

Appendix B

Methods for Determining Groundwater Demands in Sonoma Valley

Irrigation (Agricultural - 5,426 acre-feet and Turf – 701 acre-feet)

Groundwater pumping to meet Agricultural and Irrigated Turf demands was estimated from spatial information on land use and specific crop water demands.

Land use data for Sonoma Valley in 2012 was updated from a geodatabase created by Emily Heaton for a 2006 research project at the University of California, Berkeley, which covered all of Sonoma County and the Russian River watershed. This original geodatabase was created using 2004 satellite imagery to digitally identify field boundaries and associated crop type using ArcGIS. Selected fields were then field checked to confirm crop type. This original dataset was then updated by Sonoma County Water Agency (SCWA) in 2008 using 2006 National Agriculture Imagery Program (NAIP) imagery and again in 2013 using 2012 NAIP imagery. The resulting geodatabase contains the final crop land parcels used for the 2012 analysis. The parcels were then divided into the eleven subareas of the SVGB and the total acreages were calculated (Table 1).

The original geodatabase divided the land use into eleven categories listed in Table 2. However, for the 2012 Sonoma Valley analysis the crops types were consolidated into four categories based on identification in the basin and crop water demand (Table 3). Pasture land use was excluded from the analysis because it was difficult to determine if it was irrigated. Annual crop water demand for vineyards, orchards, and other agriculture are based on information from the Sonoma Valley Groundwater Flow Model (Bauer, 2008), while the values for irrigated turf are based a study of potential recycled water demands in Sonoma Valley (RMC, 2005). The overall demand was then calculated by multiplying the acreage by the crop water demand (Table 4).

While most of the agricultural and turf demands are assumed to be met with groundwater, some is met with surface water and reclaimed water. The reclaimed water service area boundary was obtained from the SCWA GIS department and the irrigated acreage it serves is shown in Table 5. The applicable surface water diversions in Sonoma Valley reported in the State Water Resources Control Board eWRIMs database were identified, inputted into a geodatabase, and summarized for each subarea (Table 6). The locations of diversions are shown in Figure 1. Then the surface water diversions and reclaimed water were subtracted from the overall demand, resulting in the estimated 2012 groundwater pumping (Table 7).

Spatial Distribution

The location and magnitude of pumping for irrigation was estimated by consolidating irrigation wells into a gridded system and relating the demand to each well. First a geodatabase was acquired from the USGS that includes well with reported use type. The USGS also supplied a shapefile of a grid ($\sim\frac{1}{4} \times \frac{1}{4}$

mile squares) that was developed for a Modflow model of Sonoma Valley (USGS 2006). The irrigation wells were then selected from the geodatabase and matched to the grid. Each grid cell that contained at least one irrigation well was identified as an approximate location of irrigation pumping. Then each irrigated parcel from the land use geodatabase was matched to the closest irrigation pumping location. The total demand for each pumping location was then calculated by summing the matched parcel demands, while separating out agricultural and turf parcels. These consolidated irrigation pumping demands were then mapped to visualize the distribution of pumping (Figure 2).

Small Systems – 372 acre-feet

The small systems category in this analysis is made up of small commercial systems such as wineries, warehouses, and regional parks. Reported pumping amounts for 2012 and estimated location of service area are supplied by the California Department of Public Health (CDPH) (Table 8). Some of the CDPH reported pumping values were supplemented with reported values from Sonoma County Permit and Resource Management Division (PRMD). All the data was then entered into a geodatabase, divided into the subareas, and the pumping was calculated (Table 9).

Spatial Distribution

The generalized location for each small system was used to map the location and magnitude of pumping (Figure 2).

Mutual/Private Water Systems – 544 acre-feet

Mutual and Private Water Systems consist of small community systems, including large subdivisions in unincorporated areas and mobile home parks. Reported pumping amounts for 2012 and estimated location of service area are supplied by the California Department of Public Health (CDPH) (Table 10). The service area data was enhanced with information acquired from the Sonoma County Local Agency Formation Commission (LAFCO), which provided shapefiles for the service areas of six out the ten systems. All the data was then entered into a geodatabase, divided into subareas, and the total pumping was calculated (Table 9).

Spatial Distribution

The demand for each system was divided evenly between each associated well (where applicable), which allowed the location and magnitude of pumping to be estimated and mapped (Figure 2).

