10 AF) of indoor use.[8] Across the entire year of 2019, 120 AF * 12 months = 1,446 AF of indoor use. Total outdoor use is a combination of the irrigation in all other months plus winter irrigation baseline for an annual total of 1,594 AF.

3.2.1.4 DSRSD

Hourly AMI data was used to calculate the parcel-specific area-based outdoor residential demand factors for DSRSD (described in Section 3.2.2). However, the minimum month method with seasonal range adjustment was still used to calculate agency-wide indoor and outdoor use (for all residential accounts) as both 2019 inputs for current demands in the Model to kick off interpolation calculations as well as to help calculate indoor R-GPCD across a multi-year period from 2016 through 2019. Hourly data from some meters had to be excluded from the analysis for certain reasons[9], so a disaggregation of the hourly disaggregation would not represent the entirety of the agency's water demands. However, the percent disaggregation was still found to be similar between indoor and outdoor use via the hourly

[8] Differences due to subtraction using unrounded values
[9] Described in more detail in Section 3.2.2

methodology and via the minimum month methodology. Note that while DSRSD provided AMI data for 2018 through 2019, bimonthly billing consumption data from 2016 through 2019 was used to look at indoor/outdoor disaggregation agency-wide over a longer time period.

Indoor/outdoor consumption disaggregation was performed separately for each year from 2013 through 2019 and later limited to a representative 2016 through 2019 for purpose of Model input (described further below). **Table 3-11** shows the calculation of the seasonal range adjustment factor using potable and recycled water irrigation meter data. **Table 3-12** shows the disaggregation of indoor and outdoor consumption for single-family using the seasonal range adjustment factor.

During hourly data disaggregation for multi-family accounts, it was observed that the vast majority of multi-family meters do not exhibit seasonal irrigation patterns, meaning most metered consumption is indoor use. DSRSD's multi-family customers living in condos, townhomes, apartments, and duplex units typically have dedicated potable irrigation meters for the common landscape area. and there are likely dedicated irrigation meters serving multi-family residential outdoor uses. During hourly data analysis, 96 percent of multi-family consumption was estimated to be indoor use, with 4 percent dedicated to outdoor use at a small number of multi-family meters. These percentages were applied to the multi-family 2013-2019 totals to estimate indoor and outdoor use (see **Table 3-14**) instead of using the minimum month method with seasonal range adjustment.

Finally, **Table 3-15** shows the summed indoor and outdoor consumption values from the single- and multi-family sectors and calculation of R-GPCD. The range of years from 2016 through 2019 was selected as the base year period for averaging indoor R-GPCDs, representing the tail end of the recent drought and some years of recovery. Indoor R-GPCD has stayed relatively flat during this period while overall residential GPCD (including outdoor use) has begun to rebound. A discussion of outdoor residential water demand factor drought rebound for DSRSD is provided in Section 3.2.2.1.

Table 3-11: DSRSD Calculation of Percent Season Range Adjustment Factor (2016-2019)

Year	Irrigation Minimum Month (AF)	Irrigation Maximum Month (AF)	Irrigation Seasonal Range (AF)	% of Seasonal Range
2013	40	615	575	6.9%
2014	77	513	436	17.6%
2015	41	412	371	11.0%
2016	28	545	518	5.4%
2017	18	637	619	2.9%
2018	63	576	513	12.2%
2019	13	582	568	2.3%

Note:

A. *(% of Seasonal Range) = (Irrigation Minimum Month) / (Irrigation Seasonal Range); where (Irrigation Seasonal Range) = (Irrigation Maximum Month) – (Irrigation Minimum Month)*

Table 3-12: DSRSD Single-Family Disaggregation 2013-2019

Year	Minimum Month (AF)	Maximum Month (AF)	Seasonal Range (AF)	Winter Irrigation (AF)	Indoor Use (AFY)	Outdoor Use (AFY)
2013	279	625	345	24	3,063	2,405
2014	296	412	117	21	3,301	1,106
2015	262	339	78	9	3,036	575
2016	251	424	173	9	2,903	1,112
2017	254	540	287	8	2,941	1,713
2018	302	532	230	28	3,283	1,757
2019	280	564	284	7	3,281	1,883

Table 3-13: DSRSD Single-Family Disaggregation 2013-2019

Year	Minimum Month (AF)	Maximum Month (AF)	Seasonal Range (AF)	Winter Irrigation (AF)	Indoor Use (AFY)	Outdoor Use (AFY)
2013	279	625	345	24	3,063	2,405
2014	296	412	117	21	3,301	1,106
2015	262	339	78	9	3,036	575
2016	251	424	173	9	2,903	1,112
2017	254	540	287	8	2,941	1,713
2018	302	532	230	28	3,283	1,757
2019	280	564	284	7	3,281	1,883

Table 3-14: DSRSD Multi-Family Disaggregation 2013-2019

Year	Total Annual (AF)	96% Indoor Estimate (AF)	4% Outdoor Estimate (AF)
2013	1,399	1,343	56
2014	1,461	1,402	58
2015	1,425	1,368	57
2016	1,526	1,465	61
2017	1,605	1,541	64
2018	1,666	1,599	67
2019	1,719	1,651	69

Table 3-15: DSRSD Indoor R-GPCD and Total Residential GPCD Calculations

Year	Total Residential Indoor (AF)	Total Residential Outdoor (AF)	Population [A]	Indoor R-GPCD	Total Residential GPCD
2013	4,406	2,461	74,447	52.8	82.4
2014	4,703	1,165	77,644	54.1	67.5
2015	4,404	632	80,678	48.7	55.7
2016	4,368	1,173	83,854	46.5	59.0
2017	4,482	1,777	87,557	45.7	63.8
2018	4,883	1,824	92,376	47.2	64.8
2019	4,931	1,952	92,540	47.5	66.4

Note:

A. *2013 population estimated based on linear trending from 2014 through 2019 data. 2014 through 2018 data from DSRSD reporting to SWRCB. 2019 value updated directly by DSRSD.*

3.2.2 Hourly AMI Data Disaggregation

For single-family water use, the hourly advanced metering infrastructure (AMI) data from DSRSD and the City of Livermore were processed using a filter to identify hourly consumption that exceeded a predetermined threshold. Ideally, the threshold should be set low enough to filter out the majority of irrigation events but not so low as to filter out what likely is indoor water use. When the study team varied the threshold between 75 and 150 gallons per hour, they determined that setting it at 100 gallons per hour was the highest value that removed the observed seasonality from monthly water use. The residual water use is assumed to primarily be indoor water use. This is consistent with previous work done for DWR by members of the study team, which suggested that setting the threshold at 100 gallons per hour effectively screens out most irrigation events (DWR, 2020).

In the case of multi-family, the simple filtering approach used for single-family is not applicable because high hourly volumes may be caused by many different households using water simultaneously. Normalizing water use by the number of housing units served by the meter might help address this issue, but that information was not available for this study. Because there are relatively few multi-family meters in the analysis, the study team was able to use visual inspection to flag those meters that exhibited a strong seasonal water use pattern and/or had obvious irrigation events. Removing these meters from the sample allowed for an estimation of the average water use per meter for the remaining sample, which was assumed to primarily be indoor water use. As described in more detail per retailer below, AMI data from multi-family homes was ultimately not used in the Model.

3.2.2.1 DSRSD

DSRSD has used an AMI system since 2014 to collect hourly meter reads from all customer meters (DSRSD, 2016). DSRSD's vendor for meter read and consumption data storage retains the last three years of data. DSRSD was able to request and provide consumption data for complete calendar years for 2018 and 2019.

Hourly water consumption data for residential meters were analyzed for 2018 and 2019. Meters were ignored if the data showed negative consumption values, missing values, or reads over 3,480 gallons per hour that is a typical maximum flow for a 1-inch meter. Additionally, properties identified as being served recycled water were removed from this analysis as they would not be expected to show seasonal variation in outdoor consumption on the potable meter.

After this conservative quality control approach, approximately 75 percent of single-family meters were included. An estimate of annual outdoor and indoor demand was developed for each meter. Total outdoor demand was summed across meters located at the same property. To maximize the number of properties considered with valid data, properties with only one year of data were included in the analysis since only two years of data were available.

For meters serving multi-family accounts, it was observed that approximately 80 percent of meters did not exhibit seasonal variation in demands. DSRSD's multi-family customers living in condos, townhomes, apartments, and duplex units typically have dedicated potable irrigation meters for the common landscape area. Several attempts were made to correlate parcel data with irrigation meters at multi-family properties. Due to a relatively small sample size and low confidence in matches between acreage irrigated and irrigation consumption data, there was a wide variability in calculated water demand factors. Ultimately, the multi-family outdoor water demand factor was set equal to single-family. A single-family outdoor residential water demand factor of 0.53 AF/ac was estimated using a robust mean analysis (see more details in Section 3.2.3) to account for outliers. Finally, a drought rebound factor was incorporated to reflect an assumption about increased outdoor water demands over the next five years. DSRSD requested to use a drought rebound factor of 15 percent based on their review of 2017 through 2019 consumption data. The residential outdoor water demand factor, applied to both single-family and multi-family properties, is 0.61 AF/ac.

3.2.2.2 City of Livermore

The City of Livermore has used an AMI system since 2016/2017 to collect hourly meter reads from all customer meters. The City of Livermore provided three years of hourly consumption from 2017 through 2019.

Hourly consumption was available for approximately 8,600 single-family meters. Hourly consumption for approximately 1,700 meters were ignored due to (1) negative reported consumption, (2) missing reads, or (3) reads over 3,480 gallons per hour that is a typical maximum flow for a 1-inch meter. Negative reads accounted for most of the ignored data. The remaining sample of 6,900 meters is suitable for a reliable estimate of outdoor water use.

A single outdoor residential water demand factor for the entire City of Livermore service area was estimated as 0.84 AF/ac using a robust mean analysis (see more details in Section 3.2.3) to account for outliers.

The City of Livermore has 149 multi-family accounts. Significant variation in water use patterns was observed where some multi-family meters exhibited irrigation use patterns only, some were only indoor use with no observable seasonal pattern, and some were mixed. Additionally, multi-family parcels in the Alameda County Assessor's Office dataset were sometimes delineated as individual dwelling units and sometimes as grouped properties, making it difficult to confidently match multi-family consumption data with a parcel. For these reasons, an outdoor water demand factor for multi-family properties could not be developed and the single-family value was applied for all multi-family properties. It is possible that outdoor residential demands for multi-family homes are thus being over-projected because multi-family homes might be expected to have a lower volume of water use per acre due to the typically higher density of building structure to property area. However, given the low acreage of multi-family properties relative to single-family properties in the City of Livermore, this potential over-projection is expected to be negligible.

3.2.3 Robust Mean Analysis

Robust regression is a statistical method used to find the relationship between one or more independent variables and a dependent variable. Robust regression is an alternative to the very common least squares regression when data is contaminated with outliers or influential observations (UCLA Institute for Digital Research & Education, 2020). In robust regression, the input data are analyzed and weights are assigned to each observation through an iterative calculation process. Observations that have stronger outlier tendencies are down-weighted so they have less influence on the final results. In STATA, a statistical analysis software package, it is possible to use one component of the tools used for robust regression to calculate the mean of a sample population. This estimation of the mean uses the same outlier analysis tools that would be used in the development of a robust regression. STATA's robust mean analysis makes the combined use of Huber weighting and bi-weighting methods which means the most influential points are typically dropped while other strong outliers are down-weighted when calculating a mean (UCLA Institute for Digital Research & Education, 2020).

STATA's robust regression command (rreg) was used to estimate the robust mean of CII and AMI-based residential outdoor water demand factors separately for each agency. It was observed that the calculated robust mean for each sector was very close to the median value.

3.2.4 Effects of Density and Percent Impervious Area on Residential Outdoor Demand Factor

A random effects panel statistical model was constructed to estimate the effect of dwelling unit density and percent impervious area on outdoor water demand factors across the Tri-Valley region as a whole. Inputs to the statistical model included:

- Individual year estimates of outdoor water demand factor (AF/ac) per parcel using the methods described in sections above.
    - Note that a small subset of parcels with area larger than 1 acre were excluded from this analysis as suspected influential outliers.
- Dwelling unit density associated with each parcel according to the overlying general plan residential land use category or (if applicable) an override density assigned for known developments (see Section 3.1.1).
- An estimate for percent impervious area per parcel based on 2016 data from the National Land Cover Database (NLCD). This dataset is developed by the U.S. Geological Survey in partnership with several federal agencies and includes an estimate of percent impervious cover for every 30-meter pixel in the United States. This is not an ideal dataset for a residential parcel level study since the pixels do not line up with individual parcel boundaries, but it does act as an acceptable temporary placeholder for expected data coming from DWR's landscape area measurement work in 2019-2020. This DWR dataset is expected to define percent irrigated, irrigable, and not irrigable area for every unique residential parcel for every California urban water supplier. When this data is available, the percent impervious area for each parcel can be updated at a significantly higher resolution and the statistical model can be re-run with higher accuracy for this factor.
- Tri-Valley water agency associated with each parcel.
- Type of property (single-family or multi-family) based on account-level data from each retailer.

The random effects panel model makes use of multiple years of data as well as which utility is associated with the parcel to account for natural heterogeneity (differences) between parcels as well as potential systematic/utility-specific differences in water use to avoid biasing the overall results. Because the density and percent impervious area are static characteristics that do not change with multiple years of outdoor water use data, it is not possible to run a full regression model that predicts outdoor water use a result of the input parcel characteristics. Instead, the statistical model describes the effect that a change in dwelling unit density or a change in percent impervious area will have on change in the area-based outdoor water demand factor. This effect is applicable for the entire Tri-Valley region; systematic differences in water use according to water agency were controlled for as part of the inputs to the statistical model. This type of model also inherently captures or controls the effect of weather by using multiple years of input data as a bias control.

For single-family parcels, statistically significant results describe that a 1 dwelling unit per acre increase in density results in a 0.14 percent decrease in the outdoor water demand factor. Similarly, a 1 percent increase in percent impervious area results in a statistically significant 0.01 percent decrease in the outdoor water demand factor. There were no statistically significant results found for multi-family parcels. This is likely due to a significantly smaller dataset as well as the fact that for some agencies, many multi-family homes were found to have very little seasonal variation (e.g., no outdoor water demand) due to separate dedicated irrigation meters.

3.3 Commercial, Industrial, Institutional

Water demand factors for CII land uses were developed for each agency (described in the sections below). For each agency, an attempt was made to match every current account/meter with a parcel number (as described in Section 2.3). For every parcel, a land use code was assigned based on current county assessor data. Land use codes in the county assessor data are fairly specific. For example, a four-digit land use code in Alameda County of 3702 is described "Shopping Center-Regional Mall." However, future land uses projected in the general plan are typically more general (commercial, industrial, or institutional). To develop water demand factors that matched the more generic land use categories in the general plan, the current land use codes were simplified. Each county assessor's land use code list is organized where the first digit indicates a larger grouped category. Continuing with the example of land use code 3720 ("Shopping Center-Regional Mall"): since it is part of the 3### series that describes Commercial uses, this land use type would be categorized as "Commercial."

For Alameda County, land use codes were standardized according to the list in **Table 3-16**. County assessor land use codes are typically assigned for tax purposes and the groupings do not always apply to water use intensity. For this reason, several case-by-case modifications were made in **Table 3-17** to recategorize certain land use codes. For Contra Costa County (used only for parcels in the San Ramon portion of DSRSD's service area), land use codes were standardized according to the list in **Table 3-18**, with modification in **Table 3-19**.

Table 3-16: Alameda County Land Use Code Series Categorization

Code Series	Series Name	Model Categorization
0###	Exempt, Not Assessed by County, Mobile Homes and Tracts	Other
1###	Single Family Residential	SFR
2###	Multiple Residential, 2-4 Units and Mobile Homes	MFR
3###	Commercial (See also 8X & 9X Series)	Commercial
4###	Industrial	Industrial
5###	Rural	Other
6###	Institutional	Institutional
7###	Multiple Residential, 5 or more units	MFR
8###	Improved Commercial	Commercial
9###	Improved Commercial	Commercial

Table 3-17: Alameda County Land Use Codes Categorized Differently Than Code Series

Land Use Code	Description	Code Series Classification	Model Categorization
0300	Exempt Public Agency	Exempt, Not Assessed by County, Mobile Homes and Tracts	Institutional
0600	Mobile home on SFR/rural land	Exempt, Not Assessed by County, Mobile Homes and Tracts	SFR
0700	Mobile home in a mobile home park	Exempt, Not Assessed by County, Mobile Homes and Tracts	SFR
0800	Vacant residential tract lot	Exempt, Not Assessed by County, Mobile Homes and Tracts	SFR
0940	Tract residential PC, R&T 402.1	Exempt, Not Assessed by County, Mobile Homes and Tracts	SFR
3200	Store/Office with Apts/Lofts	Commercial (See also 8X & 9X Series)	Office
5000	Vacant rural-res homesites, may incl misc. imps	Rural	SFR
5100	Improved rural-residential homesite.	Rural	SFR
5300	Rural property with significant commercial use	Rural	Commercial
5400	Rural property with significant industrial use	Rural	Industrial
6000	Vacant land necessary part of institutional prop.	Institutional	Other
6001	Government owned property - vacant land	Institutional	Other
6200	Secured PI	Institutional	Other
6300	Golf course	Institutional	Golf Course
6500	Cemetery	Institutional	Cemetery
6590	Cemetery - Exempt	Institutional	Cemetery
6850	Historical commercial	Institutional	Commercial
7300	Condominium - single residential living unit	Multiple Residential, 5 or more units	SFR
7320	Condominium - single res unit, first sale	Multiple Residential, 5 or more units	SFR
7330	Condominium - single res unit, R&T 402.1, First Sa	Multiple Residential, 5 or more units	SFR
7340	Condominium - single res unit, R&T 402.1	Multiple Residential, 5 or more units	SFR
9100	Mobile home park parcel with improvements	Improved Commercial	SFR
9400	One to five story office building	Improved Commercial	Office
9401	Condominium-office	Improved Commercial	Office
9491	Condominium-office, common area or use	Improved Commercial	Office

Land Use Code	Description	Code Series Classification	Model Categorization
9500	Over five story office building	Improved Commercial	Office
9801	Winery	Improved Commercial	Industrial
9901	Boat berth privately owned	Improved Commercial	Other
9902	Subsurface right-oil, gas, mineral	Improved Commercial	Other

Table 3-18: Contra Costa County Land Use Code Series Categorization

Code Series	Series Name	Model Categorization
1#	Residential	SFR
2#	Multiple	MFR
3#	Commercial	Commercial
4#	Commercial	Commercial
5#	Industrial	Industrial
6#	Land	Other
7#	Institutional	Institutional
8#	Miscellaneous	Other
9#	Unassigned	Other

Table 3-19: Contra Costa County Land Use Codes Categorized Differently Than Code Series

Land Use Code	Description	Code Series Classification	Model Categorization
13	Single Family, 2 or More Res on 1 or More Sites	RESIDENTIAL	MFR
33	Office Buildings	COMMERCIAL	Office
34	Medical; Dental	COMMERCIAL	Office
38	Golf Courses	COMMERCIAL	Golf Course
52	Research & Develpmt, with or without structures; flexible use	INDUSTRIAL	Office
74	Cemeteries (-7) & Mortuaries (-3)	INSTITUTIONAL	Cemetery
78	Parks and Playgrounds	INSTITUTIONAL	Park
84	Utilities, with or without bldgs (not assessed by SBE)	MISCELLANEOUS	Institutional
86	Taxable Municipally-Owned Property (Section 11)	MISCELLANEOUS	Institutional

3.3.1 Dublin San Ramon Services District (DSRSD)

Matching meters with locations for DSRSD was described earlier in Section 2.3.1. **Table 3-20** shows the calculated water demand factors for CII land uses. The column “# Parcels Not Meeting Consumption Criteria” indicates a handful of parcels excluded from the average water demand factor calculation because they did not meet the minimum criteria of having at least 10 months of data reported in either reporting year (2018 and 2019).

Table 3-20: DSRSD CII Water Demand Factors

Land Use Category	# of Parcels with Consumption Data	# Parcels Not Meeting Consumption Criteria	Average Water Demand Factor (AF/ac)
Commercial	179	3	1.37
Industrial	42	2	0.60
Institutional	110	2	1.21
Office	27	0	1.02
Park	-	-	2.72

Alameda County Assessor’s data does not include parks as a current land use type so a water demand factor could not be calculated for parks using the method described above. Contra Costa County Assessor’s data does include a park designation, but there were not enough parcels with this classification in the final processed data for calculation of a water demand factor. Instead, a water demand factor for General Plan land use category of parks (Community Park, Neighborhood Park, or Park/Semi-Public in City of Dublin; Park in City of San Ramon) was developed based on aggregate recycled water use data reported in DSRSD’s 2018 and 2019 annual recycled water use reports. A total of 47 parcels are tagged as Park/Open Space with 237 acres being served an average 210 million gallons per year or 645 AFY (DSRSD, 2019) and (DSRSD, 2020). This translates to a water demand factor of 2.72 AF/ac.

CII land uses from the City of Dublin General Plan are shown in **Table 3-21** and for City of San Ramon in **Table 3-22** along with their assigned land use category(ies).

Table 3-21: DSRSD (Dublin) CII Land Use Categories

General Plan Land Use Code	General Plan Land Use Description	Primary Land Use Category	Primary Weight [D]	Secondary Land Use Category	Secondary Weight [D]
BPI	Business Park/Industrial	Office	50%	Industrial	50%
BPIOS	Business Park/Industrial and Outdoor Storage	Office	50%	Industrial	50%
CO	Campus Office	Office	100%		
CP	Community Park	Park	100%		
DDRD	Downtown Dublin Retail District	Retail	80%		
DDTOD	Downtown Dublin Transit-Oriented District	Office	50%	Retail	30%
DDVPD	Downtown Dublin Village Parkway District	Commercial	70%	Office	20%
ES	Semi-Public	Institutional	100%		
GC	General Commercial	Commercial	100%		
GCCO	General Commercial/Campus Office	Commercial	50%	Office	50%
HS	Semi-Public	Institutional	100%		
IP	Industrial Park	Industrial	100%		
MHRRO	Medium High Density Residential and Retail Office	Office	75%		
MS	Semi-Public	Institutional	100%		
MU	Mixed Use	Office	50%	Retail	50%
MU2CO	Mixed Use 2/Campus Office	Office	100%		
NC	Neighborhood Commercial	Commercial	100%		
NP	Neighborhood Park	Park	100%		
NS	Park/Semi-Public	Park	100%		
OS	Open Space	Open Space			
PL	Public Land	Institutional	100%		
PSP	Public/Semi-Public	Institutional	100%		
RO	Retail/Office	Retail	100%		
ROA	Retail/Office and Automotive	Retail	100%		
RP	Regional Park	Open Space			
SC	Stream Corridor	Open Space			
SP	Semi-Public	Institutional	100%		
FCI [A]	Federal Correction Institute	Institutional	100%		
1-DSRSD [B]		1-DSRSD	100%		
2-DSRSD [C]		Commercial	17%	Park	16%
3-DSRSD [C]		Retail	80%		
4-DSRSD [C]		Office	50%	Retail	30%

General Plan Land Use Code	General Plan Land Use Description	Primary Land Use Category	Primary Weight [D]	Secondary Land Use Category	Secondary Weight [D]
5-DSRSD [C]		Commercial	70%	Office	20%
15-DSRSD [C]		Office	100%		
38-DSRSD [C]		Office	50%	Retail	30%
45-DSRSD [C]		Office	100%		

Notes:

A. *The Federal Correction Institute (FCI) is one piece of a large parcel owned by the federal government. For the purposes of the Model, it was split into two pieces: one for the Parks Reserve Forces Training Area (known proposed development Site_No 1, described in second note below) and the rest for FCI and remaining parcel land. Average 2018-2019 demand for the FCI (202 AF) was applied using the ParcelOverride tab for this facility.*

B. *1-DSRSD represents the known proposed development Site_No 1, the Parks Reserve Forces Training Area. Based on a 1998 Camp Parks Privatization Study, DSRSD projects 651 AFY over a 288 acre parcel area. A custom water demand factor of 2.26 AF/ac was applied to this area.*
   a. *An estimation of 92 AFY of existing demand was estimated for this site based on summing average 2018-2019 consumption from 162 out of 167 meters selected by GIS within development Site_No 1 (5 meters could not be matched to AMI data). This 92 AFY of existing demand is used as an adjustment factor in the Model interpolation, described further in Section 3.7.*

C. *The last seven entries (named like "#-DSRSD") were added manually to account for known housing units to be constructed (described further in Section 2.2.1). These seven sites are expected to be mixed use and needed accompanying CII water demand factors to be defined on the same row of the Model inputs where residential dwelling unit densities were also defined.*

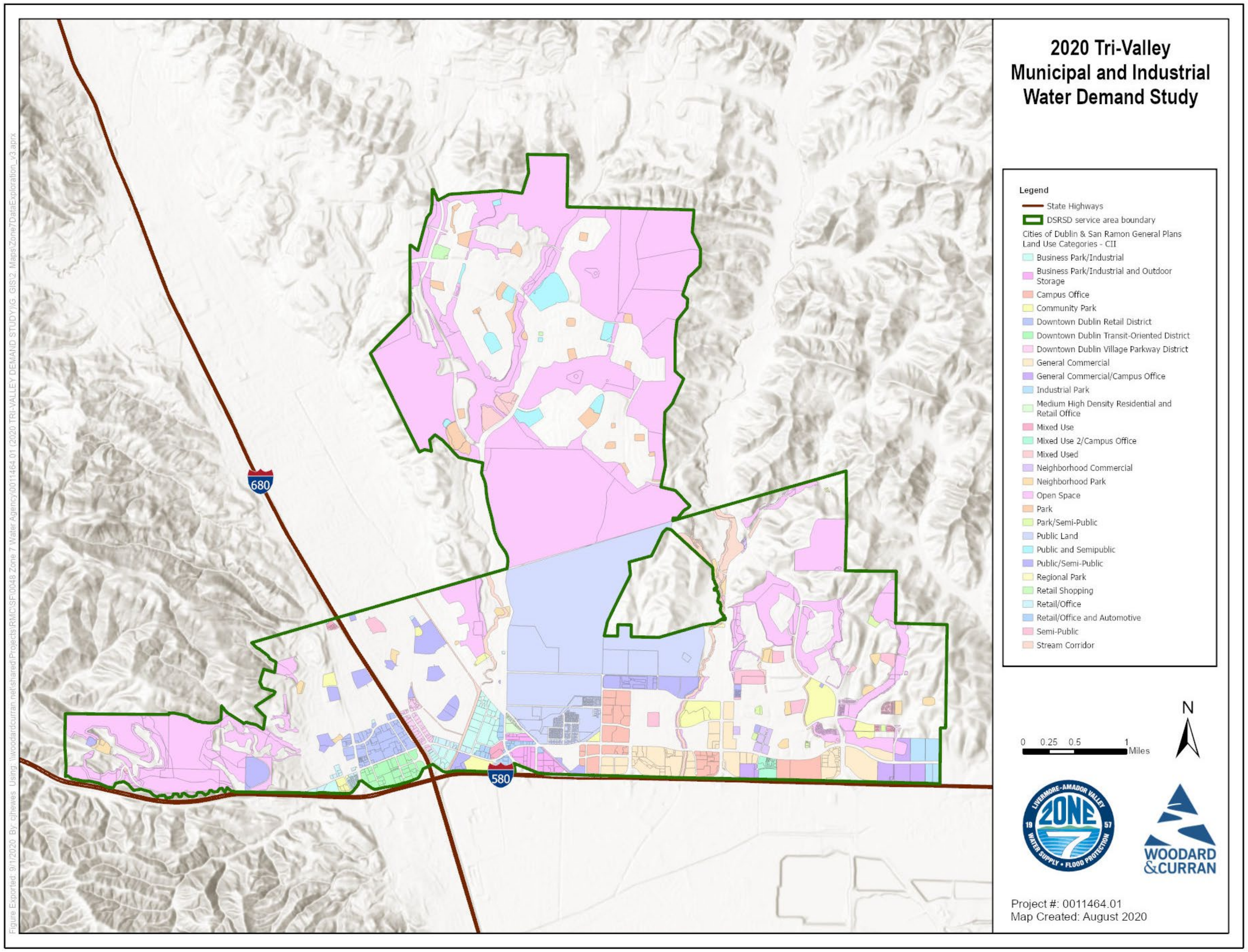
D. *In the case of mixed use land use categories, some of the weights do not add up to 100% because it is assumed some share of the area will be dedicated to residential.*

Table 3-22: DSRSD (San Ramon) CII Land Use Categories

General Plan Land Use Code	General Plan Land Use Description	Primary Land Use Category	Primary Weight	Secondary Land Use Category	Secondary Weight
CR	Commercial Recreation	Commercial	100%		
GC	Golf Course	Golf Course	100%		
MU	Mixed Used	Commercial	38%	Office	38%
MUC	Mixed Used Commercial	Commercial	50%	Retail	50%
MUCC	Mixed Used City Center	Commercial	38%	Office	38%
OFFICE	Office	Office	100%		
OS	Open Space	Open Space			
P	Park	Park	100%		
P Future	Park	Park	100%		
parkp_m	Park	Park	100%		
PS	Public and Semipublic	Institutional	100%		
RC Pk	Rural Conservation Park	Open Space			
RS	Retail Shopping	Retail	100%		
TC	Thoroughfare Commercial	Commercial	100%		

Figure 3-11 shows a map of the CII land use categories from the City of Dublin and City of San Ramon within the DSRSD service area. Note that this map does not reflect general plan land use overrides for known proposed developments. The map is intended to provide a general reference for the spatial distribution of the various general plan land use categories.

Figure 3-11: DSRSD CII Land Use Categories from General Plans



3.3.2 City of Pleasanton

Matching accounts with locations for the City of Pleasanton was described earlier in Section 2.3.2. **Table 3-23** shows the calculated water demand factors for CII land uses. The column "# Parcels Not Meeting Consumption Criteria" indicates a handful of parcels excluded from the average water demand factor calculation because they did not meet the minimum criteria of having at least 2 years of consumption reported over the 3 year reporting period (2017 - 2019).

Table 3-23: City of Pleasanton CII Water Demand Factors

Land Use Category	# of Parcels with Consumption Data	# Parcels Not Meeting Consumption Criteria	Average Water Demand Factor (AF/ac)
Commercial	257	6	1.71
Industrial	135	1	0.78
Institutional	89	1	0.96
Office	196	1	1.28
Park	-	-	3.08

Alameda County Assessor's data does not include parks as a current land use type so a water demand factor could not be calculated for parks using the method described above. Instead, a water demand factor for General Plan land use type 301 (ParksandRecreation) was developed based on aggregate recycled water use data reported in the City of Pleasanton's 2019 annual recycled water use report[10]. A total of 83 sites were irrigated with recycled water, consisting of 346 acres being served 347 million gallons or 1,065 AF (City of Pleasanton, 2020). This translates to a water demand factor of 3.08 AF/ac. Note that 7 out of 83 sites are tagged as "Parks" (103.28 acres with a calculated water demand factor 4.13 AF/ac). To calculate a robust value including more than 7 sites, data from "Landscapes" (69 sites), "Streetscapes" (4 sites), and "Schools" (3 sites) were combined to calculate the water demand factor of 3.08 AF/ac used for future projections.

CII land uses from the City of Pleasanton General Plan are shown in **Table 3-24** along with their assigned land use category(ies).

[10] Formal title: *Recycled Water Distribution and Use Program 2019 Irrigation Season Recycled Water Use Annual Report*

Table 3-24: City of Pleasanton CII Land Use Categories

General Plan Land Use Code	General Plan Land Use Description	Primary Land Use Category	Primary Weight [A]	Secondary Land Use Category	Secondary Weight [A]
201	Commercial	Commercial	100%		
202	GeneralandLimitedIndustrial	Industrial	100%		
203	SandandGravelHarvesting	Industrial	100%		
204	BusinessPark	Office	100%		
301	ParksandRecreation	Park	100%		
302	AgricultureandGrazing	Open Space			
303	PublicHealthandSafety	Open Space			
304	WildlandOverlay	Open Space			
305	WaterManagementandRecreation	Open Space			
401	PublicandInstitutional	Institutional	100%		
402	ElementarySchool	Institutional	100%		
403	MiddleSchool	Institutional	100%		
404	HighSchool	Institutional	100%		
501	MixedUse	Commercial	38%	Office	38%
502	MixedUseBusinessPark	Commercial	38%	Office	38%
600	BARTExisting	Institutional	100%		
601	BARTProposed	Institutional	100%		
2021	LakeSandandGravelHarvesting	Industrial	100%		
EastPleasantonSP [B]	East Pleasanton Specific Plan	Industrial	100%		

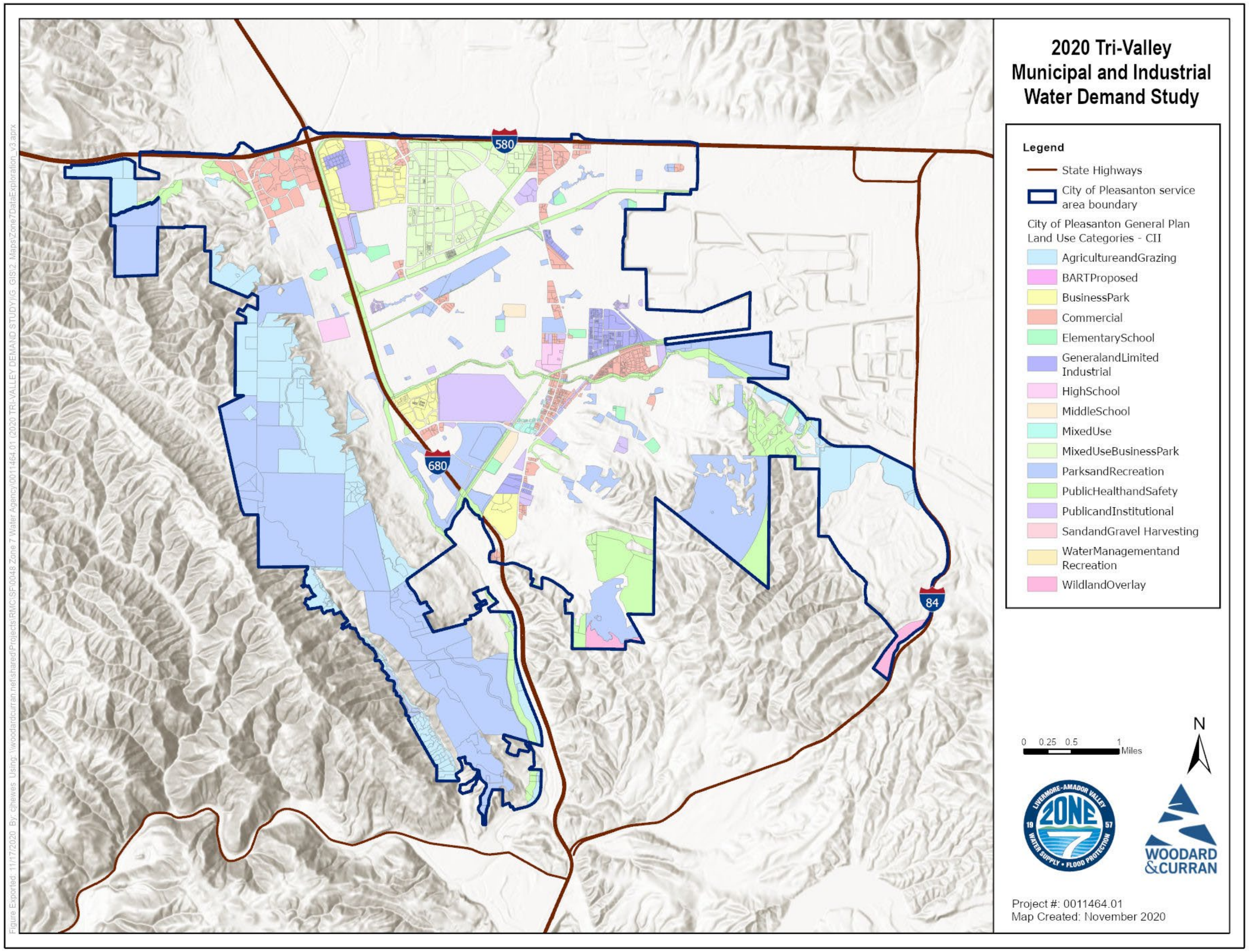
Notes:

A. *In the case of mixed use land use categories, some of the weights do not add up to 100% because it is assumed some share of the area will be dedicated to residential.*

B. *A custom land use type of "EastPleasantonSP" was added manually to account for industrial-zoned areas within the East Pleasanton Specific Plan that are outside of the City/General Plan boundary.*

Figure 3-12 shows a map of the CII land use categories from the City of Pleasanton within the City's water service area. Note that this map does not reflect general plan land use overrides for known proposed developments. The map is intended to provide a general reference for the spatial distribution of the various general plan land use categories.

Figure 3-12: City of Pleasanton CII Land Use Categories from General Plan



3.3.3 City of Livermore

Matching accounts with locations for the City of Livermore was described earlier in Section 2.3.3.

Table 3-25 shows the calculated water demand factors for CII land uses. The column "# Parcels Not Meeting Consumption Criteria" indicates a handful of parcels excluded from average water demand factor calculation because they did not meet the minimum criteria of having at least 2 years of consumption reported over the 3 year reporting period (2017 - 2019).

Table 3-25: City of Livermore CII Water Demand Factors

Land Use Category	# of Parcels with Consumption Data	# Parcels Not Meeting Consumption Criteria	Average Water Demand Factor (AF/ac)
Commercial	52	0	1.73
Industrial	235	8	0.69
Institutional	31	0	1.13
Office	14	0	0.61
Parks	-	-	2.90

Alameda County Assessor's data does not include parks as a current land use type so a water demand factor could not be calculated for parks using the land use categorization method described above. The City of Livermore's 2017 Water Master Plan developed a factor of 910 gallons per acre per day for existing General Plan land use type OSP (Park, Trail Way, Recreation Corridor, and Protection Areas) where recycled water is not used. This translates to 1.02 AF/ac. However, this value appears to have been calculated using a larger acreage of parks land than is currently considered in the Model after removing stream corridors and other non-irrigated lands (see Section 4.5). It would likely under-estimate the true volume of irrigated parks. There are two other potential values that could be used instead:

1) Estimate irrigation demand for turfgrass specific to evapotranspiration and precipitation trends in the Tri-Valley region as was done for Cal Water Livermore and shown in **Table 3-28**: 3.72 AF/ac. With 275 acres of estimated irrigated area, this would result in approximately 1,000 AF of irrigation demands.

2) Average the values used for DSRSD (2.72 AF/ac) and City of Pleasanton (3.08 AF/ac): 2.90 AF/ac. With 275 acres of estimated irrigated area, this would result in approximately 800 AF of irrigation demands.

To be more conservative, the lower value (2.90 AF/ac) was selected for the Model but can be updated.

CII land uses from the City of Livermore General Plan are shown in **Table 3-26** along with their assigned land use category(ies).

The City of Livermore General Plan has certain land use categories that indicate a Transferable Development Credits (TDC) Program whereby multiple residential densities are possible. These land uses are identified with a slash ("/") in the land use code, though not all land use codes with slashes are involved with the TDC Program. Developers of parcels subject to the TDC Program may pay a fee to exceed a baseline density or original land use designation (City of Livermore, 2014). For instance, "LII/UH-3" means the baseline use is low intensity industrial with 0 du/ac of residential. However, developers can choose the TDC option and build a maximum residential density of urban high residential 3 (14-18 du/ac). To account for both options for parcels subject to the TDC Program in the Model, a default of 50% applicable CII use was assumed with an average residential density between 0 and the average of the maximum density range.

Table 3-26: City of Livermore CII Land Use Categories

General Plan Land Use Code	General Plan Land Use Description	Primary Land Use Category	Primary Weight	Secondary Land Use Category	Secondary Weight
BART	BART Station and Parking	Institutional			
BCP	Business and Commercial Park	Office	100%		
BCP/CF-HOSP	Business and Commercial Park/Community Facility	Industrial	50%	Institutional	50%
BCP/UH-4	Business and Commercial Park / Urban HD Residential	Industrial	50%		
CF	Government Services	Office	100%		
CF-AIR	Airport	Commercial	100%		
CF-CC	Civic Center	Institutional	100%		
CF-CE	Cemetery	Cemetery	100%		
CF-E	Elementary School	Institutional	100%		
CF-FS	Fire Station	Institutional	100%		
CF-H	High School 9-12	Institutional	100%		
CF-I	Intermediate School	Institutional	100%		
CF-JC	Community College	Institutional	100%		
CF-R&D	Research and Development	Institutional	100%		
CF-S	School-General	Institutional	100%		
CSGC	Community Serving General Commercial	Commercial	100%		
DA	Downtown Area Specific Plan	Commercial	50%		
HC	Highway Commercial	Commercial	100%		
HII	High Intensity Industrial	Industrial	100%		
HII/UH-3	High Intensity Industrial/Urban High Density Residential	Industrial	50%		
HII/UH-5b	High Intensity Industrial/Urban High Density Residential	Industrial	50%		
LDAG	Limited Agriculture	Open Space			
LII	Low Intensity Industrial	Industrial	100%		
LII/UH-3	Low Intensity Industrial/Urban HD Residential	Industrial	50%		
LII/UH-5b	Low Intensity Industrial/Urban High Residential	Industrial	50%		
LII/ULM	Low Intensity Industrial / Urban Low-Medium Residential	Industrial	50%		
LII/UM	Low Intensity Industrial/Urban Medium Density Res	Industrial	50%		
LOC	Large Office Commercial	Office	100%		

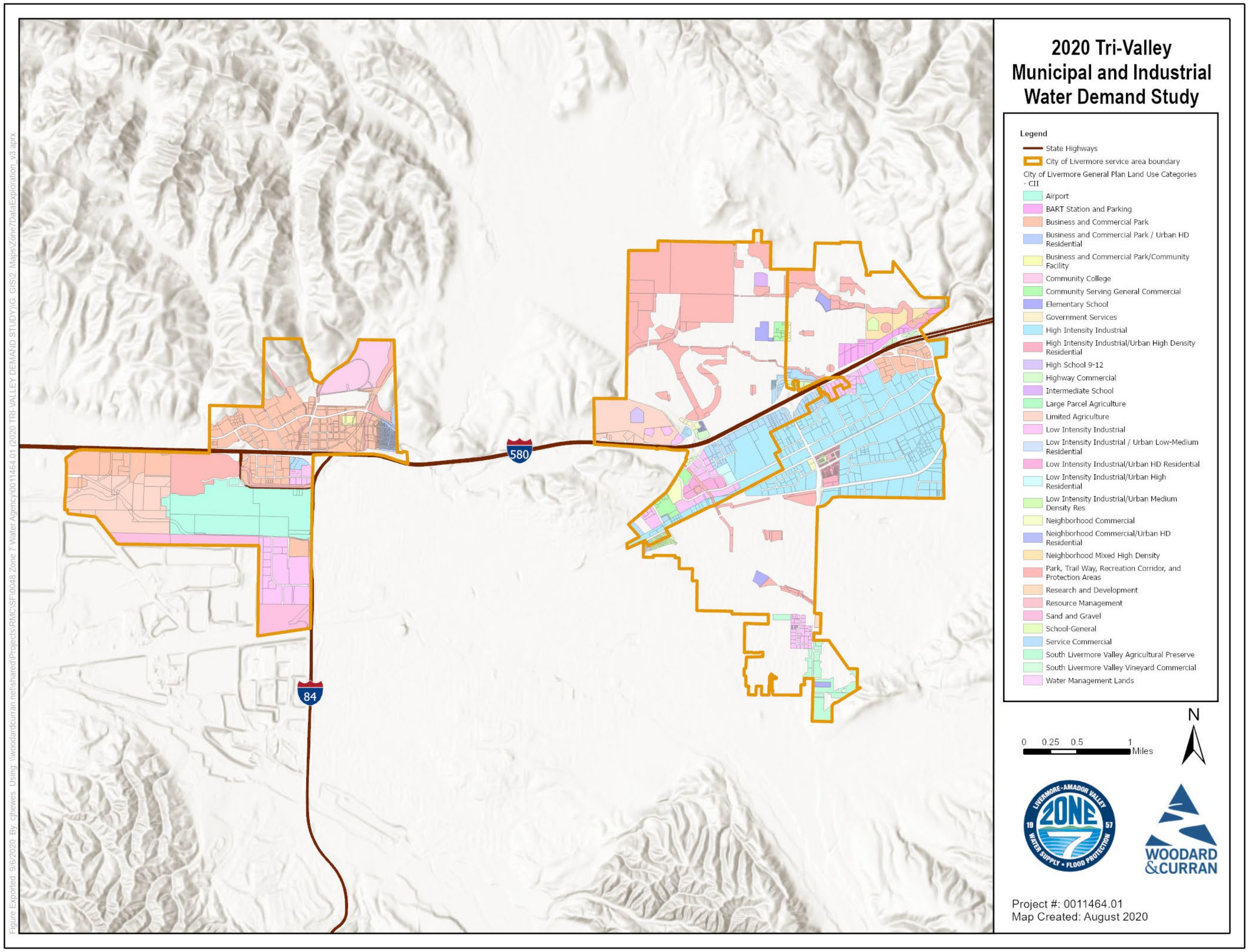
General Plan Land Use Code	General Plan Land Use Description	Primary Land Use Category	Primary Weight	Secondary Land Use Category	Secondary Weight
CF-HOSP	Hospital	Institutional	100%		
LOC/CF-HOSP	Large Office Commercial/Hospital	Office	100%		
LPA	Large Parcel Agriculture	Open Space			
NC	Neighborhood Commercial	Commercial	100%		
NC/UH-3	Neighborhood Commercial/Urban HD Residential	Commercial	50%		
NMH	Neighborhood Mixed High Density	Commercial	50%		
NML	Neighborhood Mixed Low Density	Commercial	50%		
NMM	Neighborhood Mixed Medium Density	Commercial	50%		
OC	Office Commercial	Office	75%	Retail	25%
OSP	Park, Trail Way, Recreation Corridor, and Protection Areas	Park	100%		
OSP/S&G	Sand and Gravel	Open Space			
RMG	Resource Management	Open Space			
SC	Service Commercial	Commercial	100%		
SC/UH-2	Service Commercial/Urban High	Commercial	100%		
SV-AP	South Livermore Valley Agricultural Preserve	Open Space			
SV-ROS	South Livermore Valley Regional Open Space	Open Space			
SV-VC	South Livermore Valley Vineyard Commercial	Commercial	100%		
UH-2/OC	Urban High Residential/Office Commercial	Office	50%		
WML	Water Management Lands	Open Space			
GOLFCOURSE A	Golf Course	Golf Course	100%		

Note:

A. *GOLFCOURSE was added manually to account for two golf course parcels in the Cal Water Livermore service area that fall outside of the General Plan boundary. Since Cal Water Livermore does not provide water for the golf course green, an adjustment has been made in the "ParcelOverride" tab (see Section 4.5), which can be toggled off in the future if needed to incorporate these demands.*

Figure 3-13 shows a map of the CII land use categories from the City of Livermore within the City of Livermore's water service area. Note that this map does not reflect general plan land use overrides for known proposed developments. The map is intended to provide a general reference for the spatial distribution of the various general plan land use categories.

Figure 3-13: City of Livermore CII Land Use Categories from General Plan



3.3.4 Cal Water Livermore

Matching accounts with locations for Cal Water Livermore was described earlier in Section 2.3.4. **Table 3-27** shows the calculated water demand factors for CII land uses. The column "# Parcels Not Meeting Consumption Criteria" indicates a handful of parcels excluded from average water demand factor calculation because they did not have any consumption from 2014 to 2019.

Table 3-27: Cal Water Livermore CII Water Demand Factors

Land Use Category	# of Parcels with Consumption Data	# Parcels Not Meeting Consumption Criteria	Average Water Demand Factor (AF/ac)
Commercial	248	3	1.43
Industrial	109	0	0.85
Institutional	86	5	0.82
Office	39	0	1.15
Park	-	-	3.72

Alameda County Assessor's data does not include parks as a current land use type so a water demand factor could not be calculated for parks using the land use categorization method described above. Instead, a water demand factor for General Plan land use type OSP (Park, Trail Way, Recreation Corridor, and Protection Areas) was calculated using an estimation of irrigation demand for turfgrass specific to evapotranspiration and precipitation trends in the Tri-Valley region. **Table 3-28** describes this landscape coefficient method calculation and the inputs used to develop a value of 3.72 AF/ac.

CII land uses within Cal Water Livermore come from the City of Livermore General Plan and were described previously in **Table 3-26**.

Figure 3-14 shows a map of the CII land use categories from the City of Livermore within the Cal Water Livermore water service area. Note that this map does not reflect general plan land use overrides for known proposed developments. The map is intended to provide a general reference for the spatial distribution of the various general plan land use categories.

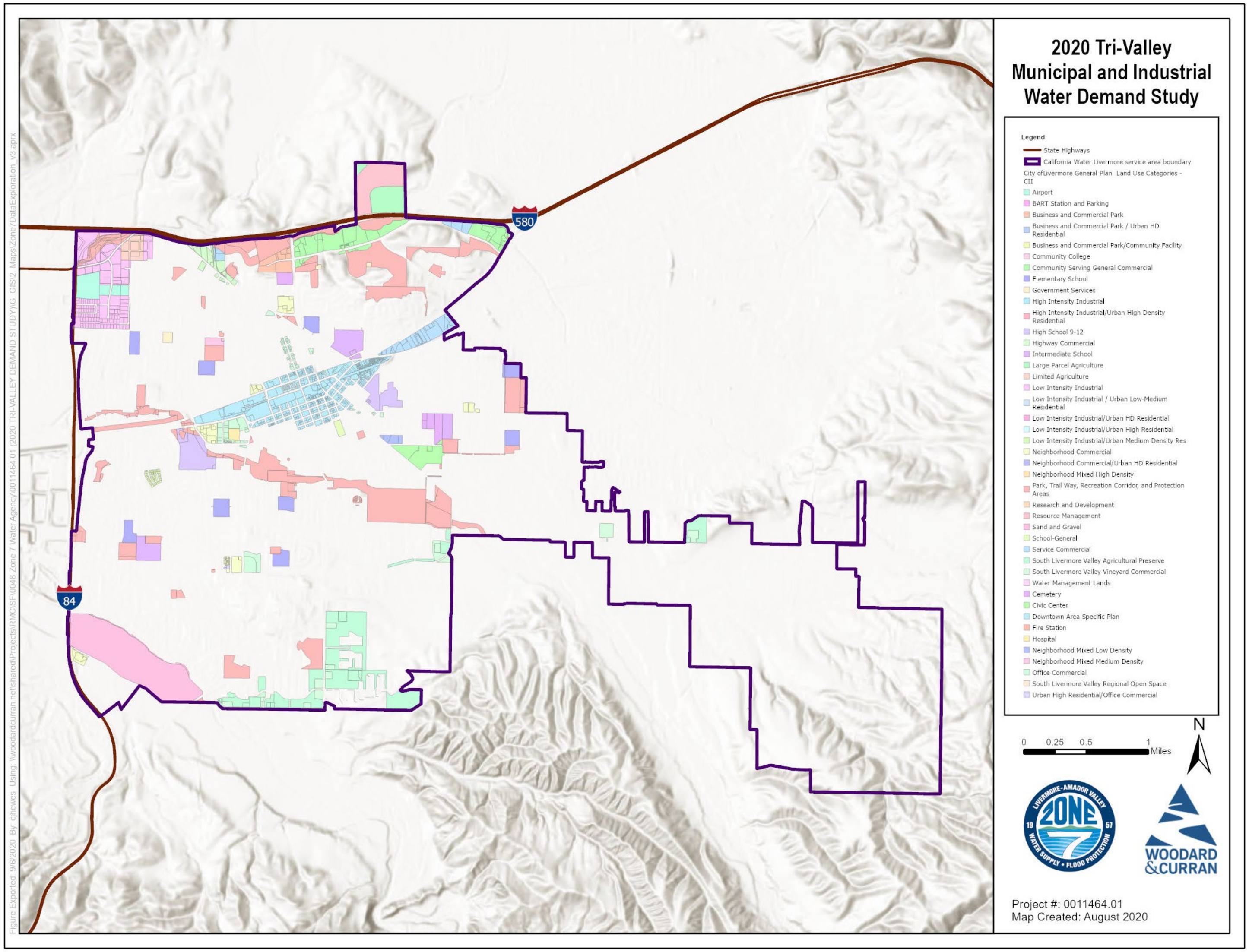
Table 3-28: Estimating Seasonal Irrigation Demand Variation

Month	Crop Coefficient [A], K_c	ET_o [B] (in / month)	Average Precipitation (in) [C]	Percent Infiltrate [D]	Leaching Rate Factor [E]	Irrigation Efficiency	Irrigation Demand, (in/unit area)	Irrigation Demand, (in/unit area)	Percent of Annual Demand	Monthly Peaking Factor [F]
Jan	0.8	1.51	2.22	75%	1.1	80%	-0.6	0.0	0.0%	0.00
Feb	0.8	2.17	2.72	75%	1.1	80%	-0.4	0.0	0.0%	0.00
Mar	0.8	3.63	1.92	75%	1.1	80%	2.0	2.0	4.5%	0.54
Apr	0.8	4.94	1.14	75%	1.1	80%	4.3	4.3	9.5%	1.14
May	0.8	6.16	0.57	75%	1.1	80%	6.2	6.2	13.9%	1.66
Jun	0.8	7.10	0.13	75%	1.1	80%	7.7	7.7	17.2%	2.06
Jul	0.8	7.53	0	75%	1.1	80%	8.3	8.3	18.6%	**2.23**
Aug	0.8	6.61	0.01	75%	1.1	80%	7.3	7.3	16.3%	1.95
Sep	0.8	4.98	0.08	75%	1.1	80%	5.4	5.4	12.1%	1.45
Oct	0.8	3.50	0.93	75%	1.1	80%	2.9	2.9	6.5%	0.78
Nov	0.8	1.93	1.41	75%	1.1	80%	0.7	0.7	1.5%	0.18
Dec	0.8	1.41	2.82	75%	1.1	80%	-1.4	0.0	0.0%	0.00
Annual Total		**51.5**	**13.95**					**44.6**	**100.0%**	
							Average Monthly Demand	**3.72**	**acre-in/acre**	
							Average Annual Demand	**3.72**	**AF/acre**	

Notes:

A. *Crop coefficient for cool season turf species from* (University of California Cooperative Extension & DWR, 2000).
B. *Average ETo values reported on CIMIS - Station 191 Pleasanton (http://wwwcimis.water.ca.gov/UserControls/Reports/MonthlyEtoReportViewer.aspx).*
C. *Average Monthly precipitation 1998-2016 for Livermore from (https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca4995).*
D. *Assumed 75 percent infiltration rate into the vegetation root zone.*
E. *Leaching rate factor represents a 10 percent leaching rate through the vegetation root zone.*
F. *Monthly peaking factor is the calculated monthly irrigation demand divided by the average monthly irrigation demand.*

Figure 3-14: Cal Water Livermore CII Land Use Categories from General Plan



Note: The southwest corner of Cal Water Livermore's service area boundary is located outside of the City of Livermore General Plan. Land use types for this area were manually assigned separately based on current Alameda County Assessor land use codes.

3.4 Water Loss

Water losses refers to both real losses, or the physical water losses from the pressurized distribution system and a utility's storage tanks up to the point of customer consumption (e.g., the water meter), as well as apparent losses, or non-physical water losses from customer metering inaccuracies, data handling errors, or unauthorized consumption. After Senate Bill (SB) 555 was passed in 2015, California urban water suppliers have been required to submit an annual water loss audit to DWR. This audit attempts to quantify all inputs and outputs of a supplier's potable distribution system along with many other factors related to quantifying water losses. SB 555 also directed the State Water Resources Control Board (SWRCB) to develop performance standards for volumetric water loss by July 2020. As of August 2020, the SWRCB has not completed final rulemaking about performance standards but has proposed to use an Excel-based economic model to calculate a unique volumetric standard for each water supplier. The standard is proposed to be quantified in units of real losses per service connection per day (gallons per connection per day). This value is a performance indicator that is automatically calculated as an output of the AWWA Water Loss Audit prepared annually by urban water suppliers and submitted to DWR. While apparent losses are not currently proposed to be regulated by the State in the future, the AWWA model also outputs a value estimating apparent losses using the same units.

The Model calculates water losses using the following calculation:

$$\begin{aligned} Water\ Losses\ (annual) \\ &= Number\ of\ Service\ Connections * (Real\ Losses\ per\ Connection\ per\ Day \\ &+ Apparent\ Losses\ per\ Connection\ per\ Day) * 365\ days/year \end{aligned}$$

"Number of Service Connections" is meant to include both active and inactive service lines that are connected to mains, as well as fire hydrant laterals. The number of service connections for each agency were pulled from their most recent water loss audits submitted to DWR and are shown in **Table 3-29**. These counts of service connections were escalated by percent growth in demands per year.

"Real Losses per Connection per Day" for DSRSD and the City of Livermore were pulled from most recent respective water loss audits and are shown in **Table 3-29**. "Apparent Losses per Connection per Day" for all retailers were pulled from their most recent respective water loss audits and are shown in **Table 3-29.**

For real losses, the City of Pleasanton indicated that a value from existing literature or an outside source should be used in lieu of recent water audit results. Cal Water Livermore's 2018 water loss audit reported unrealistic negative real losses, so an outside value was also used. A value of 30 gallons/connection/day was selected by reviewing all 2017 and 2018 water loss audits reported to DWR by urban water suppliers with 15,000 - 30,000 service connections (of a similar size to Tri-Valley Water Agencies), had no negative losses (realistic results), and a data validity grade of 70+ (relatively high confidence in data and results). A total of 55 water loss audits were considered across two years (from 34 unique agencies) to construct this average value.

Table 3-29: Water Loss Inputs by Agency

Agency	Real Losses (gallons per connection per day)	Apparent Losses (gallons per connection per day)	Base Year Number of Service Connections	Source/Notes
DSRSD	10.68	4.94	25,521	All values from FY 18-19 water loss audit
City of Livermore	33.39	8.66	10,404	Real and apparent loss rates are an average of 2017 & 2018 water loss audits; number of service connections from 2018 audit
Cal Water Livermore	30	10.04	18,905	Real loss rate averaged from other agencies; number of service connections and apparent loss rate from 2018 water loss audit
City of Pleasanton	30	13.55	22,134	Real loss rate averaged from other agencies; number of service connections and apparent loss rate from 2018 water loss audit

3.5 Unmetered Consumption

Unmetered consumption is water use that is expected and allowable ("authorized") by a utility but not metered. Typical examples may include flushing events (disinfection, hydrant, etc.), street sweeping, firefighting, or certain construction uses. The Model calculates unmetered consumption using the following calculation:

$$Unmetered\ Consumption\ = (Total\ Residential\ and\ CII\ Potable\ Demands) * (\%\ Unmetered)$$

The estimates for percent unmetered are described below for each utility in **Table 3-30**.

Table 3-30: Percent Unmetered Consumption

Agency	% Unmetered	Source/Notes
City of Pleasanton	0.25%	Based on comments noted in 2018 water loss audit for unbilled unmetered consumption
DSRSD	2.55%	Based on 1.25% unmetered unbilled authorized consumption from FY 18-19 water loss audit & additional 1.3% assumed to be jumpers used in new construction development (from FY 18-19 audit plus projections for unbilled sales and construction use in 2015 UWMP)
City of Livermore	1.25%	Default value from 2018 water loss audit & very close to calculated value for 2017 water loss audit
Cal Water Livermore	0.25%	Back-calculated from values entered into 2017 & 2018 water loss audits for unbilled unmetered consumption

3.6 Service Connection Projections

The Model provides an estimation of the projected increase in service connections for each agency. Zone 7 requested that these be expressed in Dwelling Unit Equivalents (DUEs). This increase is calculated in different ways by sector as described in the sub-sections below. Service connection growth projections are included later in Section 5.1.

3.6.1 Residential

The Model makes an estimation of the growth in single- and multi-family dwelling units based on the underlying land use data used as an input to Model calculations for water demands (i.e., the calculation of indoor residential water demand relies on an estimation of buildout population which is based on a count of dwelling units). More details on the apportionment of single- and multi-family dwelling units can be found in Appendix A.

For single-family, one dwelling unit equals one dwelling unit equivalent for the purpose of connection growth projections. However, it is assumed that multi-family homes use less water than single-family homes on a per-unit basis. To estimate multi-family dwelling unit *equivalents*, the total growth in multi-family dwelling units is divided by a ratio of single-family consumption to multi-family consumption. The default value is 1.75 which is an estimated average of a range of values reported in a 2018 Water Research Foundation study that analyzed single- and multi-family per-unit consumption (Kiefer & Krentz, 2018). In the future, this can be updated with Agency-specific values if they become available.

3.6.2 Commercial, Industrial, Institutional

CII properties have a wide range of water use types and intensities, and it can be difficult to project specific uses based on general plan land use types. Given this limitation, a simple method is used which standardizes the estimation of connection growth for the CII sector. The projected increase in CII water demands between base year and buildout is divided by average single-family consumption for each agency to calculate the increase in service connection equivalents. **Table 3-31** summarizes the average annual consumption for single-family homes for each agency which was calculated based on the provided consumption datasets. It was assumed that each individual meter serving a single-family account represents one home – no parcel matching or summing by parcels was conducted for the purpose of projecting CII use. To calculate the average value, total single-family consumption per agency was divided by a count of meters serving single-family accounts to arrive at the average water consumption per single-family home.

Table 3-31: Average Single-Family Home Consumption (AFY)

Agency	Average Single-Family Home Consumption (AFY)	Average Single-Family Home Consumption (gallons per year)	Base Year(s) Period
City of Pleasanton	0.357	116,316	2017-2019
DSRSD [A]	0.245	79,996	2018-2019
City of Livermore	0.305	99,279	2017-2019
Cal Water Livermore	0.315	102,736	2014-2019

Note:

A. *DSRSD's average single-family home consumption is significantly lower than the other three Tri-Valley Agencies. CII growth in DSRSD's service area may not match the same level of low water use in residential accounts. For the purpose of the Model's default calculations of service connection equivalents for DSRSD, an average of the values reported for the other agencies was used (0.326 AFY).*

3.7 Interpolation

The Model calculates water demands at buildout based on land use from general plans for each region. Growth from current demand to buildout demand is interpolated linearly using an average annual growth rate in water demands. This average annual value with no other adjustments can be considered the "baseline level of new growth". However, as described in Section 2.2, various developments are ongoing or known to be constructed in the near-term. Demands at these locations are calculated and assigned an "online date" representing when the development is expected to begin water service. It is assumed that these demands are occurring as part of the baseline level of new growth.

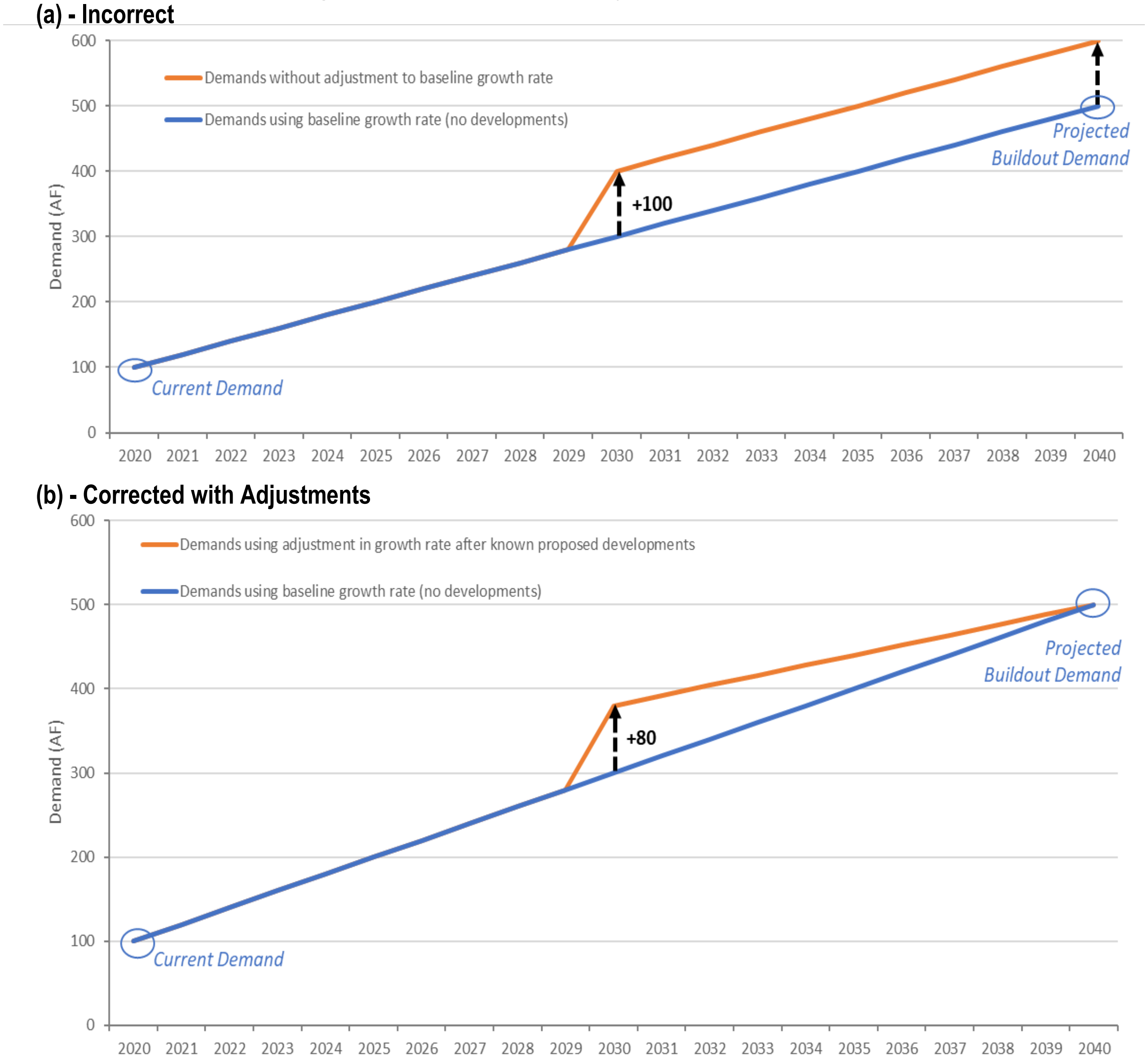
Particularly large known proposed developments may cause increases in population or water demands beyond the annual baseline level of new growth and are thus accounted for as an acceleration of growth.

Figure 3-15 (a) shows an incorrect example of a constant linear demand growth of 20 AF/yr in blue from base year to buildout. With the addition of a new known proposed development with a 100 AF demand in 2030, the total demands are increased. If the same linear annual growth rate of 20 AF/yr was used from 2030 to 2040, the total buildout demands at 2040 would be higher than actual demands.

Figure 3-15 (b) shows how these developments are captured so that two adjustments are made to model the acceleration of the demand associated with these developments:

- An adjustment (decrease) is made to the water demands of the new known proposed development. The 100 AF of demand is assumed to be part of the baseline level of 20 AF/yr. Thus, the acceleration of demands in 2030 beyond baseline is 80 AF (100 - 20).
- An adjustment (decrease) is made to the slope of the total demands line after the 2030 development. As additional known proposed developments come online, the slope of the baseline demand increase gets shallower and shallower approaching buildout.
- Not pictured, but a third adjustment may be made to reduce the increase in population or demands from a known proposed development if there is existing use (e.g., in the case of infill or redevelopment)

Figure 3-15: Interpolation Adjustments Example



4. ADJUSTMENT FACTORS

Several factors can be used to modify water demands from each of the sectors described earlier in Section 3. These are described below for Passive Conservation (Section 4.1), Price Elasticity (Section 4.2), Climate Change (Section 4.3), Recycled Water (Section 4.4), and Land Use Type Corrections/Parcel Overrides (Section 4.5).