Public Supply – 502 acre-feet

Municipal pumping in Sonoma Valley consists of groundwater use from the City of Sonoma and the Valley of Moon Water District (VOMWD). Reported pumping amounts for 2012 and service area

geographic information were provided by each municipality (Table 11). All the data was then entered into a geodatabase, divided into subareas, and the total pumping was calculated (Table 9).

Spatial Distribution

The demand for each system was divided evenly between each associated well (where applicable), which allowed the location and magnitude of pumping to be estimated and mapped (Figure 2).

Rural Domestic – 2,760 acre-feet

Rural Domestic demands consist of privately owned domestic wells located outside of municipal or mutual water company service areas.

Pumping estimates were derived from estimating population outside mutual/private water companies' and municipalities' service areas and applying a per capita water use. The population was estimated using 2010 census geographical data acquired from US Census Bureau TIGER Products. The census geodatabase contained population estimations in each census blocks, which can vary in area, within Sonoma County. The population density was then calculated for each census block by dividing the population by the block area. This method assumes an even distribution of population within the block, which is not always the case for the larger blocks. The area of the SVGB was then extracted from larger census geodatabase, with blocks that cross the border being cut, reducing their effective area. The new areas were then calculated and multiplied by the population density to get the new total populations for the SVGB (Table 12). The service areas for the City of Sonoma and VOMWD were then subtracted from the new population dataset, resulting in new sized blocks near the boundaries. The area of new census blocks were then calculated and multiplied by the corresponding population density to get the adjusted population dataset. The populations served by mutual and private water systems for 2012 were reported by CDPH (Table 10). These populations were subtracted from census blocks that intersected the service areas, resulting in the 2010 rural domestic SVGB population dataset.

In order to estimate the 2012 populations, the 2010 census populations were extrapolated using a 0.7% per year population growth (Bauer 2008, County of Sonoma, 2013). A per capita water demand of 0.28 acre-feet was then applied to the resulting 2012 population. The 0.28 acre-feet was estimated by taking the average of the per capita demand of the mutual and private water companies. The final result is the net rural domestic pumping demand for 2012, which were divided into the subareas, and summarized in Table 9.

Spatial Distribution

The method used for estimating the locations and magnitude of the rural domestic pumping is similar to one used for irrigation demands. First the 2010 census blocks were overlaid onto the USGS model cells, resulting in the largest census parcel being the size of a model cell. Then the areas of the new parcels were calculated and the corresponding population density was applied to get the population estimate. Next, the USGS well geodatabase was filtered for domestic use wells, which were then matched to cells on the USGS model grid. The model cells which contained domestic wells were assumed to be the

approximate location of domestic pumping. Each census parcel was then matched to its nearest domestic pumping location. The total 2010 population for individual pumping locations was then calculated. The populations were extrapolated to 2012 and the per capita water demand was then applied, resulting in the final estimated distribution of rural domestic demands (Figure 2).

References

Bauer, Jacob, 2008 Master's Thesis. *Update to Regional Groundwater Flow Simulation of Sonoma Valley including a New Model for Recharge and Three Future Scenarios*. Stanford University.

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National Agriculture Imagery Program (NAIP), 2006, 2012. Cal-Atlas Geospatial Clearinghouse. <http://www.atlas.ca.gov/download.html#/casil/imageryBaseMapsLandCover/imagery/naip>. Accessed December 23, 2013.

Raines, Melton & Carella, Inc., 2005. *Sonoma Valley Analysis*. Technical Memorandum No. 3.

US Census Bureau. 2010 Census geodatabase. <http://www.census.gov/geo/maps-data/data/tiger-data.html>

Table 1 - Irrigated Field Acreage

Subarea	Vineyard	Orchard	Other Irrigated	Irrigated Turf
Calabazas	238	5	0	0
Baylands	603	0	0	0
Glen Ellen	202	8	0	0
Agua Caliente	429	3	0	10
Huichica	2967	0	0	0
Western Upland	2067	60	0	0
Rodgers Creek	1494	1	8	14
Kenwood	843	50	1	0
Eastern Upland	2516	21	23	0
City	1349	10	0	18
El Verano/Fowler Creek	2010	6	13	167

Table 2 - Original Land Use Identifiers

Land Use	Description
Vineyard	Grape vines
Previous Vineyard	Was identified as vineyard previously, but now not irrigated
Converted from Vineyard	Was identified as vineyard previously, but now another irrigated land type
Possible Vineyard	Poor imagery quality makes it difficult to confirm vineyard presence
Orchard	Olive trees, fruit trees, nut trees, tree nursery
Perennial Agriculture	Ornamental shrubs
Non-Perennial Agriculture	Row crops
Pasture	Grazing land for livestock
Other Irrigated Land	Golf courses, parks, sports fields
Prepared Vineyard	Field cleared, distinctive rows, vines may have just been planted
Possible Irrigated Land	Area appears to be irrigated

Table 3 - Consolidated Land Use Identifiers

Land Use	Description
Vineyard	Grape vines
Orchard	Olive trees, fruit trees, nut trees, tree nursery
Other Agriculture	Ornamental shrubs, row crops
Irrigated Turf	Golf courses, parks, sports fields

Table 4 - Water Demand by Crop Types

Subarea	Vineyard	Orchard	Other Irrigated	Irrigated Turf	
				Golf Course	Parks/Sports Fields
Calabazas	0.6	2	2	3.5	3
Baylands	0.6	2	2	3.5	3
Glen Ellen	0.6	2	2	3.5	3
Agua Caliente	0.6	2	2	3.5	3
Huichica	0.6	2	2	3.5	3
Western Upland	0.3	2	2	3.5	3
Rodgers Creek	0.6	2	2	3.5	3
Kenwood	0.6	2	2	3.5	3
Eastern Upland	0.3	2	2	3.5	3
City	0.6	2	2	3.5	3
El Verano/Fowler Creek	0.6	2	2	3.5	3

Table 5 - Reclaimed Water Service Area Irrigated Field Acreages

Subarea	Vineyard	Orchard	Other Irrigated	Irrigated Turf
Calabazas	0	0	0	0
Baylands	211	0	0	0
Glen Ellen	0	0	0	0
Agua Caliente	0	0	0	0
Huichica	1971	0	0	0
Western Upland	0	0	0	0
Rodgers Creek	0	0	0	0
Kenwood	0	0	0	0
Eastern Upland	54	0	0	0
City	0	0	0	0
El Verano/Fowler Creek	0	0	0	0

Table 6 - Surface Water Diversion Acreages

Subarea	Agriculture	Turf
Calabazas	22	0
Baylands	21	0
Glen Ellen	0	0
Agua Caliente	0	0
Huichica	373	0
Western Upland	434	0
Rodgers Creek	0	0
Kenwood	43	0
Eastern Upland	236	0
City	15	0
El Verano/Fowler Creek	17	10

Table 7 - Net 2012 Irrigation Pumping (acre-feet)

Subarea	Vineyard	Orchard	Other Irrigated	Irrigated Turf
Calabazas	143	11	0	0
Baylands	362	0	0	0
Glen Ellen	121	17	0	0
Agua Caliente	257	5	0	16
Huichica	1780	0	0	0
Western Upland	620	120	0	0
Rodgers Creek	896	3	16	41
Kenwood	506	99	2	0
Eastern Upland	755	42	84	47
City	809	20	0	22
El Verano/Fowler Creek	1206	12	27	575

Table 8 - Summary of Small Systems Demands

Small System CDPH Number	Subarea	Year Reported	2012 Reported Pumping (acre-feet)
4901254	Carneros	2012	9
4901247	City	2012	10
4901218	City	2012	6
4900945	City	2012	7
4900845	City	2011	13
4901273	City	2011	1
4901193	City	2012	0
4901258	City	2008	40
4900918	City	2009	17
4901234	City	2012	0
4901069	City	2011	1
4901061	City	2012	0
4901225	City	2012	0
4901083	City	2012	1
4901294	City	2012	16
4900986	Eastern Upland	2012	1
4900957	Eastern Upland	2012	26
4901144	Eastern Upland	2011	8
4910302	Eastern Upland	2012	2
4901018	Eastern Upland	2012	6
4901233	Eastern Upland	2012	4
4900875	Eastern Upland	2011	6
4901274	Eastern Upland	2012	3
4901255	Eastern Upland	2012	26
4900925	Eastern Upland	2012	0
4900909	El Verano/Fowler Creek	2012	1
4901278	El Verano/Fowler Creek	2012	37
4901275	El Verano/Fowler Creek	2012	1
4901227	Kenwood	2012	4
4901133	Kenwood	2012	11
4900841	Kenwood	2011	0
4901204	Western Upland	2012	5
4910305	Western Upland	2012	2
4901028	Western Upland	2012	5
4901120	Western Upland	2012	2
4901262	Western Upland	2012	15
4901151	Western Upland	2012	2
4901198	Western Upland	2012	0
4901080	Western Upland	2012	6
4900967	Western Upland	2011	2
4901129	Western Upland	2012	6
4901096	Western Upland	2011	8