4.1 Passive Conservation

Passive water conservation refers to water savings from regulatory drivers such as codes, standards, and ordinances that result in a decrease of water use, typically due to the replacement of inefficient water fixtures with more efficient models.

M.Cubed developed a fixture saturation model specific to each retailer. The model makes estimates for the stock of different types of water fixtures annually from 1990 to 2060. The changeover from inefficient to efficient fixtures is used to calculate passive water savings.

The sectors and fixtures that are tracked in the fixture saturation model are listed below:

- Residential
    - Toilets
    - Showerheads
    - Clothes washers
    - Dishwashers
- CII
    - Toilets
    - Urinals

Section 4.1.1 describes how the annual stock of each fixture type was calculated. Section 4.1.2 describes how these annual fixture counts were translated into inefficient versus efficient fixtures with associated water savings. Section 4.1.3 describes the projected passive water savings for each retailer.

4.1.1 Estimating Annual Stock of Fixtures

Both residential and CII fixture counts are estimated based on population. Methods for calculating fixture counts for the residential and CII sectors are described below.

4.1.1.1 Residential

The annual stock of residential fixtures is calculated in any given year as follows:

$$Population * \frac{\#\ Housing\ Units}{1000\ people} * \frac{\#\ Fixtures}{Household}$$

Each calculation input is described further below:

- Population
  - 1990 to 2019 service area population was estimated based on the annual growth rate calculated from total city population reported by the California Department of Finance (DOF) (CA DOF (b), 2020).
    - Note – because DSRSD's service area covers two cities, citywide estimates of total population for Dublin and San Ramon were combined as a source in order to back-calculate a growth rate for DSRSD's service area population.
  - Current (January 2020) population was identified from the monthly retailer reporting to the State Water Resources Control Board (SWRCB, 2020), with the exception of DSRSD that provided a more recent current population based on updated service area information.
  - 2021 to 2060 population is estimated by the land-use based population projections made by the Model.
- Housing Units
  - Number of housing units annually from 1990 to 2020 was estimated based on DOF estimates of "Single-Family housing units per thousand population" (CA DOF (b), 2020)
- Ownership Rates
  - Ownership rates refer to the average number of toilets, showers, clothes washers, and dishwashers per home based on the year the home was built.
  - The American Housing Survey makes estimates for ownership rates for the Bay Area region for both single-family and multi-family homes built before 1990, in the 1990s, and in the 2000s.

4.1.1.2 CII

The counts of CII toilets were estimated using a regression equation developed by the California Urban Water Conservation Council (superseded by the California Water Efficiency Partnership). The study sampled CII buildings throughout California to record the number of toilets and developed a database that estimates toilet populations at a zip code level using a regression equation (CUWCC, 2001).

Urinals were estimated based on an assumption that there are 0.15 urinals for every CII toilet. This comes from an average of several Bay Area utilities the study team has worked with (Santa Clara Valley Water District, East Bay Municipal Utility District, and Alameda County Water District) that have studied CII toilet counts by sampling non-residential properties.

4.1.2 Fixture Saturation Tracking and Water Savings Calculations

After starting with an annual stock of total fixtures (described in Section 4.1.1), the fixture saturation model calculates the change in fixtures every year due to the following factors:

- New construction, with type of efficient fixture largely driven by changes in the California plumbing code
- Active conservation replacement programs by Zone 7 and the retailers
- Retrofit on resale ordinance requirements (not currently active for any of the retailers, but could be turned on if a program is implemented in the future)

- Natural replacement rates based on expected useful life of each fixture type

All fixtures (100 percent) are assumed to be the most inefficient model in 1990. The types of fixtures are described below along with assumptions about their introduction in new construction:

- Residential Toilets
  - 3.5+ gallons per flush (gpf)
  - Ultra-Low Flow Toilets (1.6 gpf)
    - Required by code beginning 1992
  - High-Efficiency Toilets (1.28 gpf)
    - Required by code beginning 2014
- Showerheads
  - >2.5 gallons per minute (gpm)
  - 1.8 – 2.5 gpm
    - Required by code beginning 1992
  - ≤ 1.8 gpm
    - Required by code beginning 2018
- Clothes Washers
  - Conventional
  - High Efficiency Washers
    - Estimated based on percent market share reported by Energy Star
- Dishwashers
  - Conventional
  - High Efficiency Dishwashers
    - Estimated based on percent market share reported by Energy Star
- CII Toilets
  - 3.5+ gallons per flush (gpf)
  - Ultra-Low Flow Toilets (1.6 gpf)
    - Required by code beginning 1994
  - High-Efficiency Toilets (1.28 gpf)
    - Required by code beginning 2014
- CII Urinals
  - Market share of urinals is driven by changes in the efficiency requirements in the underlying plumbing code with the exception of assumptions for 0 gpf waterless urinals (Koeller, 2020)
  - ≥ 1 gpf

- 0.5 gpf
  - Phased in by code beginning 2010, required by 2014
- 0.25 gpf
- 0.125 gpf
  - Phased in 2015, required by 2016
- 0 gpf

Water savings from the replacement of inefficient with efficient models are calculated based on the factors described in **Table 4-1**.

Table 4-1: Parameters Used in Calculation of Water Savings per Fixture

Sector	Fixture	Useful Life (yr)	Use Parameters
Residential	Toilets	28.7	5 flushes/person/day
Residential	Showerheads	20.0	0.69 showers/person/day * 7.8 minutes/shower
Residential	Clothes washers	8.0	3.5 ft^3/load * 0.3 loads/person/day
Residential	Dishwashers	8.0	0.1 loads/person/day
CII	Toilets	28.7	20-28 gal/day reduction in usage based on toilet type
CII	Urinals	28.7	17-25.5 gal/day reduction in usage based on urinal type

4.1.3 Passive Conservation Results

Table 4-2 shows the results of the fixture saturation model, showing the daily per capita reduction in water use compared to 2020 use in five-year increments through 2050. It assumes that similar rates of active conservation programs that have occurred in the past (based on historical data) will continue through 2030 and continue to affect the saturation of efficient fixtures.

Table 4-2: Passive Conservation Model Results by Agency

Agency	Year	Total GPCD Reduction Relative to 2020 By Sector and Fixture Type[A] Residential Toilets	Residential Showerheads	Residential Clothes Washers	Residential Dishwashers	CII Toilets	CII Urinals
Cal Water Livermore	2020	0.0	0.0	0.0	0.0	0.0	0.0
	2025	1.2	0.5	0.8	0.1	0.3	0.1
	2030	1.9	0.8	1.2	0.1	0.6	0.1
	2035	2.1	1.0	1.3	0.1	0.7	0.2
	2040	2.3	1.2	1.4	0.1	0.9	0.2
	2045	2.4	1.3	1.4	0.1	1.0	0.2
	2050	2.6	1.4	1.4	0.1	1.1	0.3
DSRSD	2020	0.0	0.0	0.0	0.0	0.0	0.0
	2025	0.6	0.4	0.7	0.0	0.2	0.1
	2030	1.0	0.8	1.0	0.1	0.4	0.1
	2035	1.4	1.0	1.0	0.1	0.6	0.2
	2040	1.6	1.1	1.1	0.1	0.7	0.2
	2045	1.8	1.3	1.1	0.1	0.8	0.2
	2050	2.0	1.4	1.1	0.1	0.9	0.2
City of Livermore	2020	0.0	0.0	0.0	0.0	0.0	0.0
	2025	1.0	0.5	0.8	0.1	0.4	0.1
	2030	1.6	0.8	1.1	0.1	0.6	0.2
	2035	2.0	1.1	1.2	0.1	0.8	0.2
	2040	2.3	1.2	1.3	0.1	1.0	0.2
	2045	2.6	1.3	1.3	0.1	1.1	0.3
	2050	2.8	1.4	1.3	0.1	1.2	0.3
City of Pleasanton	2020	0.0	0.0	0.0	0.0	0.0	0.0
	2025	1.0	0.5	0.8	0.1	0.3	0.1
	2030	1.8	0.8	1.1	0.1	0.5	0.1
	2035	2.3	1.1	1.3	0.1	0.7	0.2
	2040	2.7	1.2	1.3	0.1	0.9	0.2
	2045	2.9	1.4	1.4	0.1	1.0	0.2
	2050	3.2	1.4	1.4	0.1	1.1	0.3

Note:

A. *Results a cumulative through time because they are relative to 2020 base year use and it is assumed replaced fixtures do not revert back to being inefficient once replaced with an efficient model.*

4.2 Price Elasticity

A well understood economic pattern describes how demand for a good (like water) decreases with an increase in price (such as increases in water rates). The relationship between changes in demand and changes in price is known as the price elasticity of demand. Many studies have been conducted on the price elasticity of water. A price elasticity value specific to the Tri-Valley region was selected from a 2013 economic study that evaluated residential water price and consumption measures throughout California from 1995 to 2010. The price elasticity for Zone 7 was found to be -0.187 (Sunding, Hatchett, Buck, & Gorenshteyn, 2013). For example, this means that for every 1 percent increase in water rate, there is a 0.2 percent reduction in water demand.

Price elasticity of demand is calculated in the Model based on estimated changes in variable water rates. Rate changes can be entered on an annual basis throughout the planning horizon for each agency.

The formula for estimating the change in demand resulting from a change in price is:

$$\%\,Change\ in\ Demand = (\%\,rate\ change)^{e}$$
$$where:$$
$$\%\,Change\ in\ Demand = {}^{New\ Demand}/_{Old\ Demand}$$
$$\%\,rate\ change = {}^{New\ Rate}/_{Old\ Rate}$$
$$e = price\ elasticity\ of\ demand$$

Using a single unchanging value for price elasticity is not realistic nor ideal – in addition to price, demand changes as a result of sector, weather, cultural and social norms, regulations, income, and more, and is thus unlikely to follow a constant elasticity (Griffin, 2016). Price elasticity of demand can also exhibit seasonality. However, it is important to make a best estimation for the potential effect of price elasticity of demand, especially when water rates are known to increase.

In the Model, the -0.1817 value for Zone 7 price elasticity was modified for the residential indoor and residential outdoor sectors to reflect the fact that indoor use is generally less price-sensitive than outdoor use. The -0.1817 value was "decomposed" into a residential indoor elasticity and outdoor elasticity by solving for "x" in the equation below:

$$-0.1817 = x * \left(\frac{Indoor\ Demand}{Total\ Residential\ Demand}\right) + 2.5 * x * \left(\frac{Outdoor\ Demand}{Total\ Residential\ Demand}\right)$$

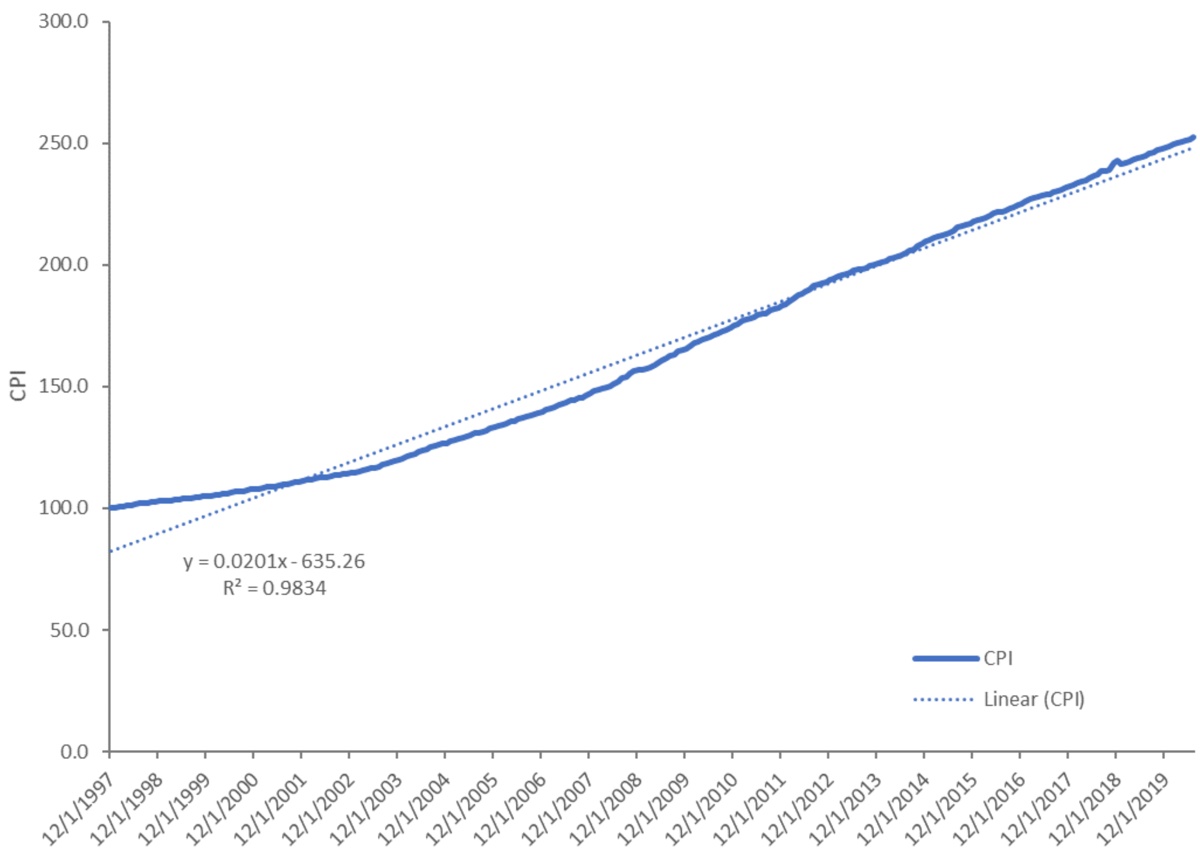
In the equation above, the price elasticity for outdoor residential is 2.5 times the indoor residential price elasticity and also weighted by the share of outdoor residential demand as a fraction of the total residential demand. The value of 2.5 is an estimation based on a range of values from the literature [e.g., (CUWCC, 1997)] that generally describe outdoor use as 2-3 times more elastic than indoor use. **Table 4-3** shows the resulting price elasticities for the residential indoor and outdoor sectors for each agency. CII and recycled water sectors were assumed to have the default price elasticity of -0.1817.

Table 4-3: Price Elasticity for Residential Sectors by Agency

Agency	% Residential Outdoor Demand	Residential Indoor Price Elasticity	Residential Outdoor Price Elasticity
DSRSD	32%	-0.126	-0.316
City of Pleasanton	54%	-0.100	-0.250
City of Livermore	47%	-0.103	-0.258
Cal Water Livermore	58%	-0.109	-0.274

It is not typical for agencies to have a long-range forecast of water rates, so rate history information (primarily from 2010 to 2020) was collected from the Tri-Valley Water Agencies for the variable component of agency rate structures. Rate increases have varied in magnitude from year to year and the approximate 10-year average rate increases across agencies were fairly different. To maintain some consistency between agencies, the long-term (1997 to 2020) average consumer price index for water, sewer, and trash collection services was used. This results in an average rate increase of 2.1 percent per year as shown in **Figure 4-1**.

Figure 4-1: Consumer Price Index for Water and Sewer and Trash Collection Services (1997-2020)



Source: (U.S. Bureau of Labor Statistics, 2020)*; CPI for All Urban Consumers (CPI-U) - Water and sewer and trash collection services in U.S. city average, all urban consumers, seasonally adjusted*

4.3 Climate Change

California's Fourth Climate Change Assessment (Bedsworth, Cayan, Franco, Fisher, & Ziaja, 2018) identifies the following impacts associated with climate change that could impact California, including the Tri-Valley Region:

- Increased average daily high temperatures of 4.4°F – 5.8°F by 2040 to 2069 based on a range of greenhouse gas emissions scenarios
- Increasing variability in precipitation
- More frequent and more intense droughts and heat waves

Several studies cited by a 2016 Pacific Institute study about evaluating future urban water demand (Pacific Institute, 2016) have shown that warmer temperatures would increase California's landscape water demand by 10 to 15 percent by the year 2050 ((Climate Change Technical Committee (CCTC), 2007), (James, van Wagtendonk, & Franklin, 2010), and others). Others provide estimates like 3.5 to 12.7 percent for San Diego by 2055 (Water Research Foundation, 2013). However, most studies appear to agree that a net increase in irrigation demand can be expected, largely driven by increased temperatures and the likelihood of drought.

This study does not involve a rigorous analysis of expected regional-specific climate change impacts on water demands. However, to account for a conservative estimate of the impact of climate change on water demands within the current planning horizon, a value of 5 percent increased outdoor water demands by 2040 has been applied. The Model interpolates the effect of this 5 percent increase linearly starting from 0 percent in 2020. This value can be easily updated separately for the Residential Outdoor or CII Outdoor water use sectors in the Model.

4.4 Recycled Water

Three out of the four retailers deliver recycled water. The Model calculates water demands per parcel for each sector using the same methodology (see Section 3), regardless of the water supply. Then, the Model allocates that water demand between potable and recycled water sources depending on where each parcel is located. Once projected recycled water demand reaches the maximum recycled water production capacity (existing and planned), the remainder of the demand is allocated as potable.

Recycled water delivered to streetscapes and medians, recycled water fill stations, or any other recycled water deliveries that are not captured or tied to a parcel must be subtracted from the total recycled water capacity per agency and current recycled water base year demand. These recycled water demands are not projected by the Model since they do not have a corresponding land use. **Table 4-4** shows the total recycled water capacity, the subtracted recycled water use not tied to parcels, and the resulting modeled recycled water capacity used for tracking maximum recycled water deliveries before allocating remaining recycled water irrigation demands to potable supplies.

Table 4-4: Modeled Current Recycled Water Capacity

Agency	Recycled Water Capacity (AFY)	Recycled Water Use Not Tied to Parcels (AFY)	Modeled Recycled Water Capacity (AFY)
DSRSD	3,360	802 [A]	2,559
City of Livermore	6,721	0 [B]	6,721
City of Pleasanton	1,370	0.4 [C]	1,370

Notes:

A. *Average of 2018-2019 for categories reported in annual recycled water report for "Streetscape/Median Greenbelts" and "Commercial Fill Station"* (DSRSD, 2019) *and* (DSRSD, 2020).

B. *It is known that some of the City of Livermore's recycled water is used at streetscapes and medians, but the exact amount or share of total recycled water use is not known. Additionally, some amount is delivered wholesale to the City of Pleasanton and this value can change from year to year. Since these are not accounted for in a total recycled water capacity adjustment, the Model has the potential to over-project recycled water demands at modeled parcels, though this is considered unlikely except in an extreme scenario of high recycled water deliveries beyond what is presented in this study.*

C. *Total recycled water use in annual recycled water report for "Dust Control/Soil Compaction"* (City of Pleasanton, 2020).

The Model identifies parcels as being served recycled water (or that have the potential to be served recycled water) through one of two ways:

1. Tag applied in GIS to parcels located within a pre-determined zone; and

2. Parcel number listed in the section of the Model for identifying active or potential recycled water use.

Recycled water zones or parcels can be tagged as "Active" (meaning recycled water is currently served and will continue to be served into the future) or "Potential" (meaning recycled water might be served but is not currently). Model users can select on an agency-by-agency basis whether to model serving recycled water to just the Active parcels or both the Active and Potential. Additionally, each parcel's status can be adjusted individually.

Given a parcel that is known to be developed currently (in 2020) and given a status of "Potential," if the Model is directed to serve recycled water to both Active and Potential parcels, this parcel will be served recycled water immediately. There is no way to set a "turn on" or "conversion" date for parcels with existing potable use.

Overall, the Model is not intended to provide a perfect estimation of recycled water use for the purpose of recycled water planning. For instance, it cannot project recycled water demands for streetscapes, street sweeping, fill stations, or other uses not tied to a parcel. The Model is focused on potable water demand projections and uses the recycled water portion of the Model to help allocate landscape demands between potable and recycled water supply sources.

The sections below describe how parcels that use or have the potential to use recycled water were identified for DSRSD (Section 4.4.1), the City of Pleasanton (Section 4.4.2), and the City of Livermore (Section 4.4.3).

4.4.1 Dublin San Ramon Services District (DSRSD)

DSRSD provided several files that describe current recycled water use:

- Excel file with list of all recycled water meters (both inactive and active) with location information, some via a physical address and some via other descriptions like "corner of <STREET1> and <STREET2>" or "recycled meter behind gate at park."
- GIS shapefile with point locations of active recycled water meters.
- Site application information describing the categorized use for each unique meter (commercial/other greenbelts, golf course, homeowner's association, park/open space, school, streetscape/median greenbelt, commercial use, or temporary construction meter).

The following processing (ordered by priority of data source) was used to attempt to assign a parcel number to every unique meter:

- Use "main address" to pull out a street number and street name and use these two fields to look up the APN in the assessor data.
- Look up APN in assessor data using an alternate or adjusted street name (e.g., changing suffixes from LANE to LN).
- Assign a parcel number to each meter using a spatial join against the respective county assessor shapefile data using "closest" geographic match (e.g., did not require meter to be located within a parcel). In this case, if a meter was located near the edge of a parcel but not strictly within it its boundaries, the nearest parcel would be assigned.
- Any meter with a site application use type of "streetscape/median greenbelt" was not assigned an APN.

A total of 50 meter/register IDs were provided in the hourly consumption data with an account type indicating recycled water use that did not appear in the three data sources (Excel, GIS, site application information) described above. These were assigned an APN using street address only (if possible).

Ultimately, 209 unique parcels were identified as being served recycled water in the DSRSD service area.

DSRSD currently has a moratorium on adding new connections to the recycled water system (DSRSD, 2020). DSRSD has indicated that current development projects (see Section 2.2.1) should be tagged as potentially able to use recycled water in the future, but by default their respective demands should be allocated to potable supply.

4.4.2 City of Pleasanton

The City of Pleasanton provided an Excel list of every recycled water site with APN and current recycled water connection status (Connected, No Response, Pending, or Unable to Connect). The City also provided a spatial GIS file representing the potential recycled water users by parcel in the 2019 recycled water user report (City of Pleasanton, 2020). These two files provided non-overlapping information and the GIS file had more entries than the Excel list. To reconcile the differences in the two data sources, the following processing was conducted:

- Used GIS file as a base for the list of APNs that could potentially receive recycled water.
- Made some edits to the Excel list to separate out rows with multiple APNs and corrected a few minor typos after conferring with City staff.
- Using the APN-15 field (parcel number formatted with dashes and no leading zeroes), matched each row from the GIS file with the Connection Status from the Excel list. All rows were recategorized accordingly to match Model fields:
    - "Connected" was recategorized as "Active"
    - "Pending" or "No Response" was recategorized as "Potential"
    - "Unable to connect" was left as "Unable to connect"
- 41 parcels from the GIS file did not match with the Excel list and were initially included as status = "Potential."
- 7 parcels from the Excel list that did not exist in the GIS file were added.
- All Account Numbers in the 2019 recycled water user report (City of Pleasanton, 2020) were matched to an APN or street address via the billing system consumption data extract. If a previously marked "Potential" recycled water parcel matched by APN or address against the active user accounts in the 2019 water user report, then it was updated to Status = "Active."
- If line items could not be matched by APN-15, but the Excel address for an Active user matched a GIS address during a manual comparison (e.g., 6155 STONERIDGE DR and 6155 Stoneridge Drive), then it was updated to Status = "Active."

Ultimately, 118 unique parcels were identified as being served recycled water in the City of Pleasanton, with an additional 39 parcels identified as "potential" customers.

4.4.3 City of Livermore

In the City of Livermore, recycled water is served to a small number of parcels within pressure zone 1. An attempt was made to identify the current parcels at which recycled water is served by matching addresses for recycled water meters recorded in the City of Livermore's billing system against the Alameda County Assessor's parcel database. Out of 141 recycled water meters, only 24 (17 percent) could be matched to an APN by street address. The addresses for the unmatched meters were loaded into an online geocoder (Geocodio) and 93 additional meters were assigned to an APN.

Ultimately, 66 unique parcels were identified as being served recycled water in the City of Livermore. An additional 30 unique addresses are stored in the Model should a parcel number eventually be identified.

In the Model, each planned development in pressure zone 1 is called out and tagged as “Potential” for recycled water delivery. Additionally, all other areas in pressure zone 1 (not part of planned developments) were grouped and tagged as “Potential” for future recycled water delivery.

All future landscape irrigation (both residential and non-residential) within the Isabel Neighborhood Plan is assumed to be met with recycled water supplies (West Yost Associates, 2017) and has thus been tagged with an “Active” status.

4.4.4 Cal Water Livermore

Cal Water Livermore has no recycled water service and thus no recycled water demands. For the small region of the Isabel Neighborhood in the Cal Water Livermore service area, no recycled water demands are projected.

4.5 Land Use Type Corrections/Parcel Overrides

In some cases, the general plan land use assigned to a particular parcel does not provide enough specificity to distinguish between water demand characteristics of sub-types of land use that may fall under one land use category. For instance, a “Parks” designation may contain both non-irrigated regional parks and small irrigated community parks. Alternatively, certain large parcels may have unique characteristics that separate them from other parcels with the same land use code, causing the model to vastly over or under-estimate water use.

The Model provides a Parcel Override tab where a parcel number and its land use can be added on a case-by-case basis and the percent area to consider in model calculations can be provided. Three examples are provided below:

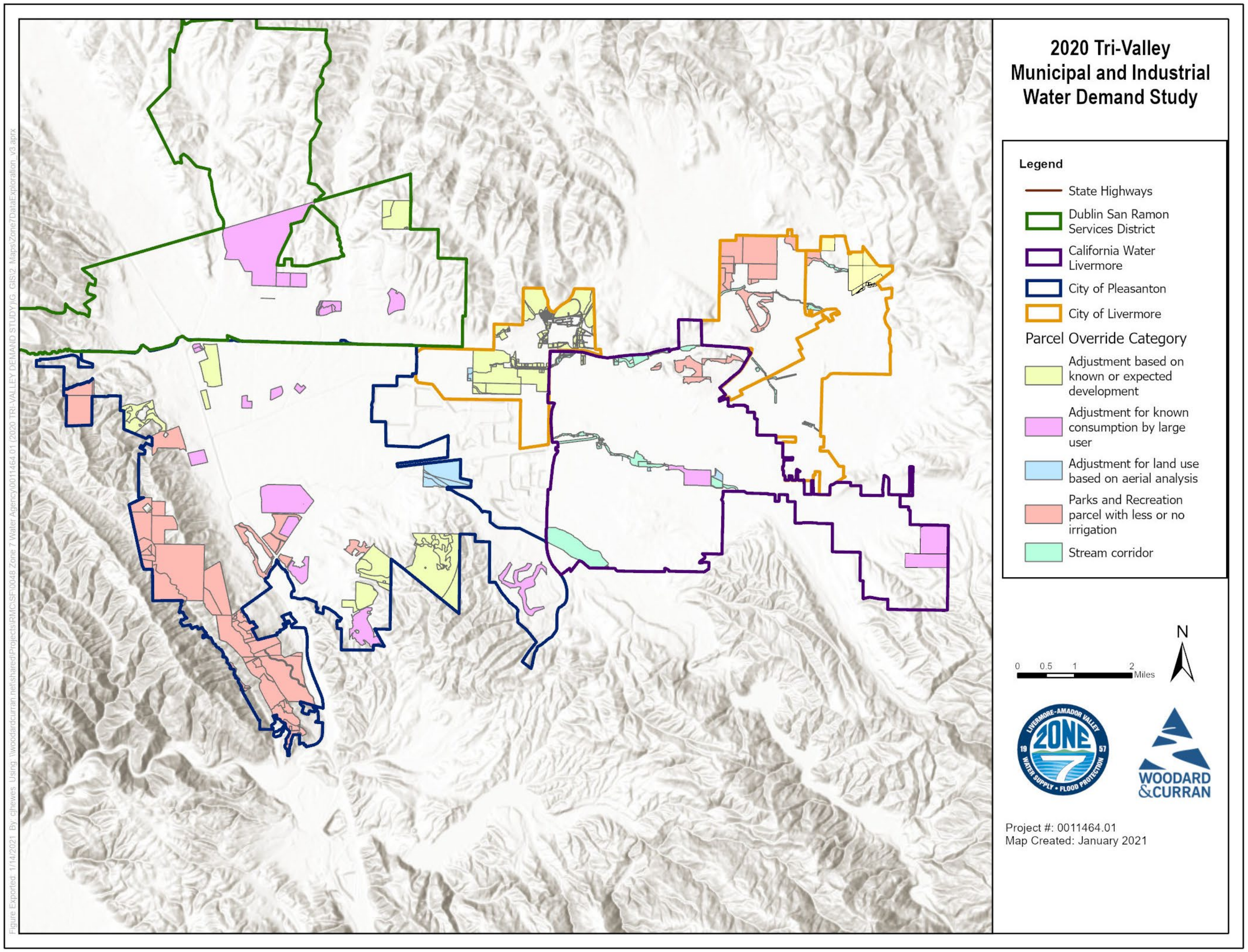
- The City of Livermore’s General Plan combines outdoor spaces under the General Plan land use category of OSP: Park, Trail Way, Recreation Corridor, and Protection Areas. The parcel override tab is used to list all non-irrigated parcels via an aerial survey (e.g., stream corridors or large wetlands or open space) and set their area to 0 percent so they are not assigned a water demand. Remaining land uses of code OSP are assumed to be irrigated parks.

- The City of Pleasanton General Plan shows one large parcel consisting of many multi-family homes as well as water feature that took up two-thirds of the parcel area. The parcel was tagged as entirely multi-family and was thus vastly over-calculating water demand in the two-thirds of the parcel that has an existing water feature. The area of the parcel was reduced to approximately 33 percent to calculate demands for only that portion with expected water demands.

- DSRSD has two major jail facilities that have abnormal water patterns compared to other institutional land uses. The average base year water consumption for each facility was calculated and used to calculate a percent area adjustment factor to increase or decrease the default model calculations for projected water demand. For instance, the Santa Rita Jail had a 2018/2019 base years consumption of 222 AFY. Using DSRSD’s default institutional water demand factor of 1.21 AF/ac, the 82.8 acre parcel would result in a default water demand of 100 AF. An adjustment factor of 222% was used to increase the projected water demand to 222 AF to resemble actual water use more closely for this specialized user.

A map of parcels with percent area overrides grouped by categories of override reason is shown in **Figure 4-2**. More detailed parcel-by-parcel notes can be found in the ParcelOverride tab of the Model.

Figure 4-2: Parcel Override Map



5. RESULTS

Section 5.1 describes the "baseline" results for total retail agency demands with subsections for each agency. Each agency contains graphs of annual population, potable demands by sector, and recycled water demands (if applicable), as well as a table of total demands by sector in 5-year increments. Section 5.2 describes five alternate scenarios and compares the results for each to the original baseline projection. These scenarios are meant to provide Zone 7 and the Tri-Valley retailers with a better understanding of how the various model factors influence the results by providing bookends to the baseline demand projection.

Groundwater Pumping Quota

This chapter references each retailer's Groundwater Pumping Quota (GPQ) from their respective Municipal and Industrial water supply contract with Zone 7. The City of Pleasanton and Cal Water Livermore pump their own GPQ and Zone 7 pumps DSRSD's GPQ. The City of Livermore has not had any groundwater pumping capacity for many years and thus has not been using its GPQ (Zone 7 Water Agency, 2016). Zone 7 typically references potable demands after subtracting out the City of Pleasanton's and Cal Water Livermore's GPQs (total of 6,569 AF on average) to reflect retailer potable demand on Zone 7. For easier comparison to each retailer's total demands from prior projections or for future consistency, tabular results are reported both with and without GPQ. Graphs are shown as total retailer potable demands (including GPQ).

5.1 Main Results

Figure 5-1 shows the total projected demands by sector. **Table 5-1** shows the total projected demands by sector in five-year increments from 2020 through the 2045 planning horizon. Total potable demands are estimated at approximately 39,000 AF in 2020 and peak at approximately 50,225 AF before holding constant beginning in 2040 (an approximate 11,200 AF increase)[11]. After subtracting out a GPQ of 6,569 AF, the total retailer demand on Zone 7 at 2040 and 2045 is approximately 43,700 AF compared to approximately 32,500 AF in 2020.

Table 5-2 shows the total cumulative service connection growth at buildout of 21,163 dwelling unit equivalents. **Table 5-3** provides an estimate of the annual (by calendar year and fiscal year) equivalent service connection growth per agency. It should be noted that the Model is designed as a long-term planning tool that focuses on projecting demands and connection equivalents at buildout. However, for planning purposes, it provides a best estimate of annual growth on the path to buildout. Annual interpolation calculations are described further in Section 3.7. Service connection growth assumptions and calculations are described in Section 3.5.

[11] At the time of publishing, actual 2020 demands were noted to be somewhat higher than projected. This is expected to be partly due to the impact of the COVID-19 pandemic and shelter-in-place orders that were in effect for most of the year and a corresponding increase in residential consumption. The Model is designed as a long-term planning tool and does not account for near-term impacts such as COVID-19. 2020 estimated consumption is based on recent trends and lines up very closely with actual 2019 demands.