Table 9 - Summary of Sonoma Valley Groundwater Basin Demands (acre-feet)

Subarea	Agriculture				Irrigated Turf*		Rural	Public Supply			Small Systems	Mutual/Private
	Total Demand	Surface Water	Reclaimed	Groundwater	SW	GW	GW	City	VOM	Total		
Calabazas	153	22		131			70					
Baylands	362	21	127	214								
Glen Ellen	138	0		138			120					11
Agua Caliente	263			263		16	11					
Huichica	1780	373	1183	224			150					87
Western Upland	740	434		306			351					176
Rodgers Creek	915			915		41	155					39
Kenwood	607	43		565			540					51
Eastern Upland	880	236	16	628		47	439		277	277	83	126
City	829	15		814		22	497	80		80	112	90
El Verano/Fowler Creek	1244	17		1227	10	575	427		145	145		
Totals	7913	1161	1326	5426	10	701	2760	80	422	502	372	544

*Irrigated golf course, parks, and sports fields

Table 10 - Summary of Mutual/Private Water Company Demands

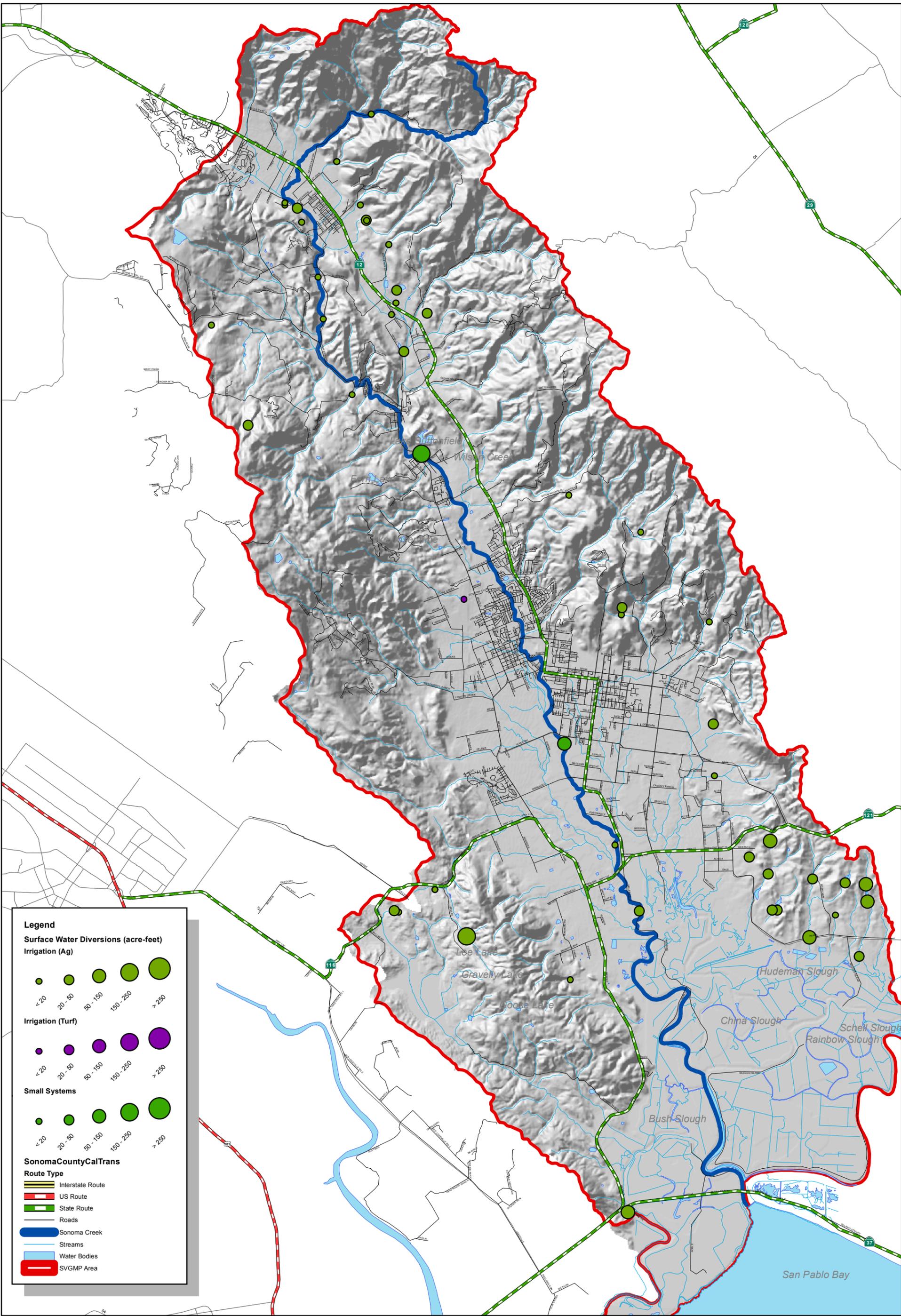
Mutual/Private Water Company	Subarea	2012 Reported Pumping (acre-feet)	2012 Served Population
Bennett Ridge Mutual Water Company	Western Upland	47	200
Diamond A Mutual Water Company	Western Upland	100	250
George Ranch Mutual Water Company	Western Upland	28	75
Kinnybrook Mutual Water Company	Eastern Upland	44	21
Mission Highlands Mutual Water Co.	Eastern Upland	56	200
Sonoma Ranch Mutual Water Company	Eastern Upland	26	100
De Anza Moon Valley Water Company	City	90	495
Sonoma Springs Water Company (PUC)	Glen Ellen	11	850
Kenwood Village Water Company (PUC)	Kenwood	140	55
Smother's Water System	Kenwood	0	45

Table 11 - Summary of Municipality Groundwater Demands

Municipality	Well Name	Subarea	2012 Reported Pumping (acre-feet)
Valley of Moon	Agua Caliente Well	Eastern Upland	91
Valley of Moon	Donal Ave Well	Eastern Upland	61
Valley of Moon	Larbre Well	El Verano/Fowler Creek	145
Valley of Moon	Mountain Ave Well	Eastern Upland	68
Valley of Moon	Park Ave Well	Eastern Upland	57
City of Sonoma	COS Well	City	80

Table 12 - Summary of Rural Domestic Demands

Subarea	Total 2012 Population	Valley of Moon 2012 Population	City of Sonoma 2012 Population	Mutual/Small Systems 2012 Population	Net Rural 2012 Population	Net Rural 2012 Pumping (acre-feet)
Western Upland	1906	129	0	525	1252	351
Eastern Upland	3737	1747	99	321	1569	439
Agua Caliente	4929	4136	0	753	40	11
Calabazas	773	522	0	0	251	70
Huichica	536	0	0	0	536	150
City	18575	5965	10340	495	1775	497
El Verano/Fowler Creek	8094	7513	56	0	525	147
Rogers Creek	1454	902	0	0	553	155
Glen Ellen	689	207	0	55	427	120
Kenwood	2824	0	0	895	1929	540
Baylands	0	0	0	0	0	0



Legend

Surface Water Diversions (acre-feet)

Irrigation (Ag)

Irrigation (Turf)