Figure 5-1: Projected Total Retailer Potable Demands by Sector (Baseline Scenario)

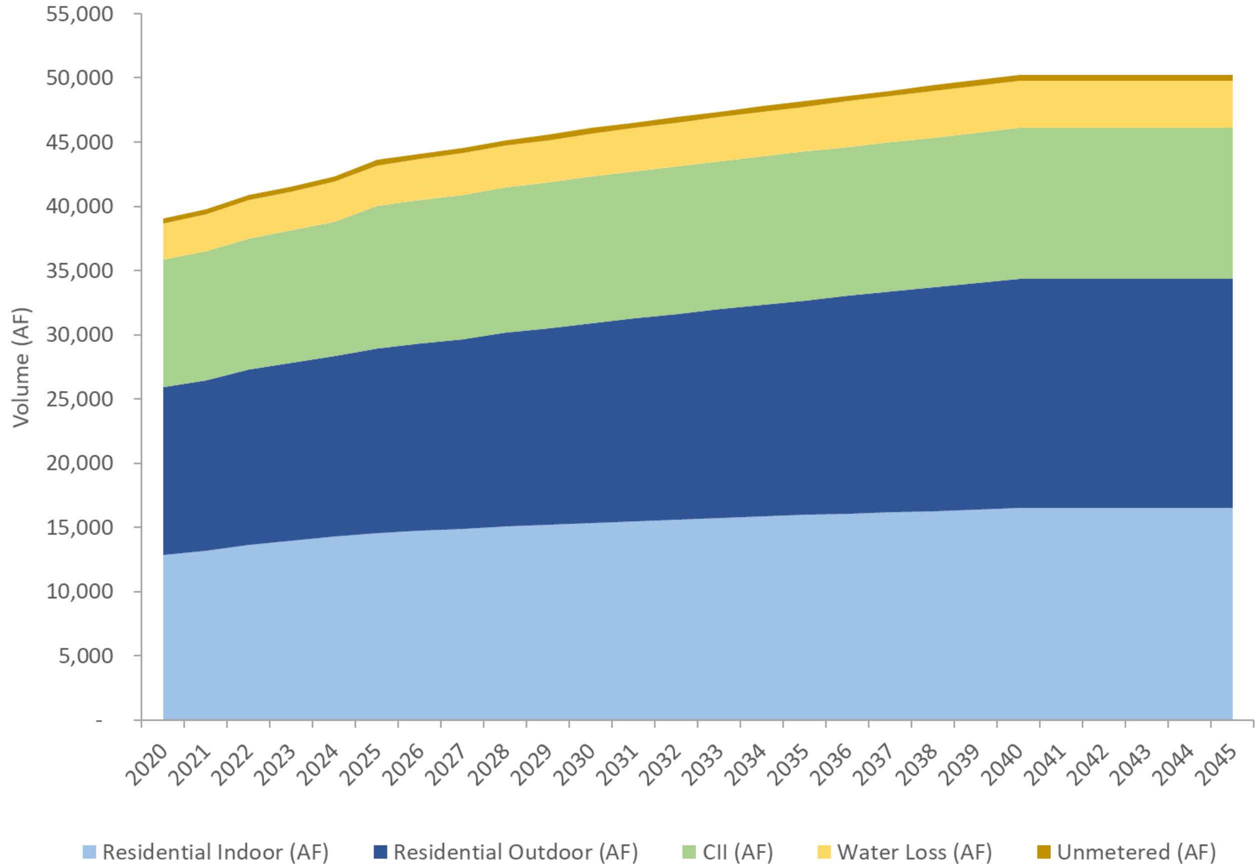


Table 5-1: Projected Demands by Sector (Baseline Scenario)

Year	Population	Residential Indoor (AF)	Residential Outdoor (AF)	CII (AF)	Unmetered Consumption (AF)	Water Loss (AF)	Total Potable (AF) [C]	GPQ (AF) [A]	Retailer Demands on Zone 7 (AF) [C]
2020 [B]	265,811	12,852	13,076	9,910	365	2,837	**39,039**	6,569	**32,470**
2025	283,964	14,576	14,332	11,129	412	3,163	**43,612**	6,569	**37,043**
2030	299,121	15,331	15,568	11,435	432	3,348	**46,114**	6,569	**39,545**
2035	311,887	15,963	16,718	11,575	442	3,517	**48,216**	6,569	**41,647**
2040	322,742	16,495	17,845	11,754	450	3,683	**50,225**	6,569	**43,656**
2045	322,742	16,495	17,845	11,754	450	3,683	**50,225**	6,569	**43,656**
Change from 2020-2045	56,931	3,643	4,769	1,844	85	846	**11,186**	0	**11,186**

Notes:

A. *645 AF GPQ for DSRSD is pumped by Zone 7 and not included in the GPQ column.*

B. *2020 population is projected population at the end of the modeled 2020 development year and is higher than the sum of individual retailer 2020 population reported to SWRCB on 1/1/2020.*

C. *Development information was updated as of May 2021 based on conversations with City Planning departments, resulting in a net increase of 42 AF and 1,117 people at buildout. These net increases are not reflected in the table.*

Table 5-2: Total Cumulative Service Connection Growth at Buildout (Baseline Scenario)

Agency	Cumulative Increase in Service Connections 2020-2040 (dwelling unit equivalents)
DSRSD [A]	6,680
City of Pleasanton	7,469
City of Livermore	4,462
Cal Water Livermore	2,553
Total [B]	21,163

Notes:

A. DSRSD provided separate service connection equivalent projections that were calculated outside of the Model.

B. Summed using unrounded values.

Table 5-3: Annual Service Connection Growth (Baseline Scenario)

Calendar Year	DSRSD [A, B]	City of Pleasanton	City of Livermore	Cal Water Livermore	Total	Fiscal Year [B]	DSRSD [A, B]	City of Pleasanton	City of Livermore	Cal Water Livermore	Total
2020 [C]	375	54	56	56	540	**FY 20-21**	254	211	138	90	693
2021	383	369	220	125	1,097	**FY 21-22**	512	369	220	125	1,226
2022	628	369	220	125	1,341	**FY 22-23**	743	369	220	125	1,457
2023	688	369	220	125	1,402	**FY 23-24**	632	415	220	125	1,393
2024	485	462	220	125	1,291	**FY 24-25**	337	413	303	125	1,178
2025	642	364	386	125	1,516	**FY 25-26**	946	405	298	125	1,774
2026	1,039	446	209	125	1,819	**FY 26-27**	1,132	402	209	125	1,869
2027	1,023	358	209	125	1,715	**FY 27-28**	913	358	209	125	1,606
2028	682	359	209	125	1,375	**FY 28-29**	451	359	209	125	1,144
2029	355	359	209	125	1,048	**FY 29-30**	259	359	209	125	952
2030	256	359	209	125	949	**FY 30-31**	253	359	209	125	946
2031	127	359	209	125	820	**FY 31-32**	0	359	209	125	694
2032	0	359	209	125	694	**FY 32-33**	0	360	209	125	694
2033	0	360	209	125	694	**FY 33-34**	0	360	209	125	694
2034	0	360	209	125	694	**FY 34-35**	0	360	209	125	694
2035	0	360	209	125	694	**FY 35-36**	0	360	209	125	694
2036	0	360	209	125	694	**FY 36-37**	0	360	209	125	694
2037	0	361	209	125	695	**FY 37-38**	0	361	209	125	695
2038	0	361	209	125	695	**FY 38-39**	0	361	209	125	695
2039	0	361	209	125	695	**FY 39-40**	0	361	209	125	695
2040	0	361	209	125	695	**FY 40-41**	0	181	105	62	348

Notes:

A. *DSRSD provided separate service connection equivalent projections that were calculated outside of the Model and assume a different buildout year of FY 2030-2031.*

B. *Fiscal year estimates were developed by averaging between the two respective calendar year outputs, except in the case of DSRSD which provided estimates by fiscal year which were then averaged to estimate calendar year projections in this table.*

C. *Actual 2020 DUEs are shown. For City of Pleasanton, City of Livermore, and Cal Water Livermore, the actuals were lower than what was projected by the Model. The difference in DUEs between actual and projected for 2020 has been calculated and spread evenly across calendar years 2021-2040 such that the total cumulative DUEs by 2040 is the same.*

5.1.1 DSRSD

Figure 5-2 shows a graph of population change (106,536 at buildout) compared to two alternate population projections: (1) 2015 UWMP population projections and (2) the same population growth patterns from the 2015 UWMP but with an adjusted 2020 starting point based on current service area population. 2020 actual population is about the same as what was projected in 2015, so the two alternate projections appear superimposed in the graph. Modeled population increases at a faster rate than the projections due to several known proposed developments coming online by 2030 but ends up at approximately the same final projection at 2035 buildout.

Figure 5-3 shows a stacked area graph of the change in DSRSD demands by water use sector. **Table 5-4** shows demands by sector in 5-year increments. The graph and table show a moderate increase in demands across all sectors due to ongoing growth in DSRSD's service area.

Figure 5-4 shows a graph of recycled water demands. The overall trend is relatively flat and acts as a control on landscape demands from potable supplies. Note that recycled water projections in the Model do not include use at medians, sidewalks, or other uses not associated with a specific parcel. Due to DSRSD's moratorium on recycled water system connection expansion, all new future outdoor demands have been assumed to be met with potable supplies in the Baseline Scenario.

Figure 5-2: DSRSD Population Projections (Baseline Scenario)

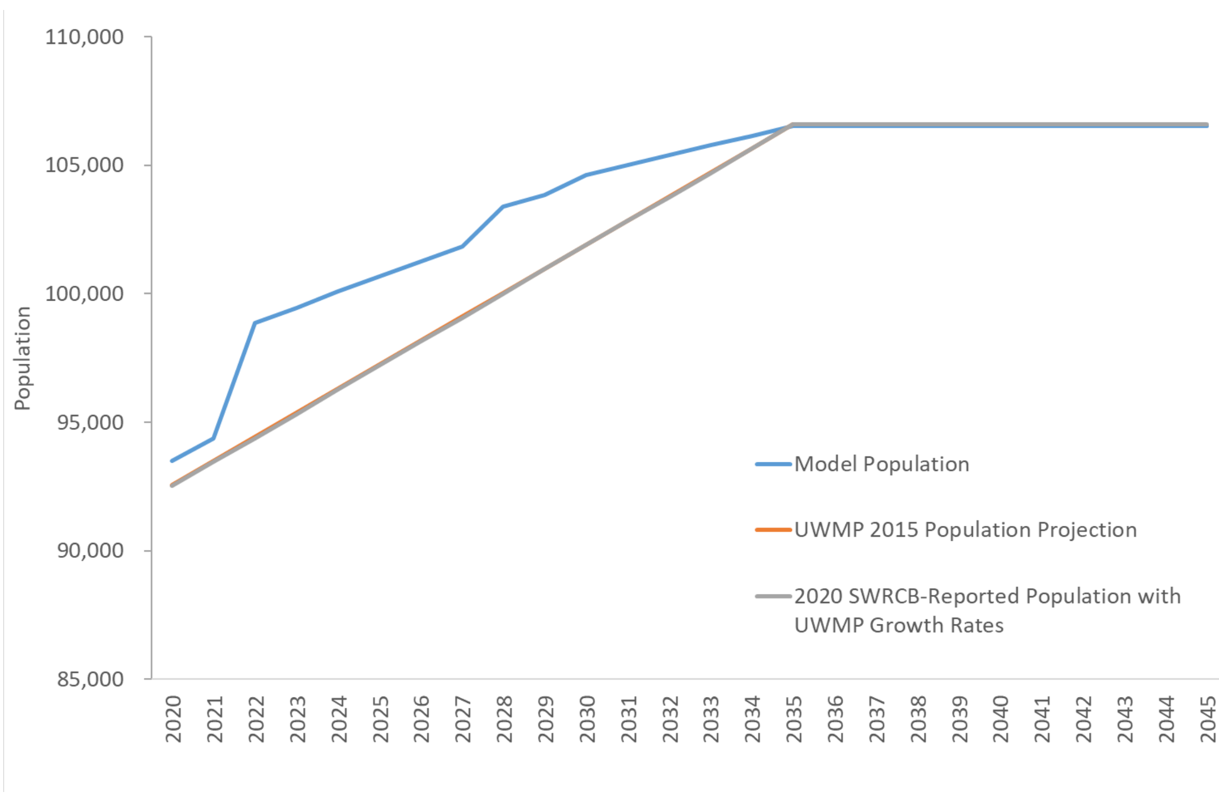


Figure 5-3: DSRSD Projected Demands by Sector (Baseline Scenario)

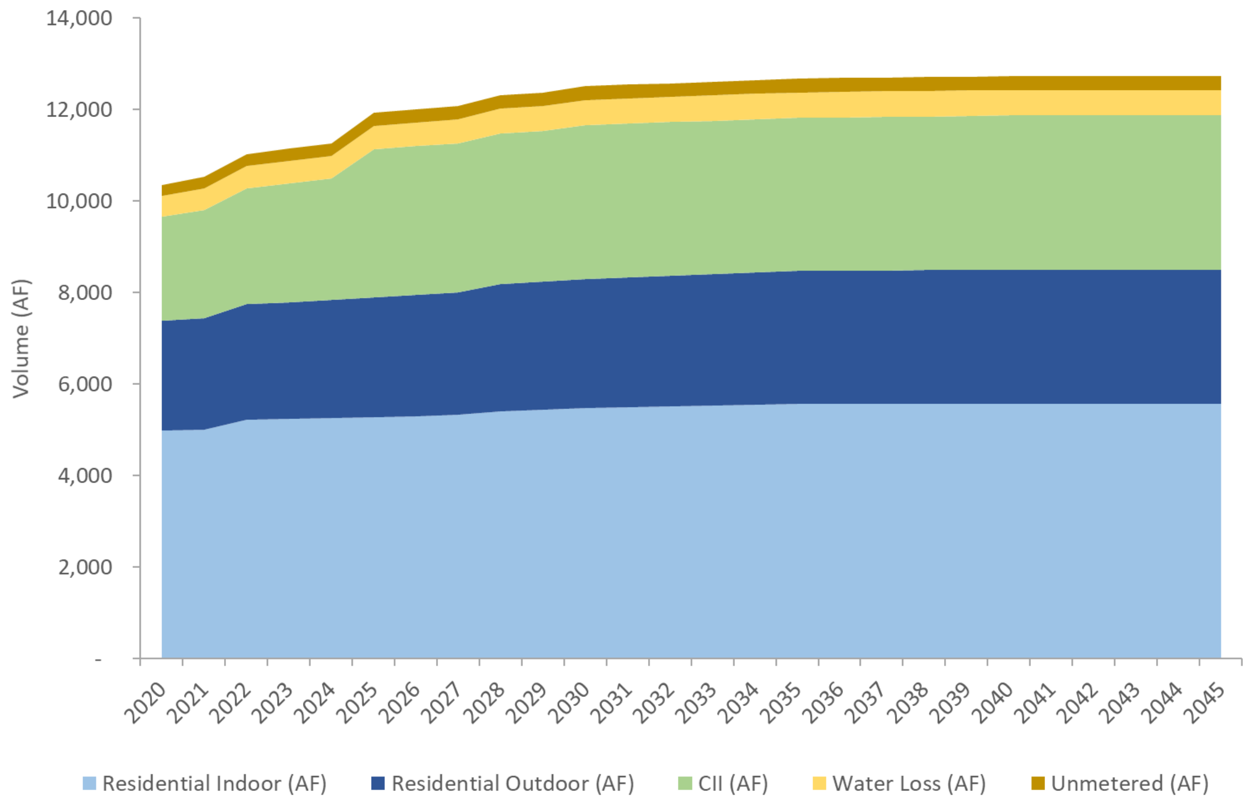


Table 5-4: Total Demands by Sector for DSRSD (Baseline Scenario)

Year	Popula-tion	Residen-tial Indoor (AF)	Residential Outdoor (AF)	CII (AF)	Unmeter-ed Cons-umption (AF)	Recycled (AF) [C]	Water Loss (AF)	Total Potable (AF)	GPQ (AF) [A]	Retailer Demands on Zone 7 (AF)
2020 [B]	93,508	4,977	2,402	2,273	246	1,919	454	**10,351**	0	**10,351**
2025	100,686	5,267	2,629	3,227	284	1,994	523	**11,929**	0	**11,929**
2030	104,625	5,473	2,814	3,373	297	2,017	548	**12,505**	0	**12,505**
2035	106,536	5,573	2,892	3,352	301	2,039	555	**12,674**	0	**12,674**
2040	106,536	5,573	2,925	3,367	303	2,065	558	**12,726**	0	**12,726**
2045	106,536	5,573	2,925	3,367	303	2,065	558	**12,726**	0	**12,726**
Change from 2020-2045	13,027	596	523	1,094	56	146	104	**2,374**	0	**2,374**

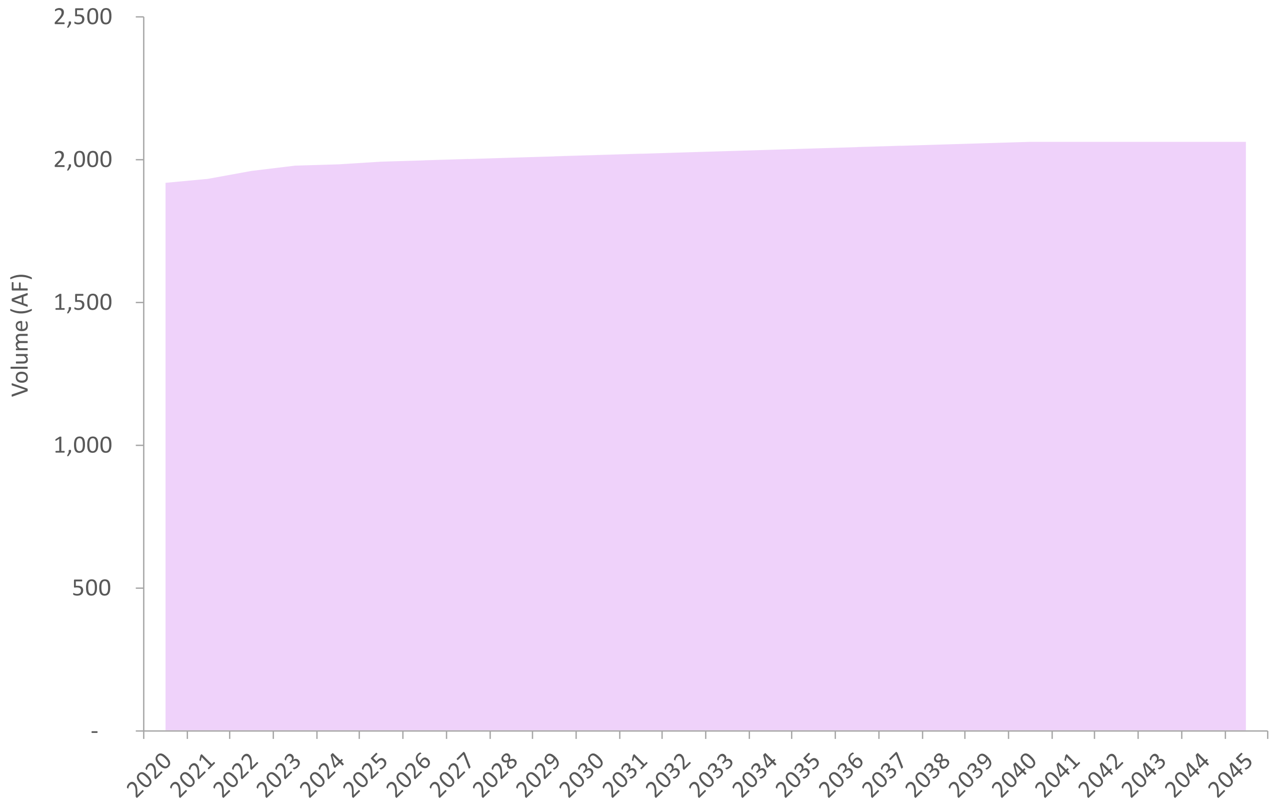
Notes:

A. 645 AF GPQ for DSRSD is pumped by Zone 7 and not included in GPQ column.

B. 2020 population is projected population at the end of the modeled 2020 development year and is higher than the 2020 population reported to SWRCB on 1/1/2020.

C. *An update was made to the Model in July 2021 to correct an issue with a few of DSRSD existing's recycled water parcels being split between DSRSD and City of Pleasanton service area boundaries. This ultimately shifted the timing in recycled water demands for DSRSD, which is reflected in the table above, but had no impact on the buildout volume of 2,065 AF. The 146 AF increase from 2020 to 2045 (despite a moratorium on recycled water expansion) is due to imperfect meter-to-parcel matching of consumption data and also due to estimates made for splitting recycled water use between parcels and other uses not tied to parcels. The overall modeled trend in recycled water use is relatively flat (no significant growth) and primarily acts as a limiting control on potable water demands. The July 2021 recycled water update on timing caused a reduction of 62 AF in CII potable demands which is not reflected in the table nor graphs of this report.*

Figure 5-4: DSRSD Recycled Water Demands (Baseline Scenario)



Note:

A. *Graph above does not include approximately 800 AF of recycled water demands for "Streetscape/Median Greenbelts" and "Commercial Fill Station" that are not tied to parcels and are thus not included in the land use based Model.*

5.1.2 City of Pleasanton

Figure 5-5 shows a graph of population change (100,913 at buildout) compared to two alternate population projections: (1) 2015 UWMP population projections and (2) the same population growth patterns from the 2015 UWMP but with an adjusted 2020 starting point based on current service area population. Modeled population is about 5,000 larger than the previously projected. One explanation for the increased expected population is that there are relatively few residential land use categories in the City of Pleasanton General Plan; any changes to dwelling unit densities in the General Plan land use type lookup tab of the Model have large impacts on the total number of dwelling units and thus population. The City of Pleasanton sets an "average holding capacity" for overall density of each General Plan residential land use type; the two land use categories with the largest number of dwelling units overall (LowDensity and MediumDensity) were both found to have higher densities of dwelling units currently built compared to their respective holding capacities. These adjusted values were maintained as an assumption for future dwelling unit densities to align with an approximate 1.2 percent annual population growth rate estimate for 2020-2040 provided by the City of Pleasanton Planning Division.

Figure 5-6 shows a stacked area graph of the change in demands for the City of Pleasanton by water use sector. **Table 5-5** shows demands by sector in 5-year increments. The graph and table show a moderate increase in demands across all sectors due to ongoing growth in the City of Pleasanton's service area.

Figure 5-7 shows a graph of recycled water demands. While the graph of recycled water demand does show some increase (e.g., one development project coming online in 2024 that is tagged as a recycled water user), the overall trend is relatively flat and acts as a control on landscape demands from potable supplies. Note that recycled water projections in the Model do not include use at medians, sidewalks, or other uses not associated with a specific parcel.

Figure 5-5: City of Pleasanton Population Projections (Baseline Scenario)

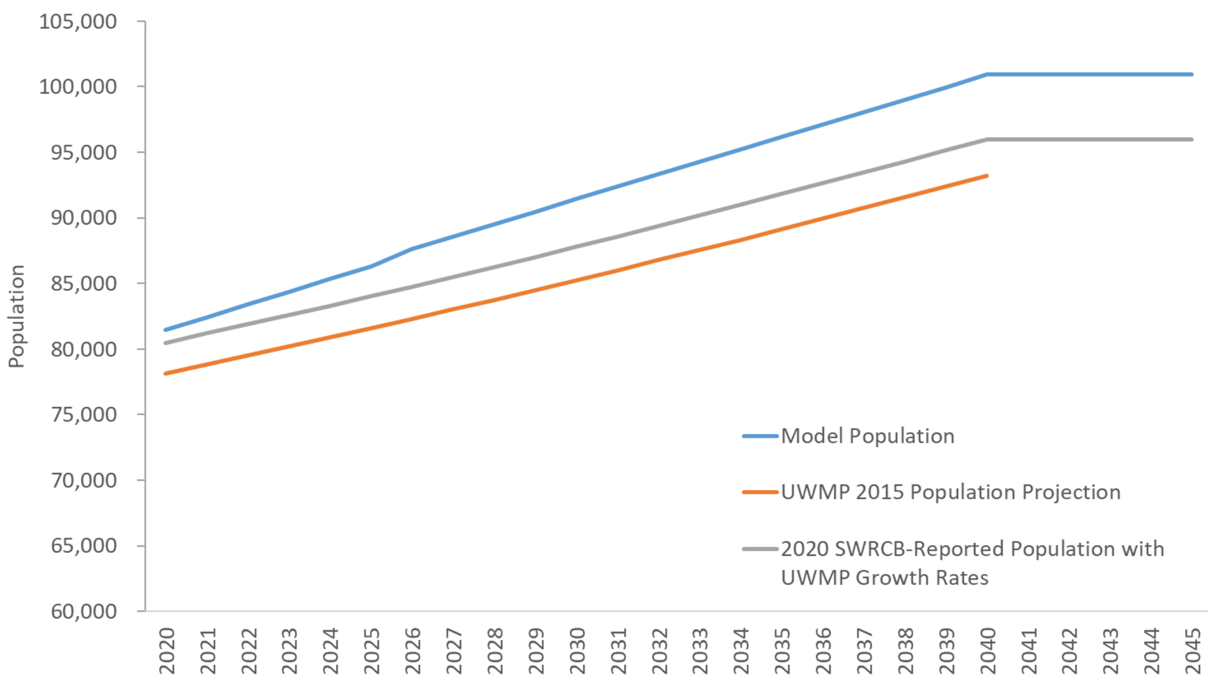


Figure 5-6: City of Pleasanton Projected Demands by Sector (Baseline Scenario)

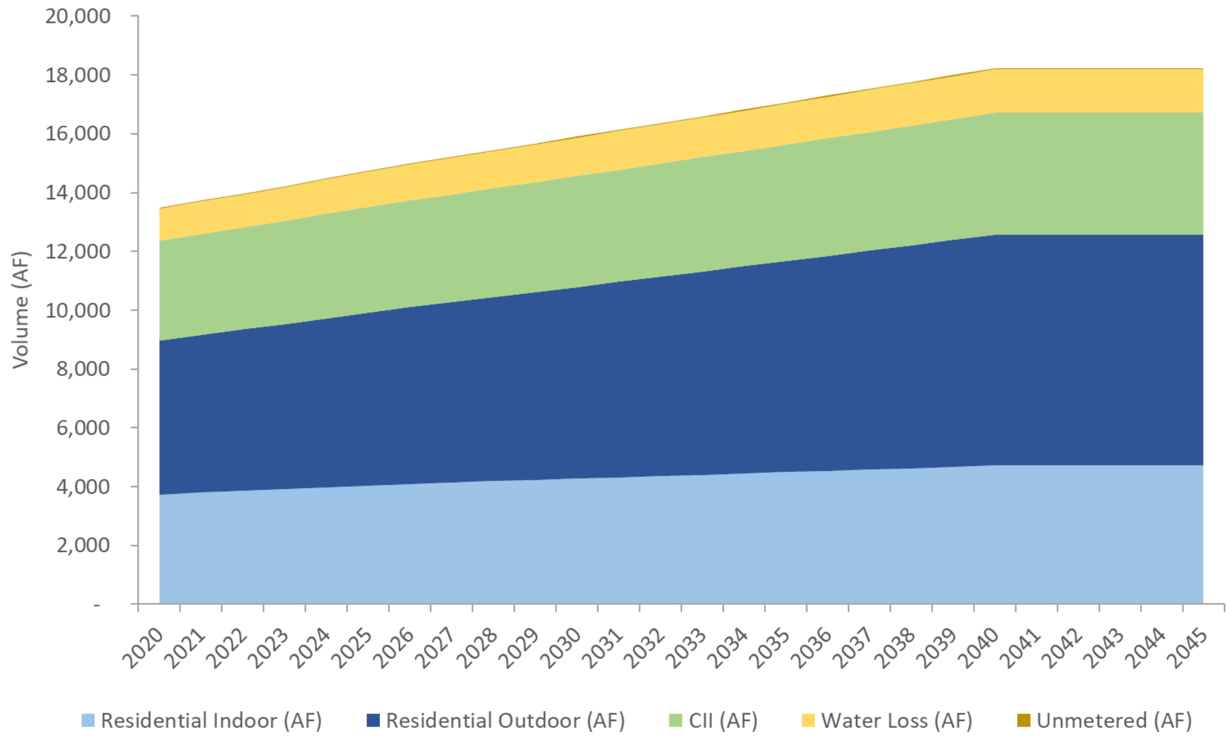


Table 5-5: Total Demands by Sector for City of Pleasanton (Baseline Scenario)

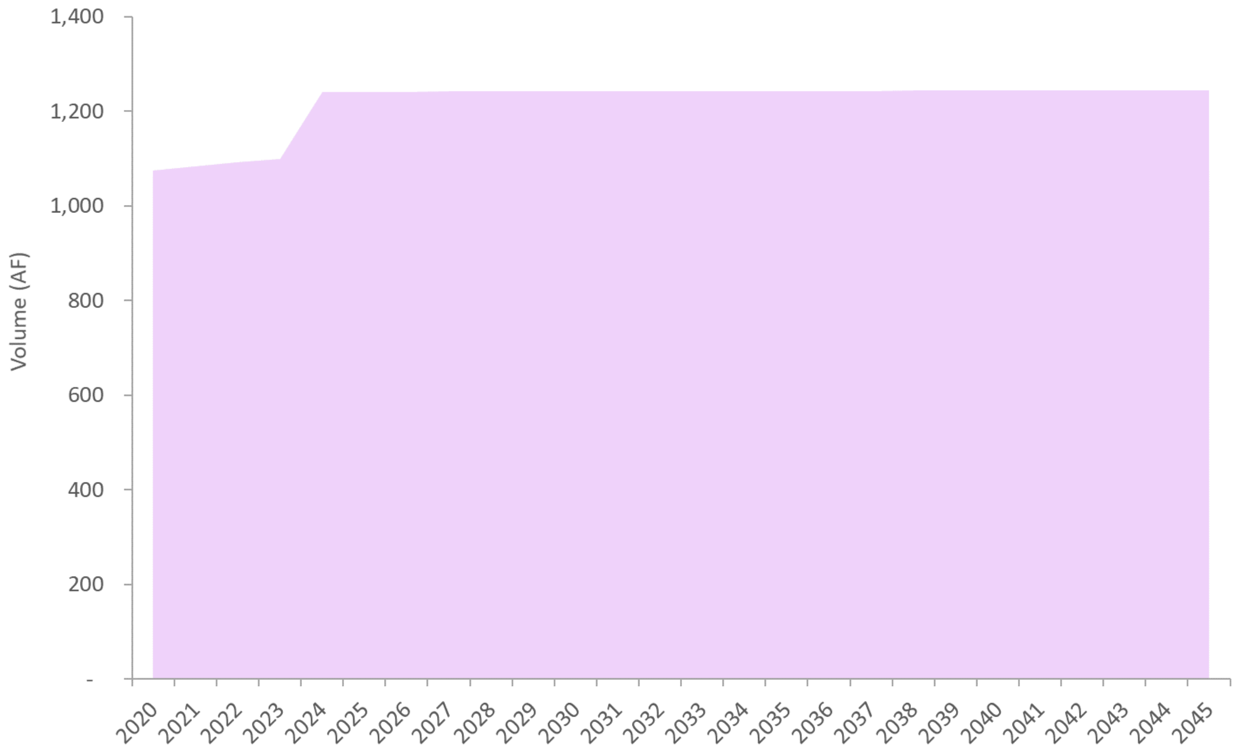
Year	Popula-tion	Residen-tial Indoor (AF)	Residen-tial Outdoor (AF)	CII (AF)	Unmeter-ed Cons-umption (AF)	Recycled (AF)	Water Loss (AF)	Total Potable (AF) B	GPQ (AF)	Retailer Demands on Zone 7 (AF) B
2020 A	81,464	3,735	5,242	3,382	31	1,075	1,098	**13,487**	3,500	**9,987**
2025	86,326	4,034	5,875	3,598	34	1,241	1,200	**14,740**	3,500	**11,240**
2030	91,430	4,272	6,521	3,777	36	1,242	1,295	**15,901**	3,500	**12,401**
2035	96,171	4,494	7,180	3,958	39	1,243	1,389	**17,060**	3,500	**13,560**
2040	100,913	4,716	7,853	4,141	42	1,243	1,485	**18,236**	3,500	**14,736**
2045	100,913	4,716	7,853	4,141	42	1,243	1,485	**18,236**	3,500	**14,736**
Change from 2020-2045	19,448	981	2,611	759	11	168	387	**4,748**	0	**4,748**

Notes:

A. *2020 population is projected population at the end of the modeled 2020 development year and is higher than the 2020 population reported to SWRCB on 1/1/2020.*

B. *Development information was updated as of May 2021 based on conversations with the City's Community Development Department, resulting in a net increase of 7 AF in total demands and 379 people at buildout. The net increases are not reflected in the table.*

Figure 5-7: City of Pleasanton Recycled Water Demands (Baseline Scenario)



5.1.3 City of Livermore

Figure 5-8 shows a graph of population change (47,371 at buildout) compared to two alternate population projections: (1) 2015 UWMP population projections and (2) the same population growth patterns from the 2015 UWMP but with an adjusted 2020 starting point based on current service area population. Note that the Model projects a significantly higher population than previous projections due the assumption that the Isabel Neighborhood Specific Plan (Section 2.2.3) will be developed by buildout.

Figure 5-9 shows a stacked area graph of the change in demands for the City of Livermore by water use sector. **Table 5-6** shows demands by sector in 5-year increments. Increases in the City of Livermore demands are largely driven by the increase in indoor residential demand as a result of increased population from the expected Isabel Neighborhood project. There is no corresponding increase in potable demands for residential outdoor or CII demands due to the assumption that recycled water will be used to meet these new demands.

Figure 5-10 shows a graph of recycled water demands which increase through time due to the assumption that the future Isabel Neighborhood development will use recycled water for outdoor residential and outdoor CII landscaping demands. Note that recycled water projections in the Model do not include use at medians, sidewalks, or other uses not associated with a specific parcel, like the City of Livermore's wholesale deliveries of recycled water to the City of Pleasanton.