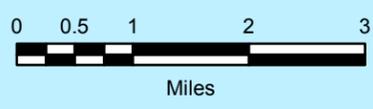
Small Systems

SonomaCountyCalTrans

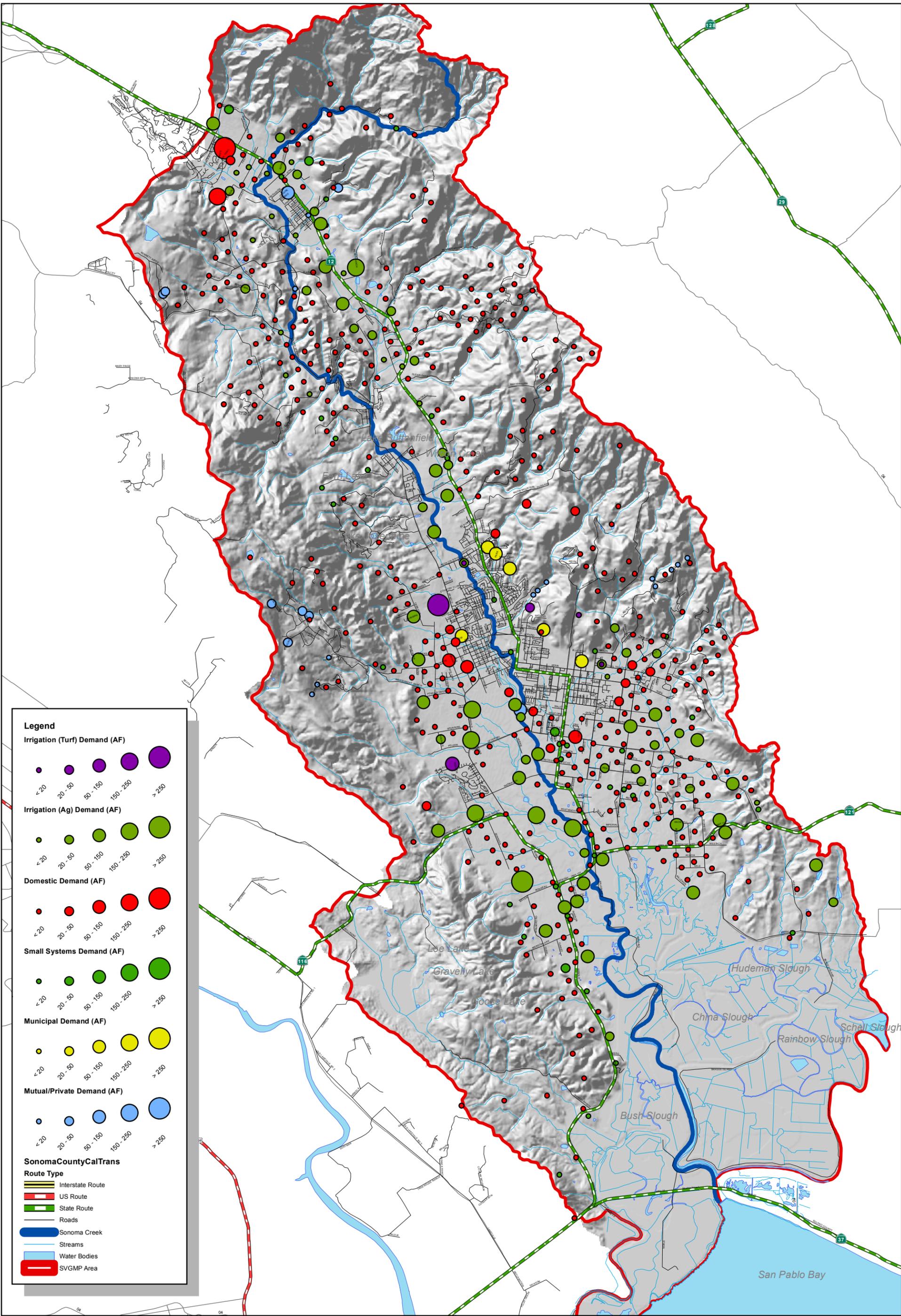
Route Type

- Interstate Route
- US Route
- State Route
- Roads
- Sonoma Creek
- Streams
- Water Bodies
- SVGMP Area

**Sonoma Valley
Groundwater Management Program
2012 Reported Local Surface Water Diversions**



**Figure
1**



Legend

Irrigation (Turf) Demand (AF)

< 20 20 - 50 50 - 150 150 - 250 > 250

Irrigation (Ag) Demand (AF)

< 20 20 - 50 50 - 150 150 - 250 > 250

Domestic Demand (AF)

< 20 20 - 50 50 - 150 150 - 250 > 250

Small Systems Demand (AF)

< 20 20 - 50 50 - 150 150 - 250 > 250

Municipal Demand (AF)

< 20 20 - 50 50 - 150 150 - 250 > 250

Mutual/Private Demand (AF)

< 20 20 - 50 50 - 150 150 - 250 > 250

SonomaCountyCalTrans

Route Type

- Interstate Route
- US Route
- State Route
- Roads
- Sonoma Creek
- Streams
- Water Bodies
- SVGMP Area

**Sonoma Valley
Groundwater Management Program
2012 Estimated Groundwater Demands**



**Figure
2**