Figure 5-8: City of Livermore Population Projections (Baseline Scenario)

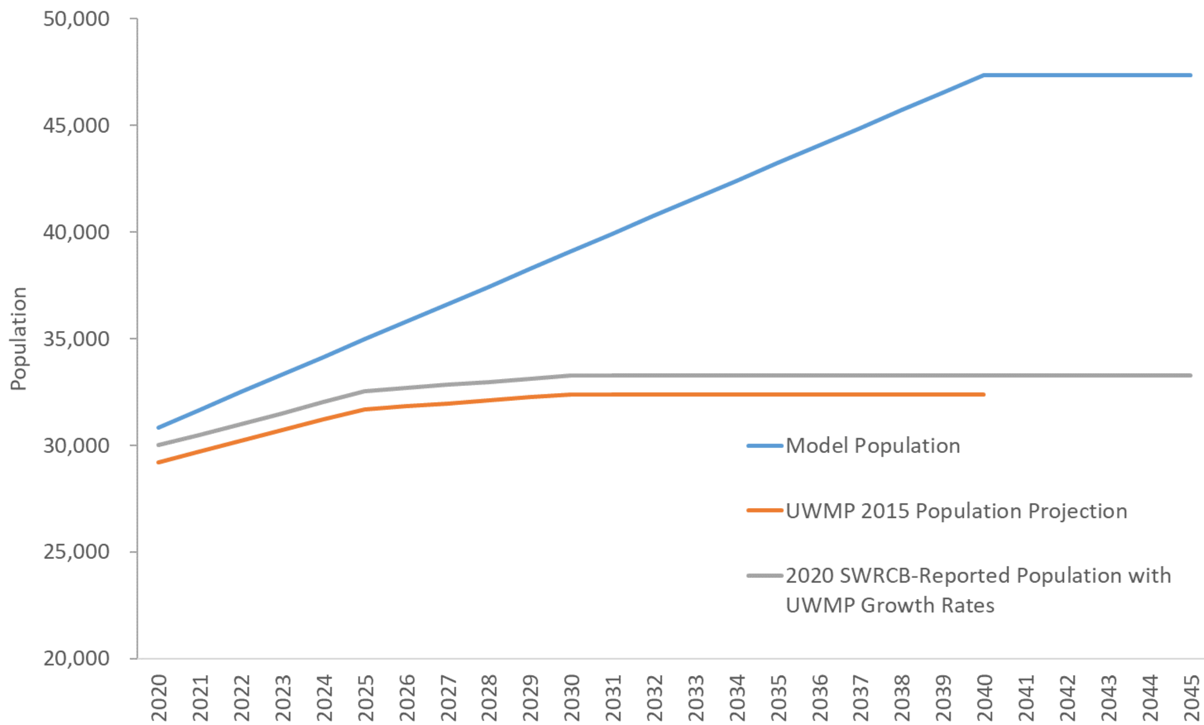


Figure 5-9: City of Livermore Projected Demands by Sector (Baseline Scenario)

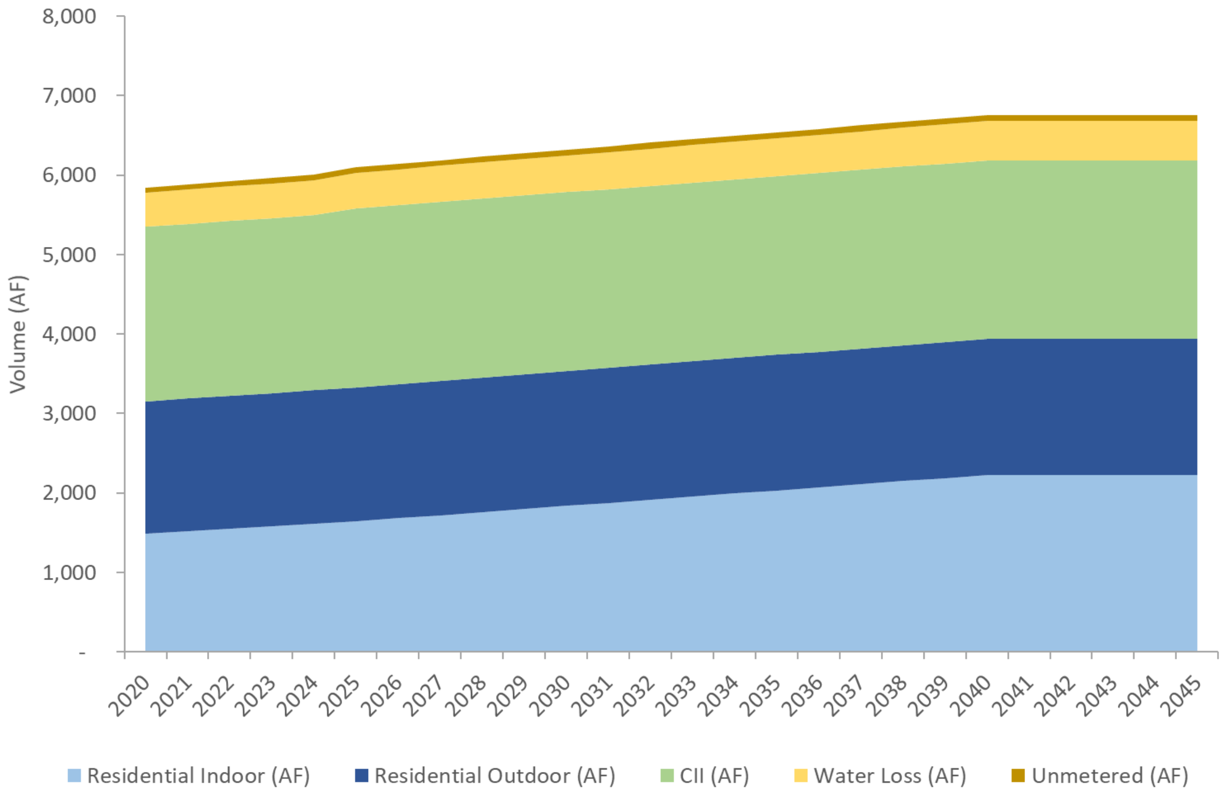


Table 5-6: Total Demands by Sector for City of Livermore (Baseline Scenario)

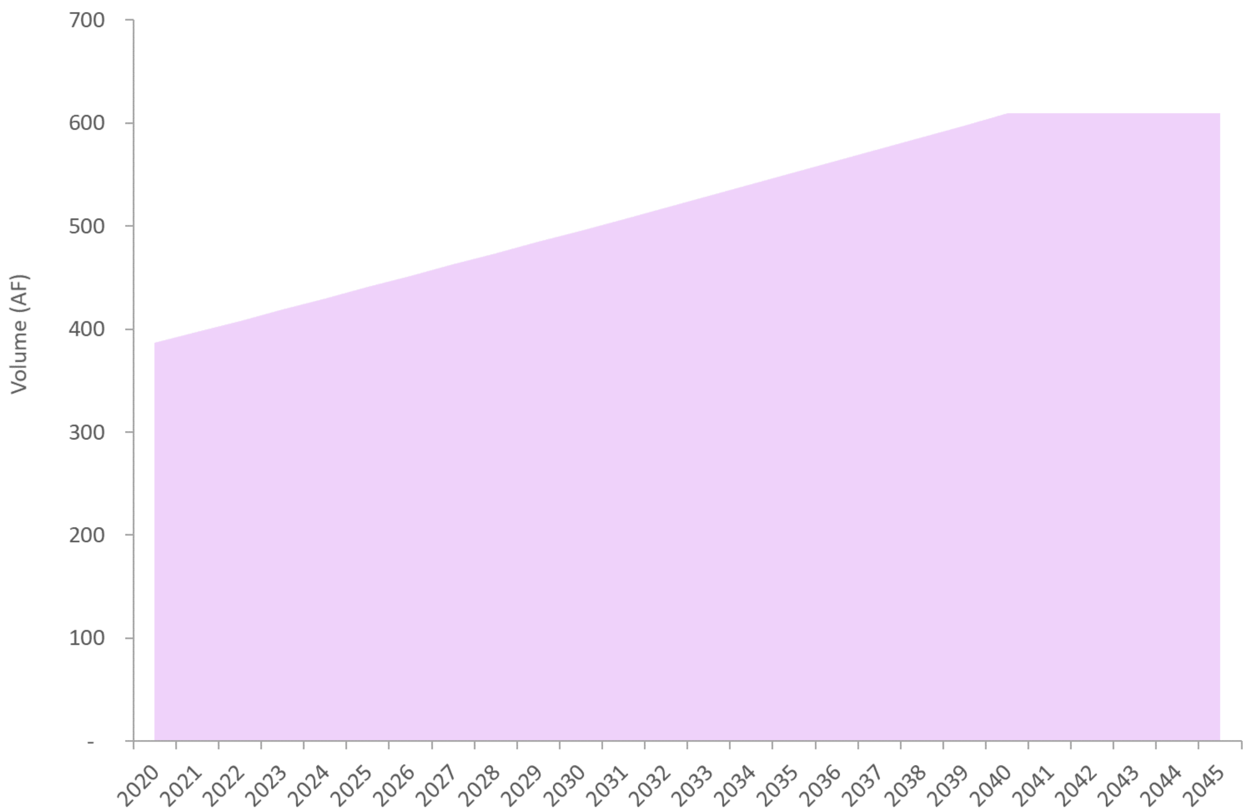
Year	Population	Residential Indoor (AF)	Residential Outdoor (AF)	CII (AF)	Unmetered Consumption (AF)	Recycled (AF)	Water Loss (AF)	Total Potable (AF) [B]	GPQ (AF)	Retailer Demands on Zone 7 (AF) [B]
2020 [A]	30,830	1,486	1,669	2,196	67	387	428	**5,845**	0	**5,845**
2025	34,965	1,644	1,681	2,258	70	441	447	**6,099**	0	**6,099**
2030	39,101	1,838	1,693	2,254	72	496	463	**6,320**	0	**6,320**
2035	43,236	2,033	1,705	2,249	75	552	479	**6,540**	0	**6,540**
2040	47,371	2,227	1,717	2,244	77	609	495	**6,760**	0	**6,760**
2045	47,371	2,227	1,717	2,244	77	609	495	**6,760**	0	**6,760**
Change from 2020-2045	16,541	741	48	48	10	223	67	**915**	0	**915**

Notes:

A. *2020 population is projected population at the end of the modeled 2020 development year and is higher than the 2020 population reported to SWRCB on 1/1/2020.*

B. *Development information was updated as of May 2021 based on conversations with the City's Planning Department, resulting in a net increase of 31 AF in total demands and 625 people at buildout. The net increases are not reflected in the table.*

Figure 5-10: City of Livermore Recycled Water Demands (Baseline Scenario)



5.1.4 Cal Water Livermore

Figure 5-11 shows a graph of population change (67,923 at buildout) compared to two alternate population projections: (1) 2015 UWMP population projections and (2) the same population growth patterns from the 2015 UWMP but with an adjusted 2020 starting point based on current service area population. Modeled population is similar to the buildout population projected in the 2015 UWMP.

Figure 5-12 shows a stacked area graph of the change in demands for Cal Water Livermore by water use sector. **Table 5-7** shows demands by sector in 5-year increments. CII water demands are projected to remain about the same as current, while Residential Indoor and Outdoor demand both drive the increase in total demands due to a projected partial drought rebound by 2025.

Figure 5-11: Cal Water Livermore Population Projections (Baseline Scenario)

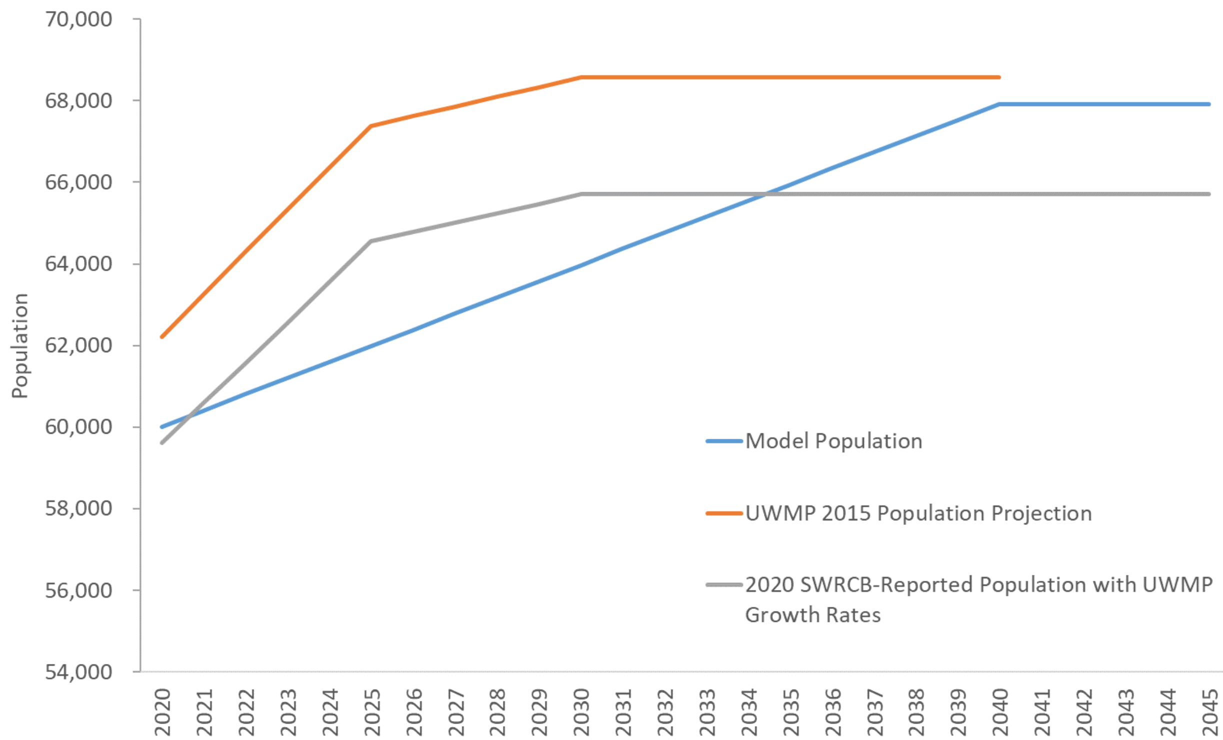


Figure 5-12: Cal Water Livermore Projected Demands by Sector (Baseline Scenario)

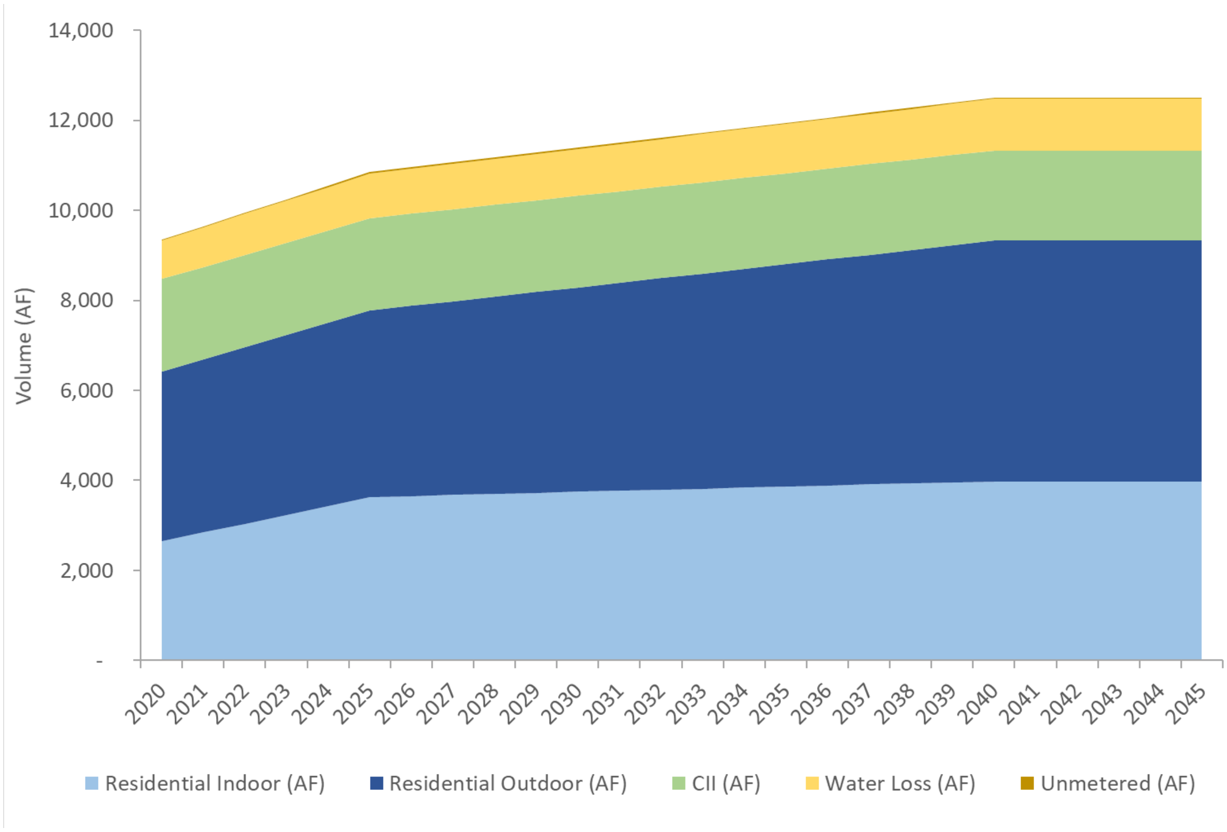


Table 5-7: Total Demands by Sector for Cal Water Livermore (Baseline Scenario)

Year	Population	Residential Indoor (AF)	Residential Outdoor (AF)	CII (AF)	Unmetered Consumption (AF)	Recycled (AF)	Water Loss (AF)	Total Potable (AF) [B]	GPQ (AF)	Retailer Demands on Zone 7 (AF) [B]
2020 [A]	60,008	2,655	3,763	2,059	21	0	857	**9,356**	3,069	**6,287**
2025	61,987	3,631	4,148	2,046	25	0	993	**10,843**	3,069	**7,774**
2030	63,965	3,747	4,541	2,031	26	0	1,043	**11,388**	3,069	**8,319**
2035	65,944	3,863	4,941	2,017	27	0	1,094	**11,942**	3,069	**8,873**
2040	67,923	3,979	5,350	2,002	28	0	1,146	**12,505**	3,069	**9,436**
2045	67,923	3,979	5,350	2,002	28	0	1,146	**12,505**	3,069	**9,436**
Change from 2020-2045	7,915	1,324	1,587	-58	7	0	288	**3,149**	0	**3,149**

Notes:

A. *2020 population is projected population at the end of the modeled 2020 development year and is higher than the 2020 population reported to SWRCB on 1/1/2020.*

B. *Development information was updated as of May 2021 based on conversations with the City's Planning Department, resulting in a net increase of 4 AF in total demands and 112 people at buildout. The net increases are not reflected in the table.*

5.2 Scenarios

The Model can be configured to run many different scenarios based on custom adjustments to the inputs. Details on the adjustments that can be made and how to implement them can be found in Appendix A. For the purposes of this study, five scenarios were run to represent a range of potential future conditions that could impact water demands. The five scenarios, along with the respective adjustments to the inputs, are summarized in **Table 5-8**, and described in more detail in the follow sections: New Normal (Section 5.2.1), Drought and Economic Rebound (Section 5.2.2), Economic Slowdown (Section 5.2.3), Growth Cycling (Section 5.2.4), and Recycled Water Expansion (Section 5.2.5). **Figure 5-13** and **Table 5-9** show the high-level summary of results by comparing total potable demands through time for each scenario against the baseline.

Table 5-8: Scenarios Summary

Parameter	Scenario				
	New Normal	Drought & Economic Rebound	Economic Slowdown	Growth Cycling	Recycled Water Expansion
Residential Indoor	Hold 2019 R-GPCD	⇧ to 55 gpcd by 2030 ⇩ to 50 gpcd by 2035	Hold 2019 R-GPCD	=	=
Residential Outdoor	⇩ 5%	⇧ 5%	=	=	=
CII	⇩ 5%	⇧ 5%	⇩ 5%	=	=
Water Loss	=	=	=	=	=
Passive Conservation	☑	☒	☑	☒	☒
Price Elasticity	☑	☒	☑	☒	☒
Active Conservation	=	=	=	=	=
Recycled Water	=	=	=	=	⇧ all "potential" deliveries
Economic Development	=	=	🕓 Delay 5 yrs	🕓 growth cycling	=
Climate Change	=	=	=	=	=

Table Legend:

⇩ **:** *decrease;* ⇧ **:** *increase;* = **:** *consistent with baseline;* ☑**:** *present;* ☒**:** *not present;* 🕓 **:** *change to growth rate*

Figure 5-13: High Level Scenarios Results (Total Potable Demands Compared to Baseline)

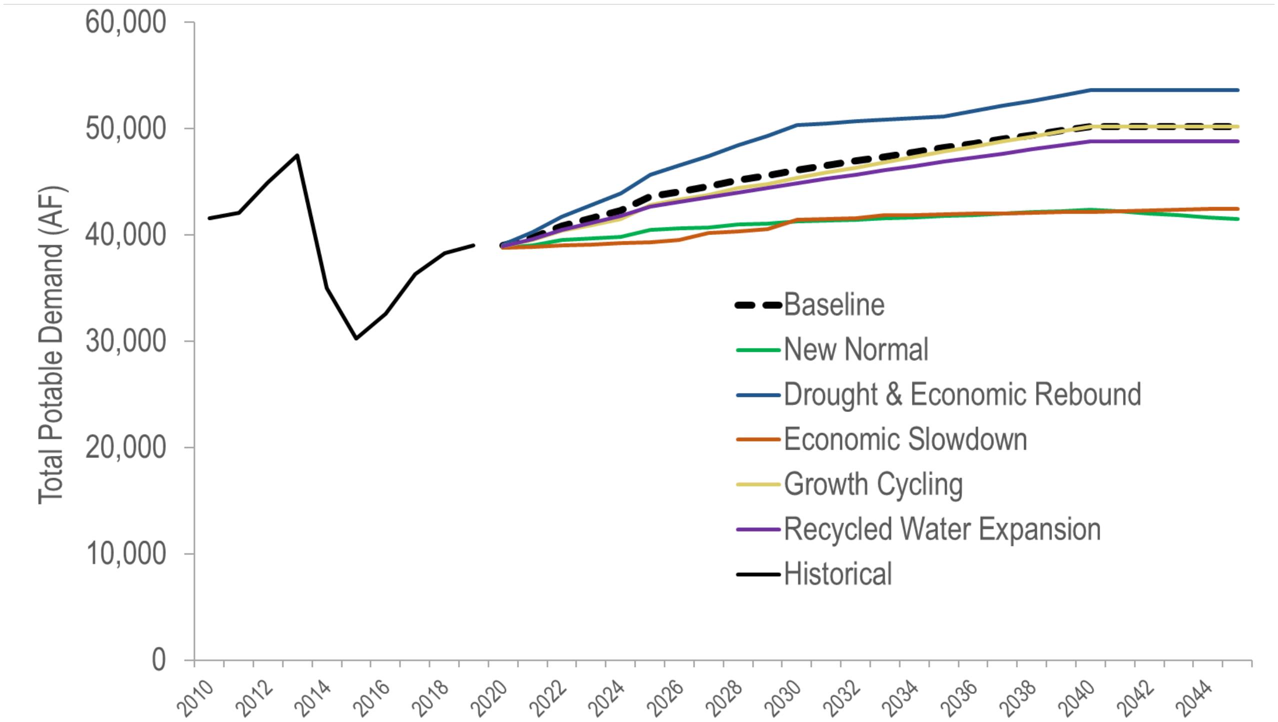


Table 5-9: Projected Total Retailer Potable Water Demands for Scenarios

Year	Baseline [A]	New Normal	Drought & Economic Rebound	Economic Slowdown	Growth Cycling	Recycled Water Expansion
2020	39,039	38,825	39,119	38,778	38,927	38,961
2025	43,612	40,482	45,628	39,321	42,849	42,654
2030	46,114	41,253	50,319	41,404	45,351	44,867
2035	48,216	41,771	51,158	41,946	47,834	46,909
2040	50,225	42,382	53,593	42,173	50,225	48,820
2045	50,225	41,489	53,593	42,481	50,225	48,820

Note:

A. *Baseline and scenarios reflect total retailer demands. GPQ has not been subtracted out from the total. To estimate the retailer demands on Zone 7, subtract 6,569 AF from the totals shown for 2025 and beyond.*

5.2.1 Scenario: New Normal

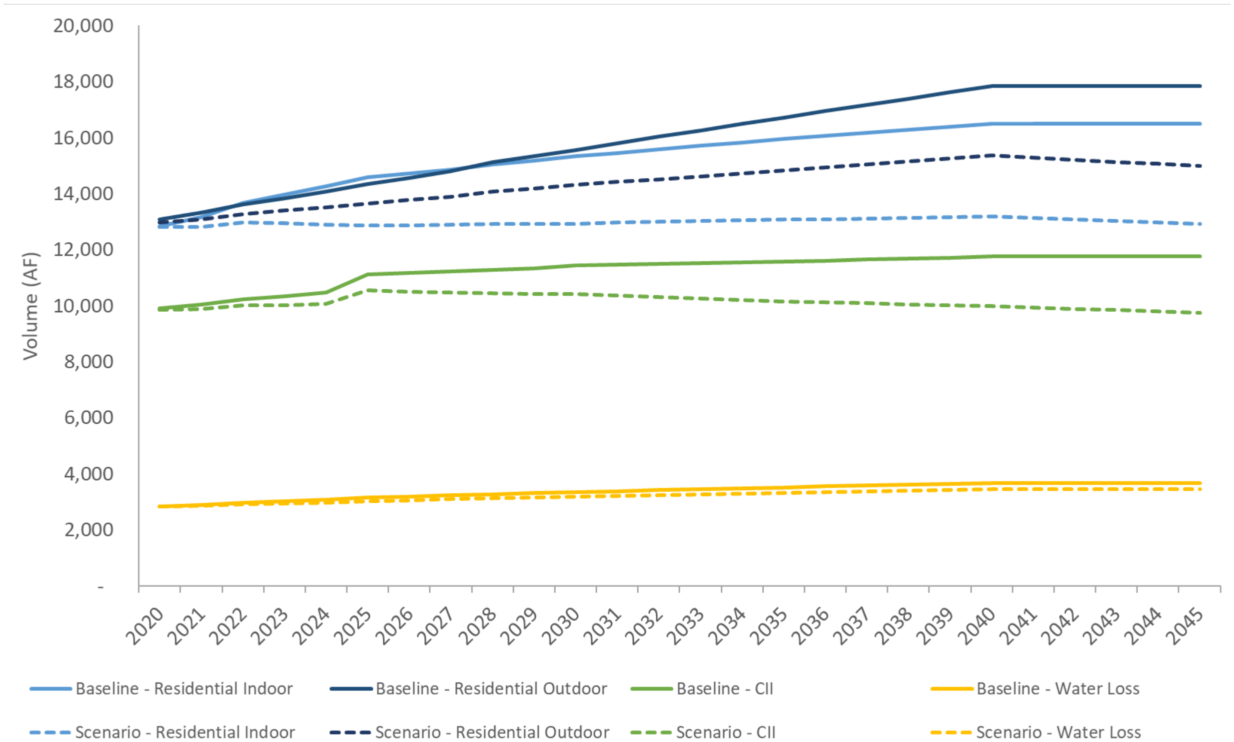
The New Normal scenario is meant to represent the low bound of potential water use where:

- Indoor water use remains at 2019 R-GPCD rates (no further rebound after the most recent drought).
- Residential Outdoor and CII water demands decrease slightly as a result of efficient behaviors from recent drought.

- Demand reductions from passive conservation (Section 4.1) and price elasticity (Section 4.2) are both accounted for.

Figure 5-14 shows the total potable demands summed for all retailers by sector (not including unmetered consumption) for the New Normal scenario (dashed line) compared with baseline (solid line).

Figure 5-14: Total Demands by Sector for Scenario "New Normal" vs Baseline



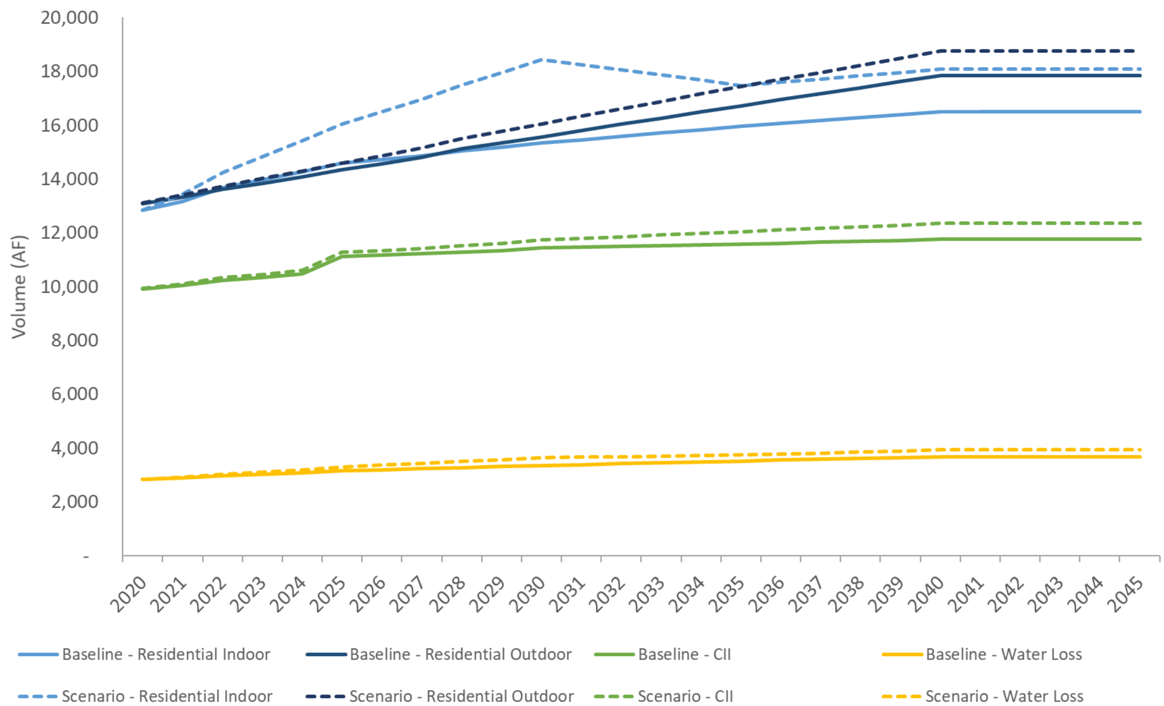
5.2.2 Scenario: Drought and Economic Rebound

The Drought and Economic Rebound scenario is meant to represent the high bound of potential water use where:

- Indoor water use increases and lags 5 years behind the current DWR proposed targets for indoor water use, meaning indoor R-GPCD goes to 55 gpcd by 2030 and then declines to 50 gpcd by 2035.
- Residential Outdoor and CII water demands increase slightly to reflect continued rebound after the recent drought.
- Demand reductions from passive conservation (Section 4.1) and price elasticity (Section 4.2) do not have an impact on total demands.

Figure 5-15 shows the total potable demands summed for all retailers by sector (not including unmetered consumption) for the Drought and Economic Rebound scenario (dashed line) compared with baseline (solid line).

Figure 5-15: Total Demands by Sector for Scenario "Drought and Economic Rebound" vs Baseline



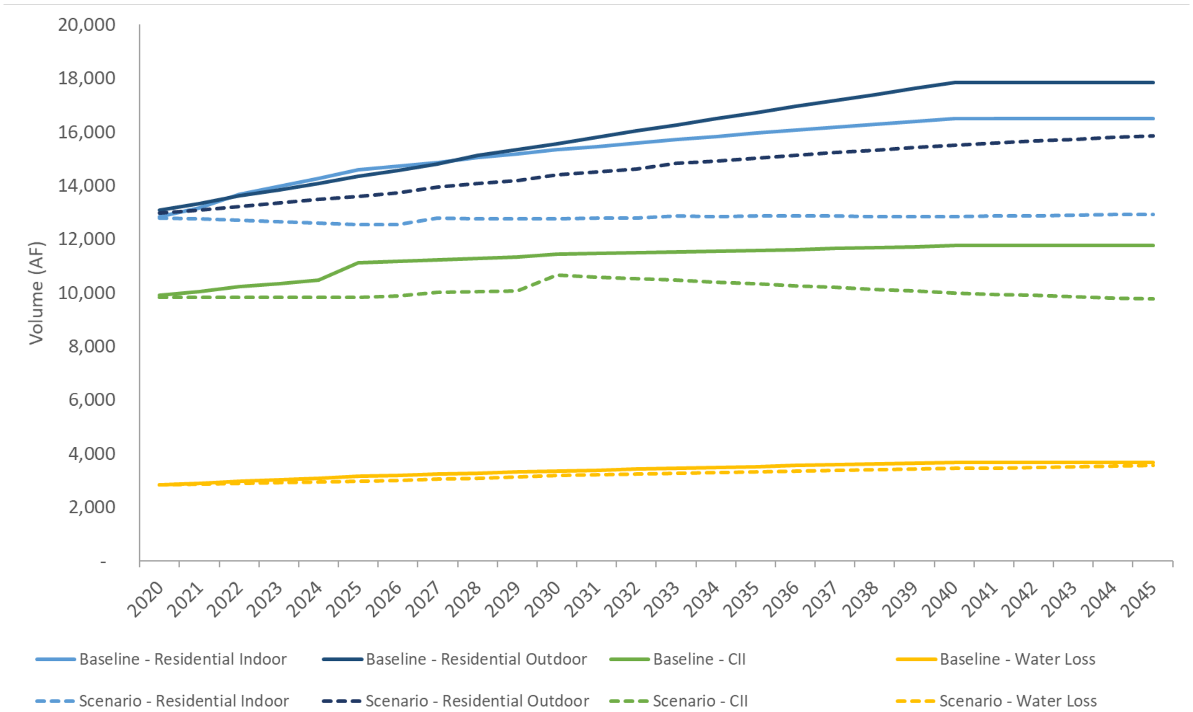
5.2.3 Scenario: Economic Slowdown

The Economic Slowdown scenario is meant to represent an alternative to the baseline scenario where there are several sources of water savings, but due to economic slowdown, the pace of development slows and takes longer to reach buildout:

- Indoor water use remains at 2019 R-GPCD rates (no further rebound after the most recent drought).
- No change to Residential Outdoor demands.
- CII water demands decrease slightly as a result of economic impacts.
- Demand reductions from passive conservation (Section 4.1) and price elasticity (Section 4.2) are both accounted for.
- Buildout is delayed by 5 years (flattening the rate of growth) and the expected online date for any known proposed developments is also delayed by 5 years.

Figure 5-16 shows the total potable demands summed for all retailers by sector (not including unmetered consumption) for the Economic Slowdown scenario (dashed line) compared with baseline (solid line).

Figure 5-16: Total Demands by Sector for Scenario "Economic Slowdown" vs Baseline

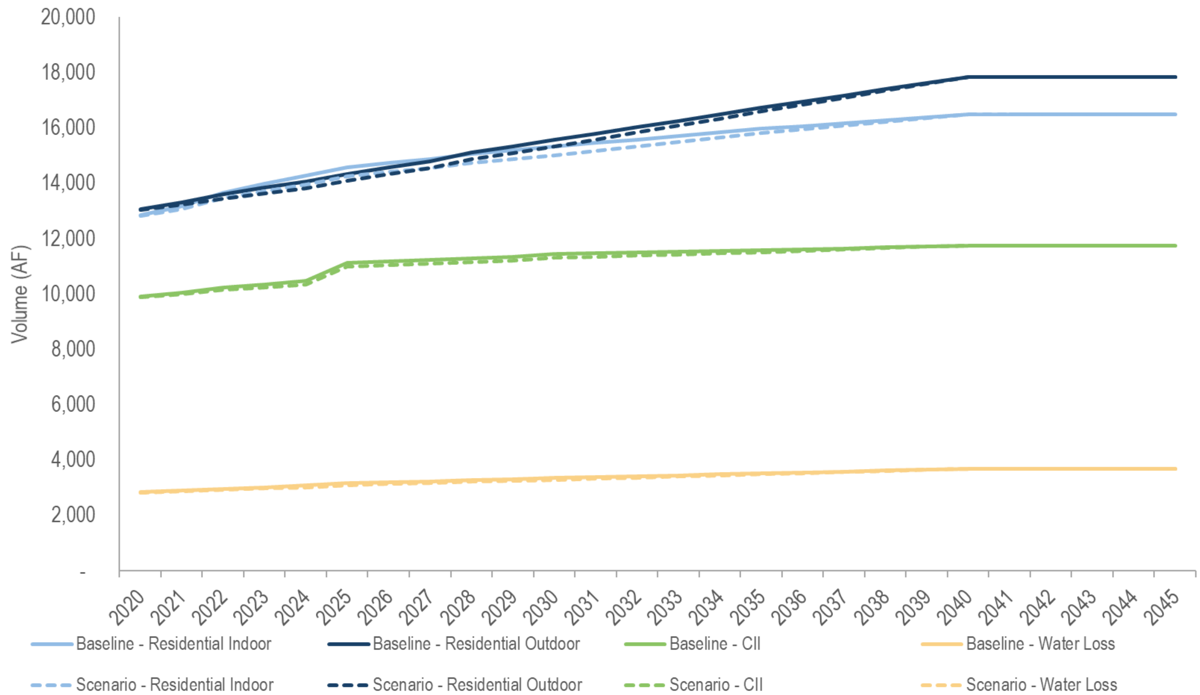


5.2.4 Scenario: Growth Cycling

The Growth Cycling scenario includes only one change from baseline demands: the rate of new growth is adjusted to mirror assumptions described in Zone 7's Connection Fee Program (Zone 7, 2017). Twenty percent of the growth in water demands expected in each of the first five years (2020-2024) is deferred and spread out evenly over a later 10-year period from 2031 to 2040. The baseline growth expected from 2025 to 2030 and 2031 to 2040 continues unchanged.

Figure 5-17 shows the total potable demands summed for all retailers by sector (not including unmetered consumption) for the Growth Cycling scenario (dashed line) compared with baseline (solid line).

Figure 5-17: Total Demands by Sector for Scenario "Growth Cycling" vs Baseline



5.2.5 Scenario: Recycled Water Expansion

The Recycled Water Expansion scenario includes only one change from baseline demands: parcels and zones that were tagged as "Potential" (see Section 4.4) are served recycled water for Residential Outdoor demands and the estimated portion of CII demands (outdoor) that could be met with recycled water. This results in approximately 1,500 AF of potable demand shifting to use recycled water supply.

Figure 5-18 shows the total potable demands summed for all retailers by sector (not including unmetered consumption) for while **Figure 5-19** shows the change in total recycled water demands for the Recycled Water Expansion scenario (dashed line) compared with baseline (solid line).

Figure 5-18: Total Potable Demands by Sector for Scenario "Recycled Water Expansion" vs Baseline

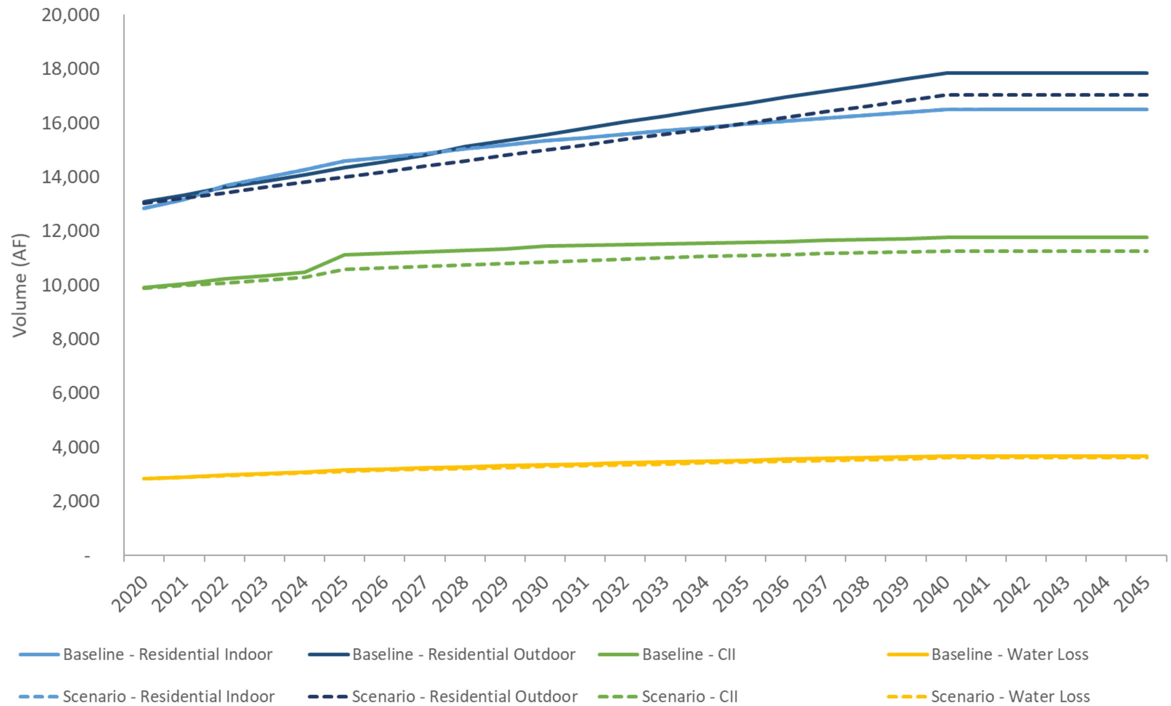
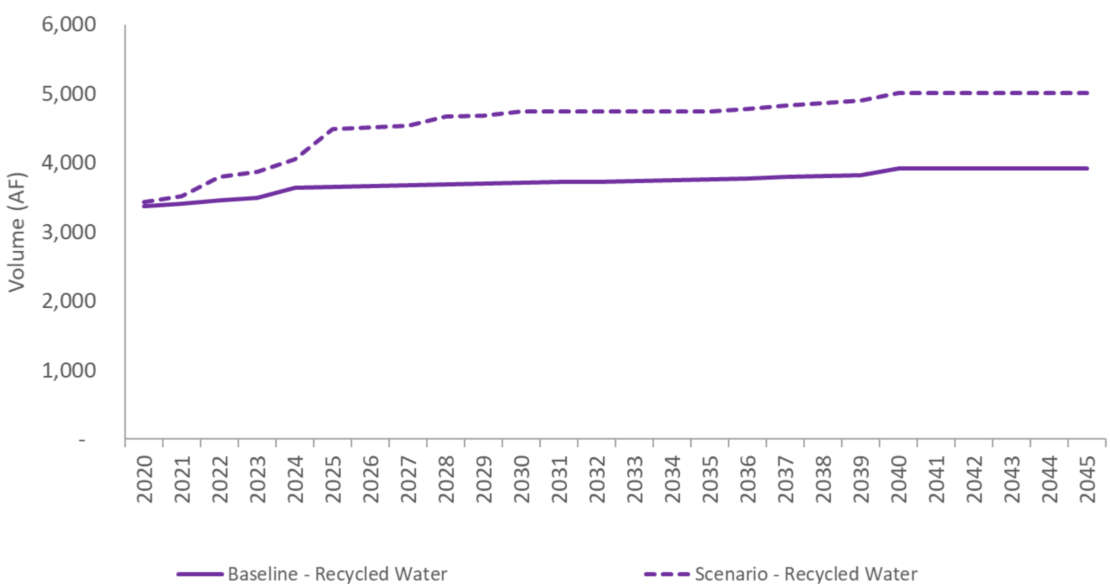


Figure 5-19: Total Recycled Water Demands for Scenario "Recycled Water Expansion" vs Baseline



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APPENDIX A: EXCEL MODEL USER GUIDE

2020 TRI-VALLEY MUNICIPAL AND INDUSTRIAL WATER DEMAND STUDY

Appendix A
Excel Model User Guide

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COMMITMENT & INTEGRITY DRIVE RESULTS

0011464.01
Zone 7 Water Agency
July 2021

TABLE OF CONTENTS

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TABLES

ACRONYMS

Acronym	Definition
AF	acre-feet
AFY	acre-feet per year
APN	assessor's parcel number
APR	Housing Element Annual Progress Report
CII	Commercial, Industrial, and Institutional
DSRSD	Dublin-San Ramon Services District
DU	dwelling unit
gal	gallons
GIS	Geographic Information System
GPCD	gallons per capita per day
GPLU	General Plan Land Use
HET	High Efficiency Toilet
HEDW	High Efficiency Dishwasher
HEW	High Efficiency Washer
R-GPCD	residential gallons per capita per day
ULFT	Ultra Low Flow Toilet
WDF	water demand factor

DEFINITIONS

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td>Region</td><td>Smallest unit of area with unique characteristics in the model - primarily used to separate Dublin from San Ramon in DSRSD and City of Pleasanton from Castlewood Country Club:
DSRSD-Dublin
DSRSD-SanRamon
CityOfLivermore
CityOfPleasanton
Castlewood
CalWaterLivermore
Note –input assumptions related to Castlewood were zeroed out because, at the time of publishing, the City of Pleasanton does not supply water to Castlewood. Castlewood continues to be mentioned throughout this document because it was built into the Model and can be turned on in the future, but by default does not generate water demands.</td></tr>
<tr><td>Agency</td><td>Corresponds with the unique agencies that provide water to each Region:
DSRSD
City of Pleasanton
City of Livermore
Cal Water Livermore</td></tr>
<tr><td>General Plan</td><td>City associated with the General Plan used for future land use type lookups:
City of Dublin
City of San Ramon
City of Pleasanton
City of Livermore</td></tr>
<tr><td>Gross R-GPCD</td><td>Base year residential indoor per capita usage before taking into account the effects of passive and active conservation.</td></tr>
</table>

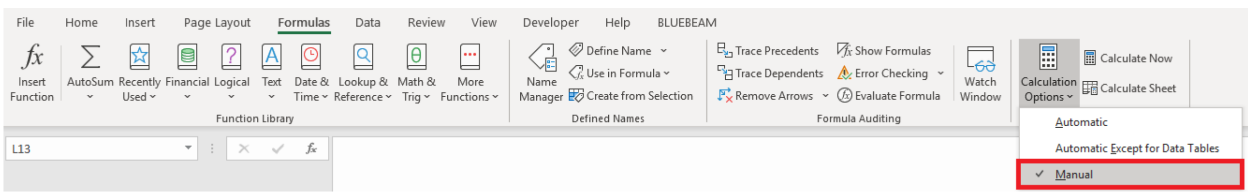
1. BACKGROUND

The regional, land-use based water demand forecasting model for the Tri-Valley Water Agencies (Model) was designed in Excel without the use of macros in an effort to increase transparency and allow the agencies to easily update inputs in the future as conditions change, new information is available, or as there is interest in running additional scenarios. The different chapters of this guide describe how each Model tab works and how to make updates.

1.1 General Model Use Instructions

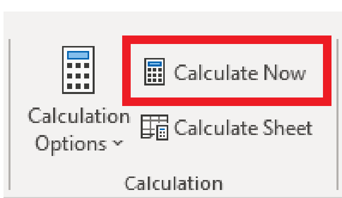
To use the Model, follow the general instructions below:

- As soon as the Model is opened, navigate to the "Formulas" tab, then the "Calculation" group, then to "Calculation Options," and ensure that "Manual" is selected:



    - This ensures that the Model will not begin running calculations while the user is making edits to Assumptions or Inputs.

- Navigate to the "Assumptions" tab to change the default inputs to the model.
- Navigate to the “Outputs” tab to view results. Each agency has its own labeled calculation tables and graphs.
- Click "Calculate Now" in the same "Calculation" section that was accessed earlier:



    - Note – the “Calculate Now” button is only necessary if changes have been made on other tabs besides “Outputs.” If the user is simply switching between agencies without making edits to inputs, the “Calculate Sheet” button is sufficient and runs significantly faster.

- To develop scenarios and make comparisons to default assumptions:
    - Visit the “Scenarios-Assumptions” tab to update assumptions that are different from the baseline "Assumptions" tab
    - Visit the “Scenarios-Outputs” tab to view and compare results

1.2 Tab Overview

Table 1-1 describes the various tabs in the Model which are described in more detail in the following sections of this document.

Table 1-1: Description of Model Tabs

Tab Name	Appendix Section	Description
Version	2	Tab where the latest version number can be documented as updates to inputs are made or if changes to model calculations are incorporated.
Instructions	N/A	Tab with Model overview and instructional information.
Assumptions	3	Main tab where user selects and edits various inputs that drive the model calculations.
DropDowns	N/A	Hidden tab with dropdown lists referenced elsewhere in model.
Development-Lookup	4	Tab with a list of all known development projects, allowing user to select a custom "Online Date" (year project will be built) and optionally override the default land use code.
OutdoorWDF-Override	5	Tab with list of known residential parcels and outdoor water demand factors calculated based on historical water consumption.
ParcelOverride	6	Tab with list of special case-by-case parcel numbers where user enters APN and an area adjustment (typically used to reduce the "active" area of an abnormally large parcel of land not currently or expected in future to be served in its entirety).
RecycledWater-Lookup	7	Tab with a list of parcels or GIS regions where recycled water is currently or could potentially be served. Optionally lets user enter in a known annual recycled water demand to override the default model calculations by land use type.
GeneralPlan-Lookup	8	Tab with all unique Land Use Codes from General Plans along with various assumptions about density, various categorizations, and weighting for multiple land use types per use code.
Model	9	Main tab where calculations occur. GIS data is pasted into this tab.
Outputs	10	Summary tab which summarizes annual growth in demands and population per agency.
Scenarios-Assumptions	11.1	Tab where alternate assumptions or adjustments to main assumptions can be entered to compare to the default scenario. One scenario can be evaluated at a time.
Scenarios-Outputs	11.2	Copy of the "Outputs" tab using the inputs from the "Scenarios-Assumptions" tab, with comparison graphs to the default scenario from the "Outputs" tab.

1.3 Updating from GIS Tool

New information can and should be incorporated into the Model. Many pieces of information can be incorporated via the various Model tabs described in the following sections. However, any new pieces of information contained in the list below will need to be updated in the GIS Tool (see Appendix B) before running the Excel Model:

- Changes in potential service area boundary
- Addition of development projects or recycled water zones where exact parcel numbers are not known and instead a boundary shape is defined (e.g., a neighborhood or pressure zone)
- Changes to General Plan land use layer
- Changes to current Alameda or Contra Costa County parcel boundaries

Appendix B contains the detailed instructions for importing updated GIS information into the Excel Model.

2. VERSION TAB

This is a straightforward tab in which the user can document the sequential version number of the model when inputs are changed or if formula calculations are updated.

	A	B	C
1	Version #	Date Created	Notes
2	1	4/2/2020	Base layout
3			
4			
5			

The latest version number is automatically picked up in the "Instructions" tab.

Tri-Valley Water Demand and Conservation Forecast Model	
Version 1; last updated 04/02/2020	
Cell Legend	
(yellow)	Assumptions that can be modified and impact calculations
(light orange)	Notes or reference information that doesn't directly impact calculations
(green)	Inputs from GIS

3. ASSUMPTIONS TAB

The "Assumptions" tab is where baseline default assumptions for the model are modified and updated. Each section below describes the various sections of the "Assumptions" tab as you scroll from left to right.

3.1 General

The General section contains tables that are used to adjust the base inputs to the model that cover more than one water use sector. Most of these will never need editing unless there is a major change to the model, such as adding a new service area. Below is a list of these tables with explanations for their purpose and use.

- Default Buildout Year
  - Changes the buildout year based on the Region.
    - NOTE for DSRSD, the default buildout year for Dublin and San Ramon must be equal.
- General Plan to Reference for Land Use Type Codes
  - Each Model Region must be assigned a General Plan – in some cases there is overlap of the same General Plan for multiple agencies (Cal Water Livermore and City of Livermore) and some agencies reference difference General Plans (DSRSD has service areas in Dublin and San Ramon.)
- Model Region Agency
  - Each Model Region is assigned an agency. This functions primarily to combine the Dublin and San Ramon Regions under DSRSD and City of Pleasanton and Castlewood under the City of Pleasanton.
    - *Note – input assumptions related to Castlewood were zeroed out because, at the time of publishing, the City of Pleasanton does not supply water to Castlewood. Castlewood continues to be mentioned throughout this document because it was built into the Model and can be turned on in the future, but by default does not generate water demands.*
- Climate Change Adjustment
  - The climate change adjustment can be used to increase or decrease outdoor irrigation (separately for residential and CII). As noted in the model, a positive (+) value increases outdoor irrigation and a negative (-) value decreases outdoor irrigation.
  - The "Effective Year" is the year in which the full percent change in outdoor demand takes place. The Model will linearly interpolate the effect of this percent change from the base year up through the entered Effective Year.
- Inputs for Connection Equivalent Calculations
  - Average Single-Family Consumption (AFY) – Average consumption (in AFY) by single family accounts in the base years period used to calculate service connection increases for the CII sector in units of dwelling unit equivalents in the "Outputs" tab.
  - Ratio of SFR/MFR Consumption – This value estimates the ratio between consumption in the Agency's average single-family vs multi-family home. It is used in the calculation of DUEs for service

connection equivalent growth in the "Outputs" tab to convert the count of MFR DUs to DUEs. The default value is 1.75, but agency-specific values can be replaced in future iterations of the Model if Retailers are able to provide the count of multi-family dwelling units associated with each billing account.[1]

- Groundwater Pumping Quota (GPQ)
  - Average annual GPQ can be entered per agency. This is used to calculate "Retailer demand on Zone 7" summary information in the "Outputs" tab.

3.2 Indoor Residential

The Residential Indoor section contains tables used to calculate population and water consumption for the indoor residential sector. Below is a list of these tables with explanations for their purpose and use.

- Gross R-GPCD
  - Gross Residential Gallons per Capita per Day (R-GPCD) refers to the average indoor water use per person per day for each agency. The "Gross" term means that estimates of R-GPCD should not include decreases due to passive and active conservation. Passive conservation is modeled separately in the Model. If the Tri-Valley Water Agencies have estimates of active conservation savings due to planned program activities, these can be entered as volumes elsewhere in the model.
  - Gross R-GPCD is projected in 5-year increments. On the Model's "Outputs" tab, the Gross R-GPCD is interpolated linearly between the 5-year checkpoints and multiplied by population in that year to calculate total indoor water use for that year.
  - Thus, any changes in Gross R-GPCD would typically be projected where changes in indoor use are expected due to drought, conservation messaging from the state or individual agencies that are not captured in Active Conservation education programs, or other influences not captured by passive and active conservation.
- People per Household
  - People per household is used to convert dwelling units (projected by general plan land use information) into population. It is estimated separately for each city.
  - This should be updated annually as more recent information becomes available from California Department of Finance or other local reporting sources.
- Population

[1] The default value of 1.75 comes from Water Research Foundation (WRF) Study 4554 ("Water Use in the Multi-Family Sector", 2018) that included an analysis of the ratio of single-family to multi-family per-unit consumption in a range of utilities around the USA. 1.75 is an estimated average of the values at five reported utilities.

- Population served by each agency as reported to the State Water Board in January 2020 or based on other local reporting sources. This is used for two purposes: (1) as a starting point for population interpolation calculations, and (2) to calculate Gross R-GPCD at base year.
- Current service population should match the base year water use and the model start year. If the base year water use and model start year are being updated, the current service area population should be updated as well.

- Housing Unit Information
  - Vacancy
    - Vacancy accounts for the fact that, at any given time, a percentage of homes are not occupied (for sale, between renters, etc.). Outdoor irrigation is expected to stay the same, but indoor use is assumed to be 0 for these homes.
    - This should be updated annually as more recent information becomes available from California Department of Finance or other local reporting sources.
  - Base Year Count of SFR and MFR Housing Units
    - Estimates for the base year count of single- and multi-family constructed dwelling units in each service area are used to help apportion the share of expected growth in single- and multi-family dwelling units from base year through buildout in the "Outputs" tab. This ratio is used in the calculation of dwelling unit equivalents for connection fee growth estimates.
- Base Year Indoor Water Use for Optional Use in Indoor R-GPCD Calculation
  - This is a reference table where a different set of values for indoor water use (e.g. for a historical range rather than most recent single year input) can be stored for use in calculation of an average indoor R-GPCD in the "Gross R-GPCD" table.

3.3 Outdoor Residential

- Base Year Outdoor Demand Factors
  - An area-based Outdoor Demand Factor is determined for single and multiple family sectors for each respective Region. Details on how this was calculated can be found in the main report.
- Elasticity of Demand and Future Assumption Values
  - Elasticity of Demand with Respect to Density
    - Described in the main Report – input the value per Region here. At the time of publishing, a single Tri-Valley region-wide value was calculated.
  - Elasticity of Demand with Respect to % Impervious
    - Described in the main Report – input the value per Region here. At the time of publishing, a single Tri-Valley region-wide value was calculated.
  - % Change Expected in Future Parcels for % Impervious Area

- Input the assumption for the percent change expected for percent impervious area for future homes. For instance, it might be expected that future lots will be smaller with a larger building footprint and less irrigable landscape. This causes a small change in the outdoor water demand factor based on the "Elasticity of Demand with Respect to % Impervious" value above.

3.4 Commercial, Industrial, Institutional

An area-based CII Demand Factor is determined for each land use category for each respective Model Region. The "Source/Notes" column describes the source of this estimation and is described further in the main report.

The "If RW available, what % of use is RW?" column is used to estimate what percentage of the water demand for each land use category could be met with recycled water if the parcel is located within a recycled water zone.

3.5 Water Loss

The Water Loss Rate table has two components:

1) The first four input rows are used to describe the current base year water loss values for each agency. Each agency must enter several loss rates (described below) as well as the number of service connections;– these values are typically reported in the annual AWWA water loss audits submitted to DWR.

    a. Real Losses (gallons per connection per day)

    b. Apparent Losses (gallons per connection per day)

    c. Unmetered Percentage of Total Demands

        i. This is calculated from the AWWA water loss audit as (Billed Unmetered volume + Unbilled Unmetered volume) / (Total Authorized Consumption volume).

    d. Base Year Number of Service Connections

2) The next 15 rows can be used to project future water loss rates for any agency in any year. The same agency can populate multiple rows in any order. By default, the Model will interpolate the water loss rate between input years. Two example model interpolation results are provided below, highlighting a gradual decline in water loss (**Table 3-1**) versus a sudden decline (**Table 3-2**).

Table 3-1: Example Water Loss Interpolation – Gradual Decline

Input Year	Input Water Loss Rate	Output Year	Output Interpolated Water Loss Rate
2019	30	2019	30
		2020	27
		2021	24
		2022	21
		2023	18
2024	15	2024	15
		2025	15

Table 3-2: Example Water Loss Interpolation – Sudden Decline

Input Year	Input Water Loss Rate	Output Year	Output Interpolated Water Loss Rate
2019	30	2019	30
		2020	30
		2021	30
		2022	30
2023	30	2023	30
2024	15	2024	15
		2025	15

3.6 Base Year Water Demands

The Base Year Water Demands section generates the base year water demands assumed at the start of the model projection period based on recent consumption history from each agency. Because the Model does not project irrigation as its own dedicated sector (there is no General Plan land use type for "irrigation"), the base year water demands as reported by the agencies are transformed slightly according the tables below:

- Base Year Water Use Before Distributing Irrigation
  - Requires inputs from each agency for Residential Indoor, Residential Outdoor, CII, Irrigation, and Recycled (if applicable).
- Distribution of Potable Irrigation Consumption
  - Describes the estimated split of irrigation use between CII and Residential Outdoor.
- Distributed Base Year Water Demand for Use in Outputs Tab
  - Displays the final base year water demand used in the "Outputs" tab as a starting point for interpolation to buildout. Residential Outdoor and CII are typically the only adjusted categories, as each have some share of potable irrigation from the first table.

3.7 Recycled Water

The Recycled Water section has two tables which help the Model project the total recycled water capacity. If total recycled water demands exceed the annual recycled water capacity, the surplus recycled water demands are allocated to potable demands.

- Recycled Water Capacity (Current)
  - Describes current annual recycled water capacity. Recycled water use not tied to parcels (e.g., recycled water fill station or recycled water use on medians/streetscapes that are not included as parcels in the GIS land use layers) is automatically subtracted out. These recycled water demands are not projected by the Model since they do not have a corresponding land use.

- The "RW Toggle" column is used to change whether the model will allocate all future recycled water demands to recycled water or potable water supplies according to the dropdown options below:
  - Active – all currently known parcels or zones being served recycled water will be served recycled water, up to the total capacity in that modeled year. These are identified as "RW Status for Model" = "Active" on the "RecycledWater-Lookup" tab.
  - Potential – Recycled water will be served (up to total capacity in the modeled year) to all currently known parcels/zones ("Active") plus any parcels or zones that are marked as "RW Status for Model" = "Potential" on the "RecycledWater-Lookup" tab.

- Recycled Water Capacity (Future)
  - This table projects the same information as the current capacity table but allows the user to enter the year this capacity becomes active in the "Effective Year" column. The model does NOT interpolate between the base year and effective year – the total capacity is static until it changes immediately on the effective year. Each agency can enter multiple effective years in any order if capacity is expected to change incrementally.

3.8 Rates and Price Elasticity

The Rates and Price Elasticity section has two tables which help the Model project the estimated change in demand due to changes in water rates.

- Projected Water Rates Increase (%)
  - The percent increase in water rates is entered for each agency by year (net increase after inflation).
- Price Elasticity
  - A value for price elasticity (unitless) is entered for each agency and sector.
    - The Residential Indoor and Residential Outdoor price elasticities can optionally be adjusted by weighting by the ratio of indoor and outdoor use at base year. Columns with information summarizing % indoor and % outdoor demands at base year is provided below the Price Elasticity table. Further information about this adjustment can be found in the main report.

3.9 Passive Conservation

The fixture saturation model which develops estimates of passive conservation savings is described in more detail in the main report. The two tables in this section are used to store the outputs from the fixture saturation model for Residential (Indoor) and CII in units of GPCD reduction relative to the starting point of the Model (2020). Instructions on how to update the values in this table can be found in Section 12.

3.10 Active Conservation

Tri-Valley Water Agencies that have modeled projections of the volume of demand reduction due to active conservation programming can enter them on an annual basis in this table. The demands must be split by residential indoor, residential outdoor, and CII sectors as they will be subtracted from the same sectors in the "Outputs" tab.

4. DEVELOPMENT-LOOKUP TAB

4.1 Fields Description

The "Development Lookup" tab is where agencies can enter information about known upcoming developments. Note that Section 13 of this Appendix provides information on the process for updating the tab on an annual basis as a result of new information from local planning authorities. The yellow highlighted columns are described below which have the potential to impact model calculations. The tan or white columns in the Model are used for storage of reference information only.

- Model Lookup ID
  - Can be populated with either the APN, the APN-15 (alternate APN formatting), or the "Development Area" populated by the GIS Tool.
- Agency
  - Must be selected from the dropdown options.
- Existing GPLU (if applicable)
  - Optional
  - The default General Plan Land Use (GPLU) code populated by the GIS Tool.
  - This value should be used when a single APN or Development Area contains multiple general plan land use type codes. Entering a specific code in this column means that the Online Year and GPLU Override will populate only on rows matching the input GPLU code if one is entered.
- Online Year
  - If known, the year that a particular development is expected to come online and begin using water can be entered in this column.
- GPLU Override
  - If the existing default General Plan land use code(s) for the parcel or Development Area are not accurate, an alternate land use code can be entered in this column.
  - The land use code entered must match a valid land use code on the "GeneralPlan-Lookup" tab for the same agency.
  - If the "Existing GPLU" column is filled in, the "GPLU Override" applies only to rows in the "Model" tab where the Existing GPLU exists within the respective APN, APN-15, or Development Area (e.g., some parcels have multiple rows with different existing land use codes and the "Development-Lookup" tab optionally allows the user to be specific about which portion they are overriding).
- Existing Population Estimate
  - If a development can be categorized as infill or there are already people living in a parcel or development area as of the Model base year, an estimate should be entered for the current population to aid in calculations on the "Outputs" tab.

- This is a semi-optional field. It does not need to be filled in for relatively small developments. Large developments with a significant number of expected dwelling units or a large area should enter an estimate of the existing population within the parcel/development area (as of the base year).

- Existing Outdoor Residential Demand Estimate (AFY)
  - If a development can be categorized as infill or there are already people living in a parcel or development area as of the Model base year, an estimate should be entered for the current outdoor residential demand to aid in calculations on the "Outputs" tab. This can be estimated by multiplying the parcel/development area (acres) by the appropriate agency's outdoor water demand factor.
  - This is a semi-optional field. It does not need to be filled in for relatively small developments. Large developments with a significant large area should enter an estimate of the existing demand within the parcel/development area (as of the base year).
- Existing CII Demand Estimate (AFY)
  - If a development can be categorized as infill or there is existing CII demand in a parcel or development area as of the Model base year, an estimate should be entered for the current CII demand to aid in calculations on the "Outputs" tab. This can be estimated by multiplying the parcel/development area (acres) by the appropriate CII water demand factor from the "Assumptions" tab.
  - This is a semi-optional field. It does not need to be filled in for relatively small developments. Large developments with a significant large area should enter an estimate of the existing CII demand within the parcel/development area (as of the base year).

Note that the three "Existing Estimate" values above effect only the timing of demands in the "Outputs" tab and do not change the overall buildout demands.

Note that the reference "Housing Units" column may be used in some cases to calculate a custom dwelling unit intensity on the "GeneralPlan-Lookup" tab.

4.2 Instructions for Adding New Rows

Fill in columns C (Model Lookup ID) and D (Agency) at a minimum.

Notes for usage:

- Column F ("Vlookup formula (do not edit)") will populate automatically for the first 1,000 rows of data. If additional rows are needed in the future, make sure to drag down the formula in column F to assist in lookup calculations running in the "Model" tab.
- There can be no blank rows between the first and last entry in the "Development-Lookup" tab (lookup formulas from the "Model" tab will count how many rows are populated in Column D in order to run formulas).

4.3 Development-Lookup vs GeneralPlan-Lookup tabs

The "Development-Lookup" and "GeneralPlan-Lookup" tabs are used in conjunction with one another when new development information becomes available. All new developments will need to be added to the "Development-Lookup" (whether via a specific APN or a GIS-assigned project name/number). If the existing General Plan land use type is not an appropriate reflection of the development type, then the "GPLU Override" column must be populated. There are two choices for what to enter in the "GPLU Override" column:

- Select a different existing GPLU from the "GeneralPlan-Lookup" tab. For instance, if a residential-zoned parcel is becoming institutional, it is likely a simple update to use an existing institutional land use code. Similarly, if a low-density parcel is being developed a at a higher density, there may be an existing GPLU for high-density residential that can be used for the "GPLU Override".

- If no existing GPLU in the "GeneralPlan-Lookup" tab exists that matches the development type (e.g. a unique mix of CII/residential or an unusual DU intensity), then you'll need to define a new row that matches the characteristics of the new development (see Section 8.2). The "GPLU Override" in the "Development-Lookup" tab needs to match the new "GPLU_Code" you enter in the "GeneralPlan-Lookup" tab.

    - Specifically for new custom residential land use types: some formulas exist on other custom residential GPLU rows that can be copied into the "Intensity (from data source)" and "Residential DUs/acre (for model)" columns to auto-calculate what the density should be to match the exact number of projected housing units in the new development.

5. OUTDOOR WATER DEMAND FACTOR OVERRIDE TAB

5.1 Fields Description

The “OutdoorWDF-Override” tab is where agencies can make adjustments for outdoor residential water demand factors on a case-by-case basis to override the default single or multiple family outdoor water demand factors. This allows agencies to account for known variations in residential outdoor water demand for existing parcels based on an analysis of historical water consumption and matching meter data to parcel(s). Any residential parcel not listed on this tab will default to using the outdoor residential water demand factors defined in the “Assumptions” tab.

- Agency
    - Used for reference.
- APN
- APN-15
    - Optional alternate formatting to APN, used for reference only.
- Outdoor Residential Water Demand Factor (AF/ac)

5.2 Instructions for Adding New Rows

Fill in columns B (APN) and D (Outdoor Residential Water Demand Factor (AF/ac)) at a minimum. There is no minimum or maximum number of rows.

6. PARCEL OVERRIDE TAB

6.1 Fields Description

The "Parcel Override" tab is where agencies can make adjustments on a case-by-case basis to reduce the area of parcels considered in the Model. The yellow highlighted columns are described below which have the potential to impact model calculations. The tan or white columns in the Model are used for storage of reference information only.

- APN
    - Enter the APN or APN-15 (alternate formatting)
- GPLU Code
    - Enter the general plan land use code for which the area should be reduced.
        - If the parcel has a GPLU Override from the "Development-Lookup" tab, make sure to enter the newly updated GPLU code.
    - This field is required because in many cases, one unique parcel may be split by two or more GPLU and only one should be altered. If all land uses for the parcel should be considered, then add multiple rows with the same APN but different GPLU Code.
- Percent Area to Include
    - Enter a percent (%) value for the area that should be considered in model calculations.
        - E.g., if a parcel has area of 100 ac and the "Percent Area to Include" is 25%, then all calculations proceed with an area of 25 ac for this parcel.
        - The model will accept increases in area as well, e.g., if a parcel has area of 100 ac and the "Percent Area to Include" is 200%, then all calculates proceed with an area of 200 ac for this parcel.

It is recommended that users fill out the "Notes" column with information about why this override was added and any supporting documentation or calculation values.

6.2 Instructions for Adding New Rows

Fill in columns A (APN), B (GPLU Code), and E (Percent Area to Include) at a minimum.

Notes for usage:

- Column C ("Vlookup formula (do not edit)") will populate automatically for the first 5,750 rows of data. If additional rows are needed in the future, make sure to drag down the formula in column C to assist in lookup calculations running in the "Model" tab.

7. RECYCLEDWATER-LOOKUP TAB

7.1 Fields Description

The "Recycled Water Lookup" tab is where agencies can enter information about current parcels or zones actively served recycled water as well as parcels or zones that could potentially be served recycled water in the future. The yellow highlighted columns are described below which have the potential to impact model calculations. The tan or white columns in the Model are used for storage of reference information only.

- Agency
  - Must be selected from the dropdown options.
- GIS Recycled Water Zone Name
  - If a "Recycled Water Zone (GIS)" is assigned to a parcel in GIS, it can be entered here.
    - Note – if this column is populated, do not populate the "APN" column for the same row.
- APN
  - If known, the APN (or APN-15 with alternate formatting) can be entered in this column.
    - Note – if this column is populated, do not populate the "Recycled Water Zone (GIS)" column for the same row.
- RW Status for Model
  - Enter "Active" or "Potential" for consideration in the model. These rows will generate recycled water use depending on their matching selection in the "RW Toggle" field in the "Assumptions" tab.
- Volume of Use (AFY)
  - If the volume of existing annual recycled water use is known at the parcel or zone, enter it here in units of AF. This use will be held constant for this parcel or zone for the entire planning horizon.
    - Total residential outdoor and CII recycled water use from the Model "Outputs" tab is summed in white columns to the right. If the "Volume of Use (AFY)" is filled in, the modeled recycled water demand (column names beginning with "Adjusted…") will be adjusted to match the known volume entered in "Volume of Use (AFY)".
    - If the parcel contains both modeled residential outdoor and CII recycled water demands (e.g., for parcels assigned a general plan land use code associated with mixed use), the known volume will be split proportionally to each sector by volume of modeled demand.

7.2 Instructions for Adding New Rows

At a minimum, you must fill in:

- Column A (Agency)
- Column B (GIS Recycled Water Zone Name) or C (APN)

- Column F (RW Status for Model)

Notes for usage:

- Columns L through T are responsible for summing total recycled water demands and will populate automatically for the first 5,000 rows of data. If additional rows are needed in the future, make sure to drag down the formulas in Column L through T to assist in the summation calculations running in the "Outputs" tab.
- There can be no blank rows between the first and last entry in the "RecycledWater-Lookup" tab (lookup formulas from the "Model" tab will count how many rows are populated in Column A in order to run formulas).

8. GENERALPLAN-LOOKUP TAB

8.1 Fields Description

The “General Plan Lookup” tab is where agencies can update assumptions about the unique land use codes provided by general plans. The yellow highlighted columns are described below which have the potential to impact model calculations. The tan or white columns in the Model are used for storage of reference information only.

- GPLU_Code
  - The unique general plan land use (GPLU) code provided by the GIS shapefile for the respective general plan. If available, the full description for the code can be found in the reference “Description” column.
- Residential DUs/acre (for model)
  - For any GPLU that has a residential component (e.g., may include some mixed use), the modeled number of dwelling units per acre is entered here. Often this is an average of a range of values specified by the general plan.
  - The reference “Source” and “Intensity (from data source)” columns can help provide more information about why this value was selected.
- Residential Type
  - For any GPLU that has a residential component, enter “Single” or “Multiple.” This selects which of the two Residential Outdoor Water Demand factors to apply.
- General Plan to Reference for Land Use Type Codes
  - Enter the City from which the GPLU came from; this must match the “General Plan to Reference for Land Use Type Codes” table in the “Assumptions” tab.
- Primary Land Use Category for CII Water Demand Factors
  - Enter the land use category under which the GPLU falls; this must match the “Land Use Category” in the “CII Demand Factor” table on the “Assumptions” tab.
  - This only applies for CII land uses; any GPLU that serves only residential (e.g., not mixed use) can be populated with “Residential Only.”
- Primary Weight
  - A percent value that describes how much to weight the land use type; for most straightforward CII uses this value should be 100%. For certain mixed uses, agencies can set this to less than 100% with the remainder covered by the Secondary Land Use and its Secondary Weight.
    - Note, however, that in some cases, the total percent weight may not add up to 100% if the GPLU is not expected to entirely be covered by CII use types (e.g., certain mixed use where residential uses are assumed to occupy some percentage of the parcel area). There are no

checks on total percentage, neither primary weight by itself nor primary plus secondary weights need to add up to 100%.

- Secondary Land Use Category for CII Water Demand Factors
    - Optional
    - See “Primary Land Use Category for CII Water Demand Factors”
- Secondary Weight
    - Optional
    - See “Primary Weight”

8.2 Instructions for Adding New Rows

At a minimum, for all land use types you must fill in:

- Column A (GPLU Code)
- Column J (General Plan to Reference for Land Use Type Codes)

At a minimum, for residential land uses you must fill in:

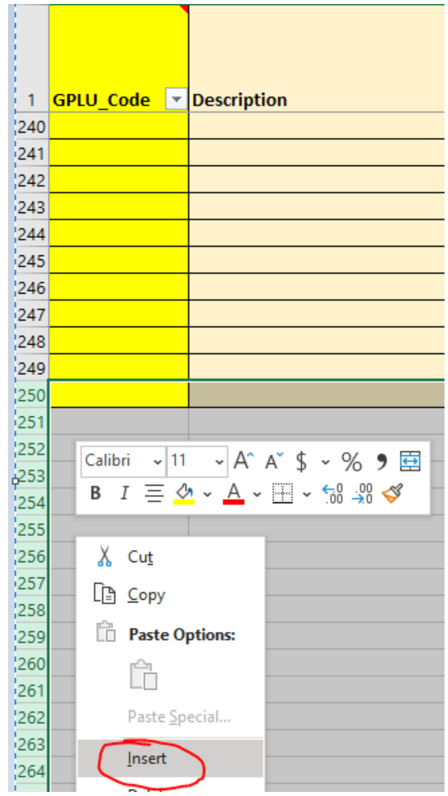
- Column G [Residential DUs/acre (for model)]
- Column H (Residential Type)
- Column F (RW Status for Model)

At a minimum, for CII land uses you must fill in:

- Column K (Primary Land Use Category for CII Water Demand Factors)
- Column L (Primary Weight)

Notes for usage:

- For GPLU Codes that appear to be numerical (e.g., with the City of Pleasanton), they must be entered as a text field in order to properly be referenced by formulas in the "Model" tab (the GIS Tool outputs format all GPLU as a text field). To format a number as text in Excel, enter the number in Excel with an equal sign and apostrophe before the number as shown below:
  - ='###
- Formulas in the "Model" tab reference up to the first 250 rows in the "GeneralPlan-Lookup" tab. If additional rows are needed in the future, the user can select row 250 and any number of rows needed below it (see screenshot to right) and then click "Insert." The model may lock up for 1-2 minutes while it updates formulas with the insertion.



9. MODEL TAB

The “Model” tab is where most calculations reside and where the GIS Tool outputs are copied. The calculations used in this tab are described throughout the main report.

Columns in the far right-hand side of this tab beginning with the word “SCENARIO” calculate values using alternate assumptions from the “Scenarios-Assumptions” tab.

10. OUTPUTS TAB

The "Outputs" tab is where the results are summarized each agency as well as the sum across agencies. The method used for interpolating population and water demands through buildout while taking into account known developments is described in the main report.

Summary Calculations

The bullets below describe the main highlighted sections (labeled in row 7 of the "Outputs" tab) and provide an overview of the calculation processing:

- Gross Indoor R-GPCD
  - Looks up the "Gross Indoor R-GPCD" in 5-year increments from the "Assumptions" tab and interpolates linearly so a value is populated for each year.
- Population
  - Sums the estimated increase in population each year due to known developments, calculates an adjustment growth rate for the next year, and then calculates the interpolated total population for the year based on baseline growth plus growth due to known developments.
- Buildout Demand Timing (Increases from Known Developments)
  - Sums the estimated increase in demands for each sector in a given year due to known developments. Two adjustments are made to this value:
    - Value is reduced if there are existing demands for a known proposed development (e.g., for infill development). This is described in more detail in Section 4.1 under fields named like "Existing ________ Estimate."
    - Value is reduced for Residential Outdoor and CII sectors by subtracting the minimum of the two inputs below:
      - Total recycled water demand associated with known proposed development in the given year. The default model estimation for demand is used rather than the adjustment if there is a known "Volume of Use (AFY)" for the recycled water zone.
      - Total recycled water demands (described in bullet below) for the zone after scaling adjustments for maximum recycled water capacity.
  - Recycled water demands are calculated two ways: they are summed first as "unadjusted for capacity" where total recycled water demands (residential outdoor or CII) are summed. The "adjusted for capacity" columns may be different if total recycled water demands were to exceed system capacity (checked separately in the "Recycled Water Factors" section described below.
- New Annual Growth Rate for Next Year
  - Calculates a growth rate for the next year by calculating:

$$\frac{(Buildout\ Demand - \ Current\ Year\ Interpolated\ Demand)}{(Buildout\ Year - Current\ Year)}$$

- Interpolated Total Demands (pre-climate change)
  - For Residential Outdoor, CII, and Recycled, this is calculated using the formula below:

$$D_{n-1} + G_{n-1} + I_A$$

Where
$D_{n-1} = Last\ Year's\ Demand$
$G_{n-1} = Last\ Year's\ New\ Annual\ Growth\ Rate\ for\ Next\ Year$
$I_A = Adjusted\ increase\ from\ known\ developments\ where:$
$i = Increase\ in\ demands\ from\ known\ developments\ before\ adjustment, and:$
$if\ i < G_{n-1}, then\ I_A = 0$
$if\ i > G_{n-1}, then\ I_A = G_{n-1} - i$
$if\ G_{n-1} < 0, then\ I_A = i$

- Climate Change Factors
  - Linearly interpolates the % change in outdoor demand due to climate change from the "Assumptions" tab from base year through the selected effective year.

- Interpolated Total Demands (with climate change, no conservation, no price elasticity)
  - For sectors effected by climate change:
    - Residential Outdoor: multiplies residential outdoor values from "Interpolated Total Demands (pre-climate change)" section by the residential outdoor climate change factor.
    - CII: Uses the value "Estimate % of CII which is Outdoor" to multiply a portion of the total CII use from "Interpolated Total Demands (pre-climate change)" section by the CII climate change factor. The remaining portion of CII use estimated to be indoor is carried through without adjustment.
    - Recycled: Starting with the recycled water projections from ""Interpolated Total Demands (pre-climate change)," multiplies the outdoor residential portion of recycled use by the residential climate change factor and multiplies the CII portion of recycled use by the CII climate change factor.
  - For Residential Indoor, calculates accordingly:

$$Population * \left(Gross\ Indoor\ RGPCD * \frac{AF}{325{,}851\ gallons} * \frac{365\ days}{year}\right) * (1 - \%\ Vacancy)$$

  - For Water Loss, calculates accordingly:

$$\#\ Service\ Connections * \left(\frac{Real\ Losses\ (gal)}{connection/_{day}} * \frac{AF}{325{,}851\ gallons} * \frac{365\ days}{year}\right)$$

- Recycled Water Factors
  - Looks up changes in recycled water capacity from the "Assumptions" tab and populates the total recycled water capacity for each year.
  - Interpolates the recycled water demand (unadjusted for capacity) to determine if a % reduction in demand is needed if recycled water demand exceeds capacity.
- Service Connections
  - OLD OUTDATED METHOD (column has been grayed out as of Model v5): Subtracts total potable base year demands from total potable "Interpolated Total Demands (with climate change, no conservation, no price elasticity)" and divides by the average single family consumption reported in the "Assumptions" tab. This converts the cumulative increase in demands into estimated dwelling unit equivalents as an estimate for the Zone 7 service connection fee study.
  - NEW: see "Connection Projection Calculations" section below.
- Water Loss Factors
  - Calculates the percent growth in potable demands and then scales up the base year number of service connections by the same growth rate.
    - Note – the formula prevents the percent growth in any given year from going below 0%.
  - Looks up changes in the water loss rate from the "Assumptions" tab and interpolates the water loss rate.
- Passive Conservation
  - Looks up the GPCD Reduction relative to base year in 5 year increments from "Assumptions" tab, then interpolates linearly.
  - Multiplies GPCD reduction by population and converts to AF.
- Active Conservation
  - Looks up the active conservation savings from the "Assumptions" tab.
- Interpolated Total Demands (with conservation, no price elasticity)
  - For Residential Indoor and CII:

$$[Interpolated\ Total\ Demands\ (w/climate\ change)] - Passive\ Conservation - Active\ Conservation$$

  - For Residential Outdoor:

$$[Interpolated\ Total\ Demands\ (w/climate\ change)] - Active\ Conservation$$

  - Recycled Water and Water Loss are carried through with no adjustment.

- Price Elasticity Adjustment
    - The percent change in demand due to price elasticity for each sector is calculated using the formula below:

$$\%\ Change\ in\ Demand = (1 + \%\ rate\ change)^{e}$$
$$where:$$
$$e = price\ elasticity\ of\ demand$$

- Cumulative savings from price elasticity
    - The adjustment due to the price elasticity adjustment is reported in cumulative volume savings using the formula before:

$$First\ year: Total\ Demands\ for\ Sector * (1 - \%\ Change\ in\ Demand\ Expected)$$
$$Subsequent\ years: (Total\ Demands\ for\ Sector - Cumulative\ Prior\ Savings) * (1 - \%\ Change\ in\ Demand\ Expected) + (Cumulative\ Prior\ Savings)$$

- Final Water Demands (with conservation, with price elasticity)
    - Performs subtraction calculation below:

$$[Interpolated\ Total\ Demands\ (with\ conservation, no\ price\ elasticity)] - [Cumulative\ savings\ from\ price\ elasticity]$$

- UWMP Projections
    - References UWMP projections for comparison purposes only (stored in the hidden “Calibration-Water” and “Calibration-Population” tabs).
    - By default, these are referencing 2015 UWMP demands considered during the initial development of the Model.
- UWMP Projections Interpolated
    - Interpolates the 5 year estimates from the “UWMP Projections” columns.
- 2020 SWRCB-Reported Population with UWMP Growth Rates
    - References interpolated population growth using 2015 UWMP growth rates applied to the 2020 SWRCB-reported population.
- GPQ impact calculations
    - GPQ (AF)
        - Looks up (on “Assumptions” tab) the average groundwater pumping quota for the retailer (if applicable).
    - Potable Demands Minus GPQ, no cons. or price elasticity (AF)
        - [Interpolated Total Demands (with climate change, no conservation, no price elasticity)] minus [GPQ]

- Potable Demands Minus GPQ, w/cons. & price elasticity (AF)
  - [Final Water Demands (with conservation, with price elasticity)] minus [GPQ]
- Zone 7 Delivery Request (AF)
  - Values reported by retailers for delivery requests upon Zone 7; referenced from the hidden "Calibration-Water" tab.
- Zone 7 Delivery Request + GPQ (AF)
  - [Zone 7 Delivery Request] + [GPQ]

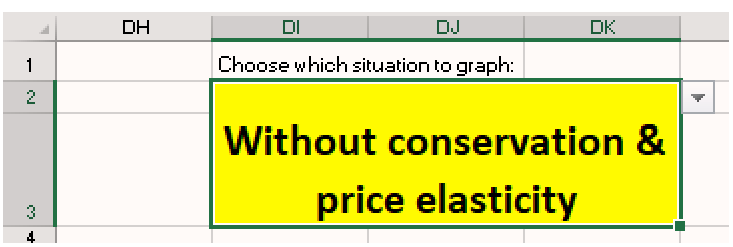
- Connection Projection Calculations
  - There are two separate sections. One for annual estimates of connection growth and one for total at buildout. The calculations for the individual annual estimates refer to some overall values that are calculated for the total at buildout, as described below. For example, the split in % of growth SFR vs MFR is calculated at buildout and then applied to each individual annual interpolation.
  - Annual Estimates (columns)
    - Total Dwelling Unit Growth = [Interpolated total population in year] / [Persons per Household] – [Estimated Occupied Base Year DUs]
    - SFR Dwelling Unit Equivalents = [Total Dwelling Unit Growth] * [% of growth SFR]
    - MFR Dwelling Unit Equivalents = [Total Dwelling Unit Growth] * [% of growth MFR]
    - CII Dwelling Unit Equivalents = ([Interpolated Total CII Demands (w/clim. chng., no cons., no price elast. in current year)] - [Interpolated Total CII Demands (w/clim. chng., no cons., no price elast. in Model base year)]) / [Average Single Family Consumption (AFY)]
    - Total Cumulative Growth in DUEs = (sum of last three columns above)
    - DUE Growth in year = [Cumulative growth of DUEs in current year] - [Cumulative growth of DUEs in previous year]
  - Buildout Estimates for Connection Projections (table underneath 5 year increment summaries)
    - Estimated Occupied Base Year DUs = Base Year Population / Persons per Household
    - Buildout DUs = Sum of DUs calculated per Agency at buildout in the "Model" tab
    - Growth in DUs = [Buildout DUs] – [Estimated Occupied Base Year DUs]
    - Estimated Occupied Base Year SFR DUs = [Lookup of total constructed single-family dwelling units in "Assumptions" tab] * [1 - Vacancy Rate]
    - Estimated Occupied Base Year MFR DUs = [Lookup of total constructed multi-family dwelling units in "Assumptions" tab] * [1 - Vacancy Rate]
      - Note that the Estimated Occupied Base Year DUs for SFR and MFR are only used for the purpose of calculating the "% of growth SFR/MFR" values below. The

sum of these values will not match the earlier total "Estimated Occupied Base Year DUs" because they are each calculated using different methodologies and for different purposes.

- Estimated Buildout SFR DUs = Sum of DUs calculated per Agency at buildout in the "Model" tab, filtered for single-family only based on estimation made per land use category in "GeneralPlan" tab
- Estimated Buildout MFR DUs = Sum of DUs calculated per Agency at buildout in the "Model" tab, filtered for multiple-family only based on estimation made per land use category in "GeneralPlan" tab
- % of growth SFR = [Growth in SFR units] / [Growth in SFR + MFR units]
- % of growth MFR = [Growth in MFR units] / [Growth in SFR + MFR units]
- Estimated Growth in SFR DUs (DUEs) = [Growth in DUs] * [% of growth SFR]
- Estimated Growth in MFR DUs = [Growth in DUs] * [% of growth MFR]
- Ratio of SFR/MFR Consumption = (see "Assumptions" tab description)
- Estimated Growth in MFR DUEs = [Estimated Growth in MFR DUs] / [Ratio of SFR/MFR Consumption]
- Average Single Family Consumption (AFY) = (SEE "Assumptions" tab description)
- CII DUEs = [Growth in CII demands from base year to buildout] / [Average Single Family Consumption (AFY)]

Summary Graphs and Tables

Cell DI2 on the "Outputs" tab allows the user to select via dropdown whether they'd like to see graphs with or without passive conservation and price elasticity effects. Values associated with and without conservation & price elasticity are calculated in the tables; this is just a selection for which to summarize in graph and table form.



11. SCENARIOS TABS

11.1 Scenarios-Assumptions Tab

This tab can be used adjust the default inputs from the "Assumptions" tab. Below is a list of the tables with explanations for adjustments that can be made.

- Shift Buildout Year or Development Online Year
    - Enter values to delay (+ years) or speed up (- years) growth.
    - The "Buildout" column will affect only the parcels where a development was not identified in the "Development-Lookup" tab an "Online Year" defined.
    - The "Development" column will affect only parcels where a development was identified in the "Development-Lookup" tab and an "Online Year" was defined.
- Climate Change Adjustment
    - Enter a new climate change adjustment. To enact no change from default, enter the same values from the "Assumptions" tab.
- Gross R-GPCD % Change
    - You have two choices on how to enter data:
        - In the "% Change in Gross Indoor R-GPCD" column, enter a negative % value to decrease the default gross indoor R-GPCD or a positive % value to increase the default gross indoor R-GPCD.
        - In the "Alternate R-GPCD (gpcd)" column, enter the new gross indoor R-GPCD value to use in the scenario. This will be transformed into a percent difference in the "% Change for use in calculations".
    - e.g. causing R-GPCD to become 55 gpcd in 2030 and 50 gpcd in 2035 would look like this:

Gross R-GPCD % Change

Agency	Year	Alternate R-GPCD (gpcd)	% Change in Gross Indoor R-GPCD	% Change for use in Calculations
DSRSD	2020			0%
DSRSD	2025		9%	9%
DSRSD	2030	55		18%
DSRSD	2035	50		7%
DSRSD	2040	50		7%
DSRSD	2045	50		7%

(where the yellow highlighted 9% for 2025 is a formula set to divide the calculated percent change in 2030 by two).

- Outdoor Demand Factor % Change
  - Enter a negative value to decrease the default water demand factor or a positive value to increase the default water demand factor.
- CII Demand Factor % Change
  - Enter a negative value to decrease the default water demand factor or a positive value to increase the default water demand factor.
  - In the "If RW available, what % of use is RW?" column, update the % value as desired. To enact no change from default, enter the same values from the "Assumptions" tab.
- Water Loss Rate
  - Enter new values for the water loss rates. To enact no change from default, enter the same values from the "Assumptions" tab.
- Recycled Water Capacity (Current)
  - This table allows you to change the "RW Toggle" only. Default base year recycled water capacity stays the same.
- Recycled Water Capacity (Future)
  - Enter new values into this table. To enact no change from default, enter the same values from the "Assumptions" tab.
- Projected Water Rates Increase (%)
  - Enter new values into this table. To enact no change from default, enter the same values from the "Assumptions" tab.

- Price Elasticity
    - Enter new values into this table. To enact no change from default, enter the same values from the "Assumptions" tab.

11.2 Scenarios-Outputs Tab

This tab operates in the same way as the "Outputs" tab (see Section 1), but uses alternate values pulled from the "Scenarios-Assumptions" tab. The major difference is that total water demands by sector have been pulled in from the "Outputs" tab for comparison in charts.

12. UPDATING THE FIXTURE SATURATION MODEL

12.1 When to Re-Run

The fixture saturation model should be updated any time there is:

- A major change in the population projections (see instructions in Section 12.2).
- A major change to the active conservation history or projections (see instructions in Section 12.3)
    - E.g., if updating the model annually, you should add in counts of the number of fixture replacements that occurred in the past year as a result of active conservation programs.

12.2 How to Update Population

NOTE – users are advised to not open the fixture saturation model and main demand forecast Model at the same time. Saving one workbook when having both open can cause Excel to crash.

Follow the instructions below to update the fixture saturation model population projections:

1. Open the fixture saturation model Excel workbook ("zone7_plumbfix_efficiency_model_v1.xlsx").
2. Navigate to the "2020 Service Area Population" tab.
3. Under the "Total Population Served" table, update the columns describing population projections in 5-year increments.
    a. A legend for the codes describing each agency is: CWSLIV = Cal Water Livermore; DSRSD = DSRSD; CITYLIV = City of Livermore; PLEAS = City of Pleasanton.
4. Follow the instructions in Section 12.4 to run the updated calculations and copy over the updated results into the main demand forecast Model.

12.3 How to Update Active Conservation History and Projections

NOTE – users are advised to not open the fixture saturation model and forecast demand Model at the same time. Saving one workbook when having both open can cause Excel to crash.

Follow the instructions below to update the fixture saturation model projections of active fixture replacement program activities. Note – entering these fixture counts updates the fixture saturation model estimates of fixture saturation only and does not include estimations of the water savings due to active replacements. Water savings from active replacements need to be calculated externally and entered into the "Active Conservation" section of the Model "Assumptions" tab (see Section 3.10).

1. Open the tabs listed below and enter the number of each respective fixture that were replaced historically or are expected to be replaced based on updated forecasts of program activity. Each row represents a year and each column represents a separate agency.
    a. Res ULFT Replacement
        i. Residential Ultra Low Flow Toilet - likely none, most are expected to be HET

b. Res HET Replacement

   i. Residential High Efficiency Toilet

c. Res Shwr (1.8-2.5) Replacement

   i. Residential Showerhead 1.8-2.5 gpm

d. Res Shwr LE1.8 Replacement

   i. Residential Showerhead less than 1.8 gpm

e. Res HEW Replacement

   i. Residential High Efficiency Washer (clothes washer)

f. Res HEDW Replacement

   i. Residential High Efficiency Dishwasher

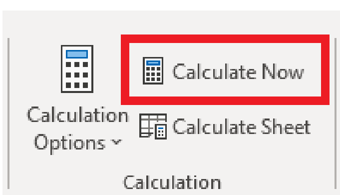
2. Follow the instructions in Section 12.4 to run the updated calculations and copy over the updated results into the main demand forecast Model.

12.4 How to Copy Over Updated Outputs into the Model

NOTE – users are advised to not open the fixture saturation model and forecast demand Model at the same time. Saving one workbook when having both open can cause Excel to crash.

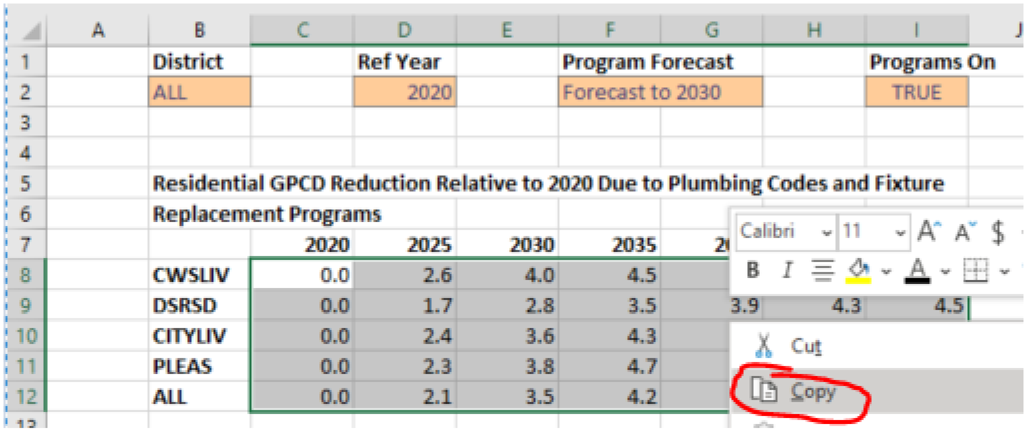
Follow the instructions below to update the fixture saturation model population projections:

1. Navigate to the "Fixture Efficiency Summary" tab.
2. Navigate to the "Formulas" tab in the Excel ribbon, then the "Calculation" group, then click "Calculate Now".

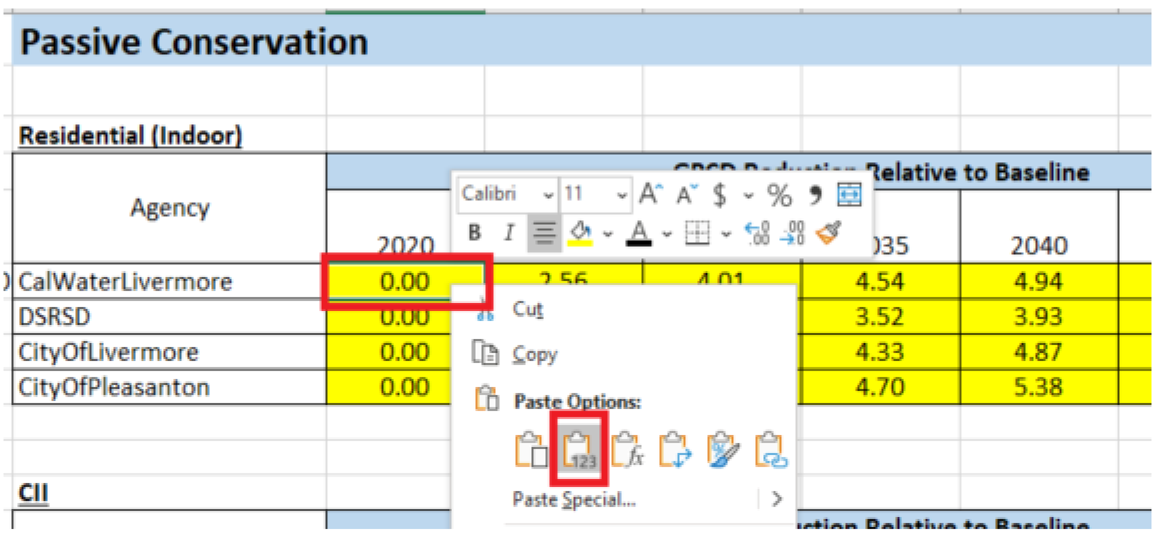


   a. It may take a minute for calculations to finish running. You should notice a message flash repeatedly in the bottom-right corner of the screen counting data tables being calculated like "Data Table: #." When this stops refreshing (about 15-20 data tables will be calculated), then the calculations are complete.

3. In the top-left corner of the "Fixture Efficiency Summary" tab, select the values reported in the table titled "Residential GPCD Reduction Relative to 2020 Due to Plumbing Codes and Fixture Replacement Programs," right-click, and select "Copy."



4. Navigate to the “Residential (Indoor)” table under the “Passive Conservation” section of the “Assumptions” tab of the main Excel Model. Right-click in the top-left yellow highlighted cell, right-click, and select Paste (as values).



5. Repeat steps 3 and 4 to copy the values from the “Non-Residential GPCD Reduction Relative to 2020 Due to Toilet and Urinal Plumbing Codes and Fixture Replacement Programs” in the fixture saturation model into the “CII” table in the Excel Model.

13. UPDATING THE DEVELOPMENT-LOOKUP TAB

13.1 When to Update

The Development-Lookup tab should be updated when one of the following occurs:

- A Tri-Valley Water Agency or City Planning Department makes Zone 7 aware of a new planned development or significant changes to an existing planned development that would likely have impacts on projected water demands.
- A City Planning Department publishes a Housing Element Annual Progress Report for submission to the California Department of Housing and Community Development (HCD) (typically annually in the spring).

13.2 How to Screen and Import Information from the Housing Element Annual Progress Report

Follow the instructions below for general guidance on how to screen and import information about proposed, entitled, and constructed housing developments summarized in a city's Housing Element Annual Progress Report (APR):

Note – it is recommended that you attempt to get a copy of the latest parcel dataset from the County Assessor's office and update the GIS model (see Appendix B) and Excel Model with the latest parcel numbers before screening and importing information from the Housing Element APR. It is likely some parcels are newly subdivided or renumbered as reflected in the APR and may not show up in the existing/prior GIS layer.

1. Obtain an Excel version of the appropriate agency's Annual Progress Report. This is typically populated in a standardized template provided by the California HCD. If only a PDF is available, information will need to be manually copied or exported to Excel format.

2. Navigate to the "Table A2" tab which summarizes units issued entitlements, units issued building permits, and units issued certificates of occupancy.

3. Copy the data into the "Annual Report Screening and Import Template" Excel workbook, columns I through BA. Drag down to apply the formulas in columns A through H to each row (see screenshot below).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		Name of Model File:	Zone7Model_v5.xlsx												
2		APR Year:	2020												
3		# Years to Online for Entitlements:	5												
4		# Years to Online for Permits:	3						Copy data here from Housing Element Annual Progress Report:						
5	Parcel Number match in Model?	Sum of Dwelling Units Currently Projected in Model	Parcel Number Match in DevelopmentLookup tab?	Number of Units in Annual Progress Report	Difference in Units (+ =model over, - =model under)	Proposed Online Year	Development Area Defined in GIS	Existing GPLU Defined in GIS	Prior APN+	Current APN	Street Address	Project Name+	Local Jurisdiction Tracking ID+	Unit Category (SFA,SFD,2 to 4,5+,ADU,MH)	Tenu R=Re r O=Ow r
6	Y	186.0	Y	186	0.0	2025		SC		099 002300800	LASSEN RD		SPDR18-0	SFA	O
7	Y	68.7	N	56	12.7	2020	22A	HI/UH-3		099B576001300	1023 WESTWINDST			5+	
8	Y	34.4	Y	34	0.4	2023		DA		097 000300701	1900 First ST			5+	
9	Y	27.3	Y	24	3.3	2025		OC		098 024000117	460 N LIVERMOREAVE		SPDR19-0	5+	R
10	N	0.0	N	13		2020				903 001708600	801 TRANQUILITYCI			SFA	
11	Y	8.0	Y	8	0.0	2025		DA		097 001800600	2108 THIRD ST		DDR18-02	5+	O
12	N	0.0	N	7		2020				099 139004400	102 APRICOT ST			SFA	
13	N	0.0	N	7		2020				099 139006400	201 PLUM TREE ST			SFA	
14	Y	6.5	Y	6	0.5	2023		SC		099 139000600	116 APRICOT ST			SFA	
15	Y	6.3	Y	6	0.3	2023		DA		098 024900400	1702 PEDROZZICM			SFA	
16	N	0.0	N	5		2023				099 139008300	232 PLUM TREE ST			SFA	
17	Y	4.8	Y	5	-0.2	2023		SC		099 139000700	242 PLUM TREE ST			SFA	
18	N	0.0	N	5		2020				099 139003600	111 APRICOT ST			SFA	
19	N	0.0	N	5		2020				099 139003800	121 APRICOT ST			SFA	
20	Y	5.1	Y	5	0.1	2020		SC		099 139000800	131 APRICOT ST			SFA	
21	N	0.0	N	5		2020				099 139007800	222 PLUM TREE ST			SFA	
22	Y	3.7	Y	4	-0.3	2025	31	UM		099B510000500	1080 CENTRAL AV		SPDR18-0	SFD	O
23	Y	4.0	Y	4	0.0	2023	Transition	BCP		903 001521200	609 SANDALWOODDR			SFA	
24	Y	4.6	Y	4	0.6	2023	Transition	BCP/UH-4		903 001722300	649 SANDALWOODDR			SFA	

4. Open the latest Model at the same time and put its file name in the highlighted cell C1, formatted like "Zone7Model_v5.xlsx". Fill in the APR Year, # Years to Online for Entitlements, and # Years to Online for

Permits highlighted cells as well. These "# Years" are estimates for how long of a lag there is between entitlements/permits and going online – they should be updated if more specific information is known. Then click "Calculate". The screening template will automatically do the following in the listed columns:

a. Parcel Number match in Model?

    i. Check's the Model's main "Model" tab to see if the APN was present in the GIS file from the Assessor's office. If "N," then it hasn't officially been subdivided yet or is otherwise missing from the water service area boundary.

b. Sum of Dwelling Units Currently Projected in Model

    i. Sums the number of DUs currently projected in the Model's "Model" tab, regardless of whether there are existing "DevelopmentLookup" tab assumptions or if it's just based on General Plan defaults.

c. Parcel Number Match in DevelopmentLookup tab?

    i. Checks the Model's "DevelopmentLookup" tab to see if the APN already is listed and likely has assumptions associated with it. NOTE – if the APN is located within a development area defined in GIS, it may not be flagged.

d. Number of Units in Annual Progress Report

    i. Displays the maximum number from the columns "# of Units issued Entitlements," "# of Units Issued Building Permits," and "# of Units issued Certificates of Occupancy or other forms of readiness."

e. Difference in Units (+ =model over, - =model under)

    i. If "Parcel Number match in Model?" = Y, then calculates:
        1. [Sum of Dwelling Units Currently Projected in Model] – [Number of Units in Annual Progress Report]

f. Proposed Online Year

    i. If the maximum number of units is within the "# of Units issued Certificates of Occupancy or other forms of readiness" column, populates with the APR Year.
    ii. If the maximum number of units is within the "# of Units Issued Building Permits" column, populates with the [APR Year] + [# Years to Online for Permits]
    iii. If the maximum number of units is within the # of Units issued Entitlements" column, populates with the [APR Year] + [# Years to Online for Entitlements]

g. Development Area

    i. Checks the Model's "Model" tab to provide the Development Area if defined in GIS as reference.

h. Existing GPLU Defined in GIS

    i. Checks the Model's "Model" tab to provide the GPLU assigned in GIS as reference.

5. Apply the following filters:

    a. "Parcel Number match in Model?" = "Y"

    b. "Parcel Number Match in DevelopmentLookup tab" = "N"

c. “Unit Category” does not equal “ADU”

d. “Number of Units in Annual Progress Report” > 1

6. Then, review the remaining rows for potential inclusion in the “DevelopmentLookup” tab.

    a. Generally, if the "Difference in Units” is < 3 or so, it’s probably not worth exploring further as there is minimal impact on Model results from importing new development information into the “DevelopmentLookup” tab.

    b. For others, it is generally recommended to review the “Development Area Defined in GIS” and “Existing GPLU Defined in GIS” columns if there is a potential existing Development Area or particular land use type already defined.

        i. For instance, if an APN is part of a larger housing development project with an overall defined dwelling unit density, it may not be necessary to update a particular parcel or small set of parcels given that the whole project is likely already defined and modeled accurately.

    c. If it makes sense to apply a General Plan Land Use override, follow the general instructions in Section 4.2 to add a new row with the APN and reference information needed.

        i. At a minimum, you need to fill out “Model ID” and “Agency” columns. You will likely need to populate the “Housing Units” reference column. You may also choose to copy over the “Proposed Online Year” column.

        ii. If you can assign a GPLU override based on an existing GPLU with a similar DU/ac density, do that! If no existing GPLU exists with a similar DU/ac density, you can add a new row to the “GeneralPlan-Lookup”. Some formulas exist on other custom residential GPLU rows that can be copied into the “Intensity (from data source)” and “Residential DUs/acre (for model)” columns to auto-calculate what the density should be to match the exact number of projected housing units.

7. Apply the following filters:

    a. “Parcel Number match in Model?” = “Y”

    b. “Parcel Number Match in DevelopmentLookup tab” = “Y”

8. Then, look up the flagged APNs in the “DevelopmentLookup” tab to review existing assumptions for updating as-needed if the “Difference in Units” is >3.

APPENDIX B: GIS TOOL UPDATE GUIDE

2020 TRI-VALLEY MUNICIPAL AND INDUSTRIAL WATER DEMAND STUDY

Appendix B
GIS Tool Update Guide

WOODARD & CURRAN

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woodardcurran.com
COMMITMENT & INTEGRITY DRIVE RESULTS

0011464.01
Zone 7 Water Agency
July 2021

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FIGURES

1. BACKGROUND

A GIS Tool was developed in ArcGIS Pro using ModelBuilder to process the spatial data in Zone 7 Water Agency's service area necessary to develop a land-use based water demand forecast model in Excel (Model). The GIS Tool exports an Excel file that is used as the input to the Excel demand forecast model. **Figure 1-1** shows an overview of the GIS Tool.

This Appendix describes how the GIS Tool works (processing by region in Sections 1.1 through 1.6 and inputs in Section 2) as well as how to run the GIS Tool and update the Excel Model (Section 3).

A high-level description of the GIS Tool processing for each region is described below. After the steps below are completed, the results for each agency are merged together into one shapefile, rows with less than 0.01 acres are removed, and the results are exported to an Excel file. It is this exported Excel file that becomes an input into the Excel demand forecast Model.

1.1 DSRSD – City of Dublin

1. Clip Alameda County parcel map to DSRSD service area boundary.
2. Split parcels into multiple pieces if they have multiple overlying General land use types.
3. Split parcels into multiple pieces if they have multiple overlying future developments from DSRSD's custom future development plans shapefile.
4. Spatial join on General Plan land use category.
5. Spatial join on DSRSD's custom future development plans shapefile to pull in SiteNo for every current parcel (if available).
6. Assign the SiteNo to both the Development and RWZone fields in the final GIS Tool output file.

1.2 DSRSD – City of San Ramon

1. Clip Contra Costa County parcel map to DSRSD service area boundary.
2. Split parcels into multiple sections if they have multiple overlying future developments from DSRSD's custom future development plans shapefile.
3. Spatial join on General Plan land use category.
4. Spatial join on DSRSD's custom future development plans shapefile to pull in SiteNo for every current parcel (if available).
5. Assign the SiteNo to both the Development and RWZone fields in the final GIS Tool output file.

1.3 City of Pleasanton

1. Clip Alameda County parcel map to City of Pleasanton service area boundary.
2. Split parcels into multiple pieces if they have multiple overlying General Plan land use types.
3. Spatial join output from #2 on General Plan land use category.

4. Spatial join on Specific Plan boundary and assign Specific Plan name to the Development field in the final GIS Tool output file.

1.4 Castlewood Country Club

Note – input assumptions related to calculations of consumption for Castlewood are zeroed out in the Excel Model because, at the time of publishing, the City of Pleasanton does not supply water to Castlewood. Castlewood continues to be mentioned throughout this document because it was built into the Model and can be turned on in the future, but by default does not generate water demands.

The Castlewood Country Club was processed by creating a one-time custom shapefile for this region for use in further GIS Tool processing:

- Selected all rows in the City of Pleasanton 2017-2019 billing data where AcctType = CW - CASTLEWOOD SERVICE AREA. The APNs were found in the Alameda County parcel dataset primarily by looking up the Pleasanton billing data street address (only 1 row already had an APN). Not every address could be matched to an APN; unmatched addresses were not mapped directly in GIS.
- Mapped parcels in GIS (match by APN in Alameda County parcel dataset). Note - there were clearly gaps in the mapping where certain parcels had not been found based on address in the billing system.
- Manually selected all parcels (via polygon select tool) that appeared to be within Castlewood Country Club zone (i.e., selected any parcels surrounded by or adjacent to a group of parcels that were tagged in the billing system).
- Clipped all selected parcels such that they were outside of the existing City of Pleasanton potential service area boundary shapefile (to avoid later double-counting of area in the Excel Model).

The only processing that occurs in the GIS Tool every time it is run (since the input file has already been created):

1. Spatial join on General Plan land use category (City of Pleasanton General Plan data).

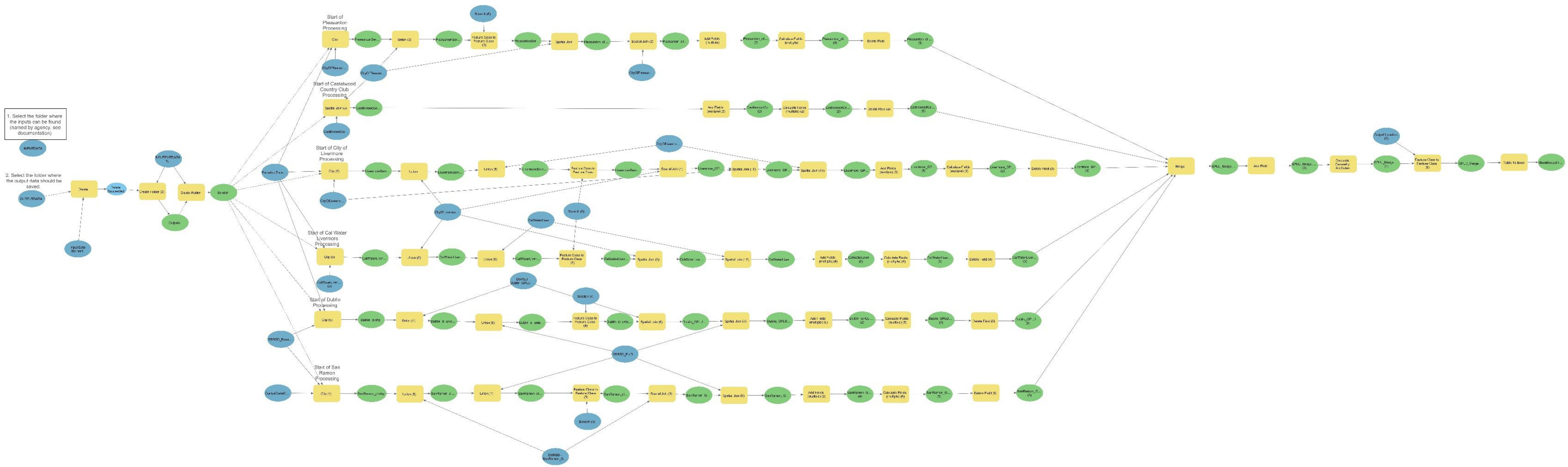
1.5 City of Livermore

1. Clip Alameda County parcel map to City of Livermore service area boundary.
2. Split parcels into multiple pieces if they have multiple overlying General Plan land use types.
3. Split parcels into multiple pieces if they have multiple overlying future developments from City of Livermore 2017 Water Master Plan designation of “Reasonably Foreseeable Development Projects” and Isabel Neighborhood Specific Plan.
4. Spatial join on General Plan land use category.
5. Assign City of Livermore pressure zone (1, 2, or 3) to the “RWZone” (recycled water zone) field in the final GIS Tool output file.
6. Spatial join on “Reasonably Foreseeable Development Projects” shapefile to pull in Project Number for every current parcel (if available) or Isabel Neighborhood Specific Plan land use.

1.6 Cal Water Livermore

1. Clip Alameda County parcel map to Cal Water Livermore service area boundary.
2. Split parcels into multiple pieces if they have multiple overlying General Plan land use types.
3. Split parcels into multiple pieces if they have multiple overlying future land uses in Isabel Neighborhood Specific Plan.
4. Spatial join on General Plan land use category.
5. Spatial join to pull in Isabel Neighborhood Specific Plan land use (if applicable).

Figure 1-1: ModelBuilder GIS Tool Overview



2. FOLDER SETUP AND DATA

To set up the GIS Tool and populate the required input files, users are instructed to follow the steps below:

1. Set up a folder to house the shapefile inputs and outputs of the GIS Tool – it can be named whatever you would like. We then suggest creating an “Inputs” and “Outputs” subfolder.
2. Save the “Zone7_Demand_Model.tbx” (toolbox) file inside the main folder.
3. Inside the “Inputs” subfolder, save the files described in **Table 2-1**.

Note that several input files contained overlaps in the original source data. The GIS Tool uses a “Union” tool to split Assessor parcel boundaries into multiple pieces if they have more than one overlying general plan land use type or known development (this is described in the section above for each region). If the general plan or known development layer contains multiple shapefiles occupying the same space, the GIS Tool will duplicate the original parcel and it will populate twice in the final Excel export file. The ArcGIS tool “Count Overlapping Features” was used to identify overlaps in the source data which were manually removed in some files as described in **Table 2-1**.

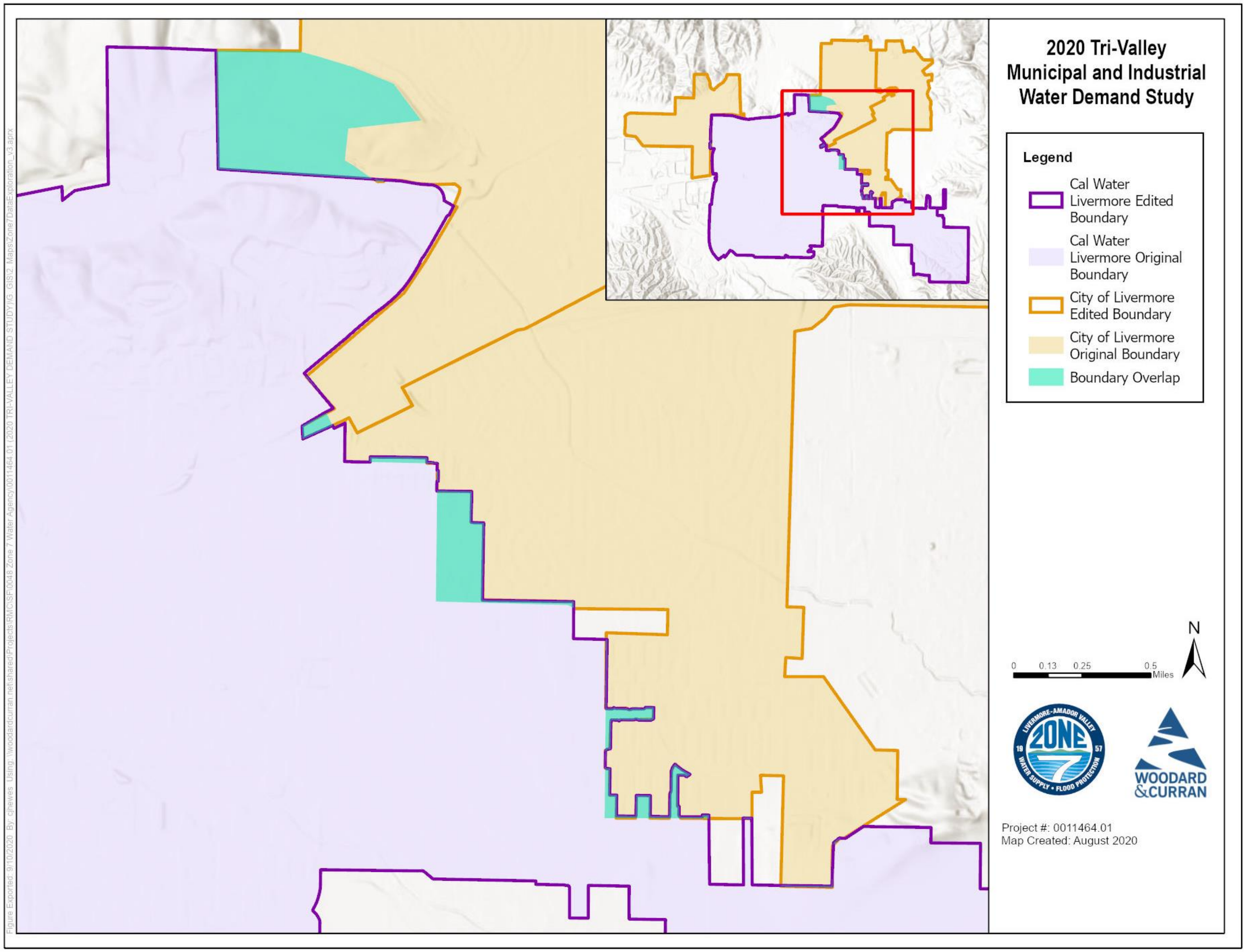
Table 2-1: File Inputs

File Type Category	Agency(ies)	Required Field Name	Description of File
Service area boundary	DSRSD	DSRSD_Boundary.shp	
	City of Pleasanton	CityOfPleasanton_Boundary.shp	
	Castlewood Country Club (City of Pleasanton)	CastlewoodCountryClub_Boundary.shp	See more details in Section 1.4.
	City of Livermore	CityOfLivermore_Boundary.shp	Note – for the 2020 demand study, the City of Livermore boundary was manually edited in several locations to avoid overlap with Cal Water Livermore – see Figure 2-1.
	Cal Water Livermore	CalWaterLivermore_Boundary.shp	Note – for the 2020 demand study, the Cal Water Livermore boundary was manually edited in several locations to avoid overlap with City of Livermore – see Figure 2-1.
General Plan Land Use	DSRSD (Dublin)	DSRSD-Dublin_GPLU.shp	
	DSRSD (San Ramon)	DSRSD-SanRamon_GPLU.shp	Shapefile was updated to Union with itself to identify areas where there are duplicate land uses delineated in the General Plan. Identical areas were reviewed manually and overlaps were eliminated. In most cases, these were overlaps of a park with a residential land use.
	City of Pleasanton	CityOfPleasanton_GPLU.shp	Shapefile was updated to Union with itself to identify areas where there are duplicate land uses delineated in the General Plan. Identical areas were reviewed manually and overlaps were eliminated. In most cases, these were overlaps of the WildlandOverlay land use type which were removed where they duplicated another land use that would generate water demands.
	Cal Water Livermore City of Livermore	CityOfLivermore_GPLU.shp	

File Type Category	Agency(ies)	Required Field Name	Description of File
Special Development Zones	DSRSD	DSRSD_FutDev_SiteNo.shp	Shapefile provided by DSRSD with locations of tracked future development numbers identified by a Site Number that links with an Excel project tracking sheet with additional info. • Note – this is a special version where holes were cut and removed in several large developments where there was a small underlying development occupying the same space. One additional area was added: a portion of APN 986 000100133 was clipped and added to this development layer with a SiteNo of 999 which represents the Federal Correction Institute (FCI). This portion of the parcel needed to be added as a planning area as there was no other way to distinguish it in the Excel model as separate from other portions of the same APN.
	City of Pleasanton	CityOfPleasanton_SpecificPlanBoundary.shp	Simple shapefile with labeled polygons identifying various Specific Plans in City of Pleasanton.
	City of Livermore	CityOfLivermore_PLANNING.shp	Special merged shapefile of: 1. Extract of Citywide parcels shapefile from 2017 Water Master Plan where Status = PLANNING to bring in Project/Planning number for tracked "Reasonably Foreseeable Development Projects." 2. Isabel Neighborhood Specific Plan Public Draft June 2020 land uses, override Projects 7a, 7b, 7c, 8, and 9 from bullet above • Removed K-12 School Overlay, BART Parking, and Ground Floor Retail – Flex which are all duplicate overlays on top of other primary land uses. • "Public/Institutional" was overwritten with "Educational/Institutional" to match the terminology in the Isabel Neighborhood Specific Plan June 2020. A single "Project" field was populated in the merged planning shapefile with either the project/planning area from #1 or the land use description from #2.

File Type Category	Agency(ies)	Required Field Name	Description of File
	Cal Water Livermore	CalWaterLivermore_PLANNING.shp	Clip of the Isabel Neighborhood Specific Plan Public Draft June 2020 land uses within Cal Water Livermore service area, where Land Use description has been placed in a "Project" field. This allows future shapefiles to be merged in if additional City of Livermore development planning areas are discovered.
Base Parcel Files	All	ParcelsInZone7ServiceArea.shp	Shapefile of all current parcels provided by Zone 7 GIS group, sourced from Alameda County Assessor's Office.
	Applies to San Ramon in DSRSD only	ContraCostaCountyParcel_SanRamon.shp	Shapefile of parcels with Situs City = SAN RAMON within Contra Costa County Assessor's Office parcel shapefile.

Figure 2-1: Livermore Water Agencies Overlap and Edited Boundaries

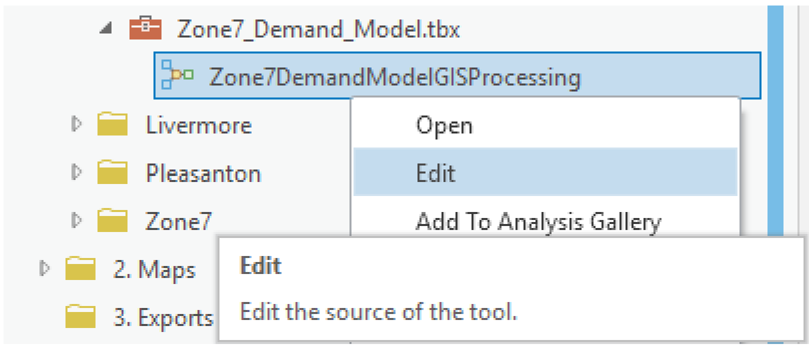


3. RUN GIS TOOL AND UPDATE EXCEL MODEL

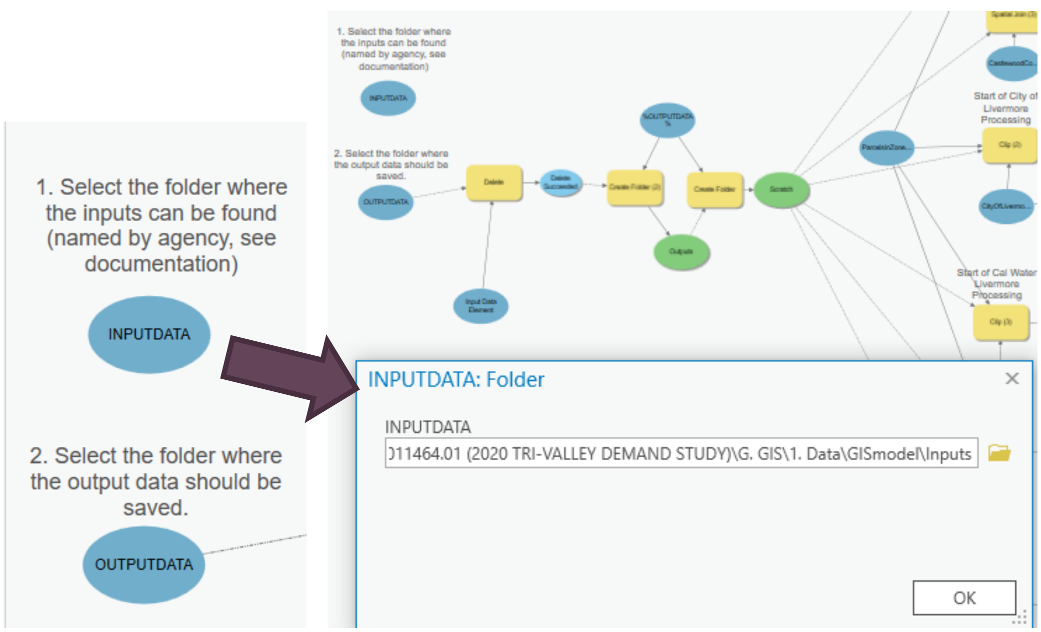
3.1 Run the GIS Tool

The instructions below describe how to run the GIS Tool in ArcGIS Pro.

1. Create a new ArcGIS Pro project. Navigate to the model folder, open the toolbox, right-click on the "Zone7DemandModelGISProcessing" model, and select "Edit".



2. In the ModelBuilder window that comes up, double-click separately on the blue circles INPUTDATA and OUTPUTDATA on the left-hand side and update the filepath describing the location of the input and output data folders, respectively.



3. Click the "Validate" button and then "Run." The tool may take up to an hour or more to run entirely. The following items will output to the "Outputs" folder:

    a. Individual "final" processed outputs for each individual agency (agency name or codename is in file name of each shapefile).

b. "GPLU_Merge_Filter.shp" – final processed and combined shapefile for all agencies, minus any parcels with less than 0.01 acres.

c. "ModelInputsFromGIS.xlsx" – Excel export of the attribute table for "GPLU_Merge_Filter.shp."

4. Proceed to Section 3.2.

3.2 Update the Excel Model

The instructions below describe how to clear out existing data from the Excel model, format the GIS-generated data for import, and then copy it into the Excel model and update the formulas. Because the Excel Model was specifically designed to not include Macros, there are a few manual steps required to bring in updated GIS data, but they are relatively straightforward, as outlined below.

1. In the Excel Model, navigate to the "Model" tab. Delete rows 3 and below. ***Make sure NOT to delete row 2 as the central Model formulas as stored here.*** A quick way to delete rows 3 and below is:

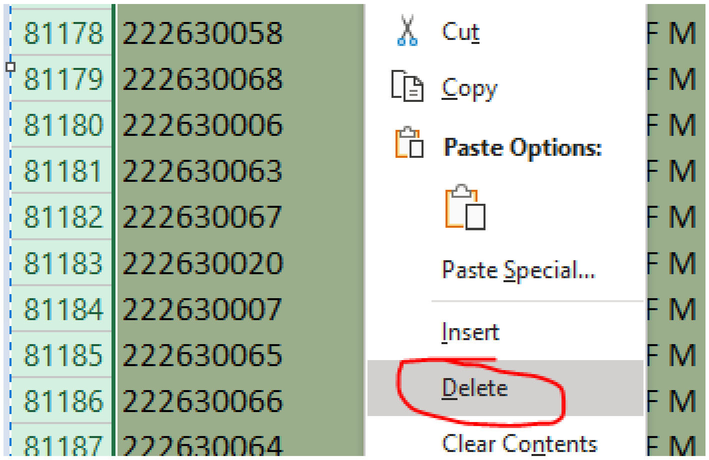
   a. Click on row #3 to select the entire row.

2	096 054701600	96-547-16	0
3	096 054606201	96-546-62-1	0
4	096 054400400	96-544-4	0

   b. On your keyboard, hold Control+Shift and press the down arrow. This should select all rows from row 3 to the end of the sheet.

81191	222630018	SF M	57
81192	222630010	SF M	57
81193	222630014	SF M	57
81194	222630013	SF M	57
81195	222630015	SF M	57
81196	222630016	SF M	57
81197	222630017	SF M	57
81198	222630011	SF M	57
81199	222630012	SF M	57
81200	222280013	OS	57

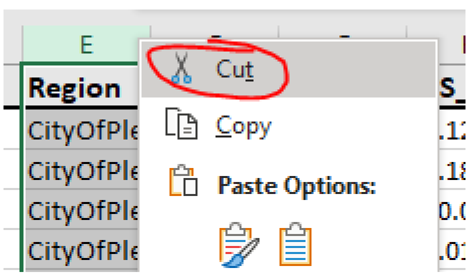
c. Right-click on the selection and click "Delete." It may take a minute to clear the rows.



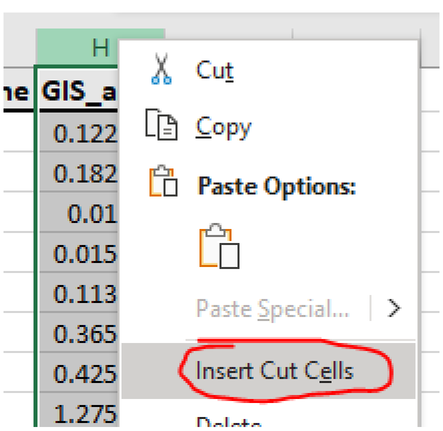
2. Open the GIS export called "ModelInputsFromGIS.xlsx."

3. Move the "Region" column so it is placed to the left of "GIS_acres." The bullets below describe how to do this:

a. Right-click on Column E (Region) to select the entire column and then choose "Cut."



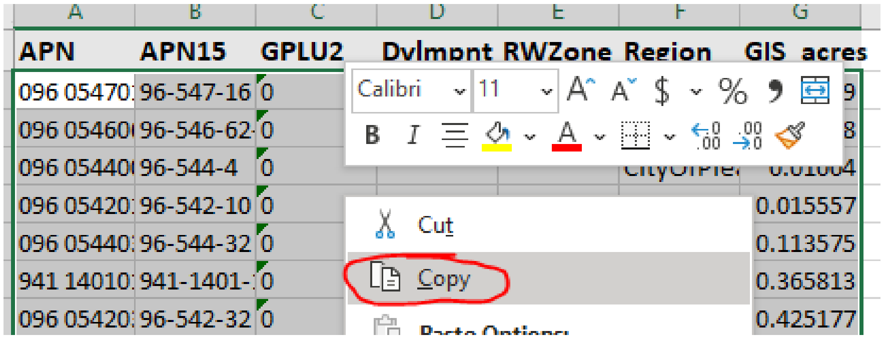
b. Right-click on Column H (GIS_acres) and select "Insert Cut Cells."

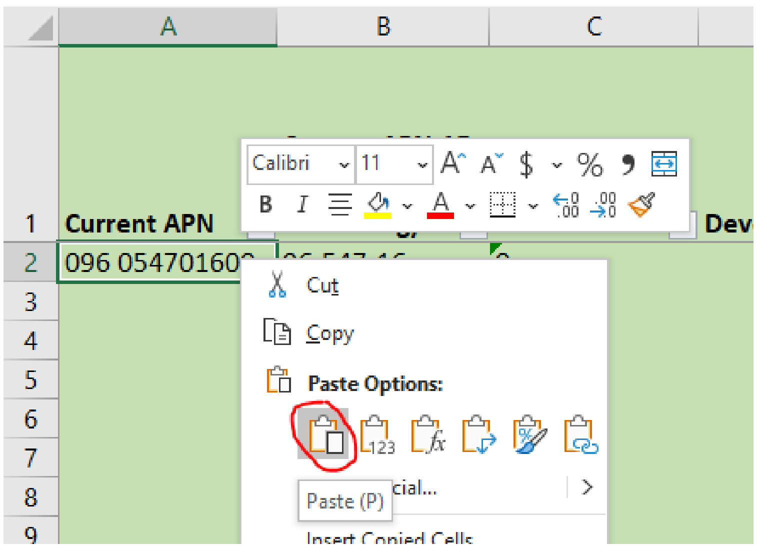


4. Delete Column A (FID).

5. Select rows 2 and below and copy them over into the first 7 columns of the "Model" tab.

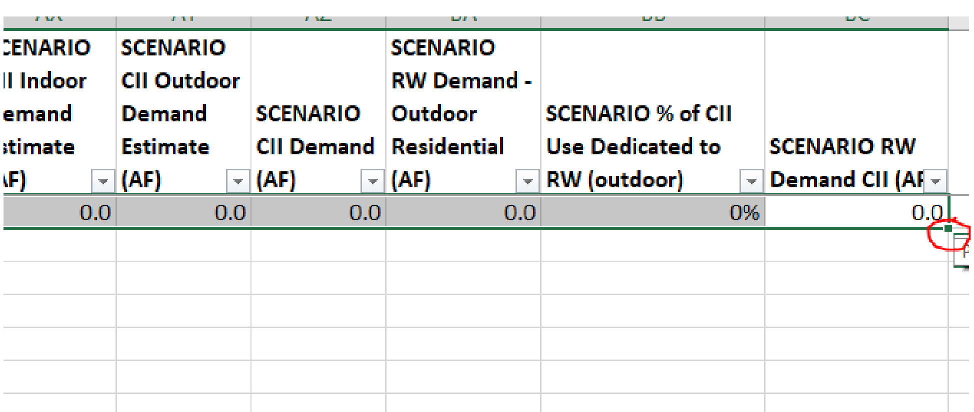
a. To select row 2 and all rows below, click on row 2 to select the entire row, then on your keyboard hold Control+Shift and press the down arrow.



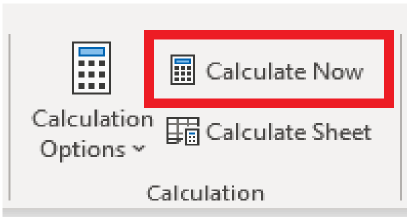


6. In the "Model" tab, select row 2 from column H through BC (these are all the model formulas). In Column BC ("SCENARIO RW Demand CII (AF)"), double-click on the small square in the bottom-right corner of the square which should cause the formulas to populate down across all columns.

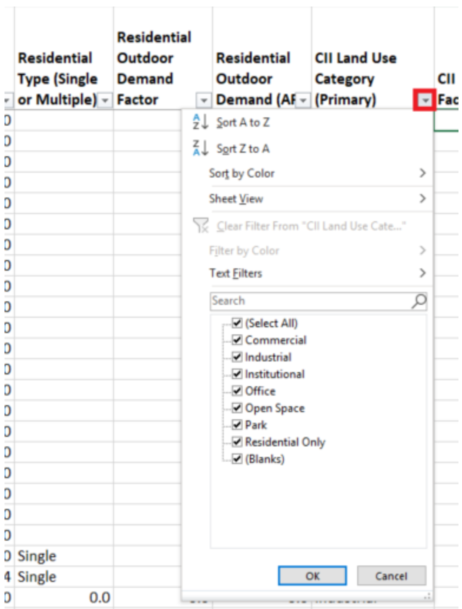
a. A warning about copying and pasting cells will likely come up from Excel; click accept or OK to move forward. It may take several minutes to copy and paste all formulas.



7. Once the formulas have copied through, click the “Calculate Now” button on the Formulas tab of the Excel ribbon:



   a. After waiting for calculations to finish, click the dropdown arrows under several of the columns to make sure that various values have populated (other than 0 or another default value).



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