APPENDIX B

Ramboll:
Evaluation of Domestic Well Owners' Pumping Rates in the Indian Wells Valley Basin

EVALUATION OF DOMESTIC WELL OWNERS' PUMPING RATES IN THE INDIAN WELLS VALLEY BASIN

Identification of Parcels

In the Indian Wells Valley Groundwater Basin (IWV Basin), domestic wells supply water for household beneficial uses, including drinking, cooking, bathing, and outdoor irrigation. These primarily unmetered domestic wells are mostly located in rural areas where public water supplies are not available, although nearly one-third lie within municipal water supply jurisdiction and are not connected. Within the IWV Basin, a total of 1,507 residential parcels have been identified with domestic wells, as illustrated in **Figure 1**. The purpose of this evaluation is to map the number of residential parcels relying on domestic water supply wells and estimate the domestic water demand on an average annual basis.

A total of 482 parcels were identified within the Indian Wells Valley Water District (District) jurisdiction, including 15 industrial parcels, that are not connected to the district water supply. Additionally, outside the district boundary, there are 991 parcels within Kern County and 34 parcels within Inyo County where water is supplied by domestic wells. Vacant parcels and those without residential (or industrial buildings in a few cases) buildings have been excluded from this compilation.

Kern County GIS data was processed to identify the construction dates for structures on the domestic parcels. This dataset provides the necessary information for assessing whether any new structures, such as residences, have been built within the last 10 years, consistent with the baseline period used for evaluating the safe yield. The dataset indicates that approximately 20% of the parcels lack information on the construction year of the structures. For the remaining parcels with available data, it was observed that new residences constructed in the past decade constitute a very small fraction—less than 1% of the total.

The finding of very little construction suggests that the number of new buildings, including residences, has remained relatively stable throughout the ten-year baseline period. The data also indicates that the number of domestic parcels with structures and without metered connections has seen insignificant growth. The stability in the number of residential parcels further suggests that the domestic well water demand has remained constant during the ten-year baseline period.

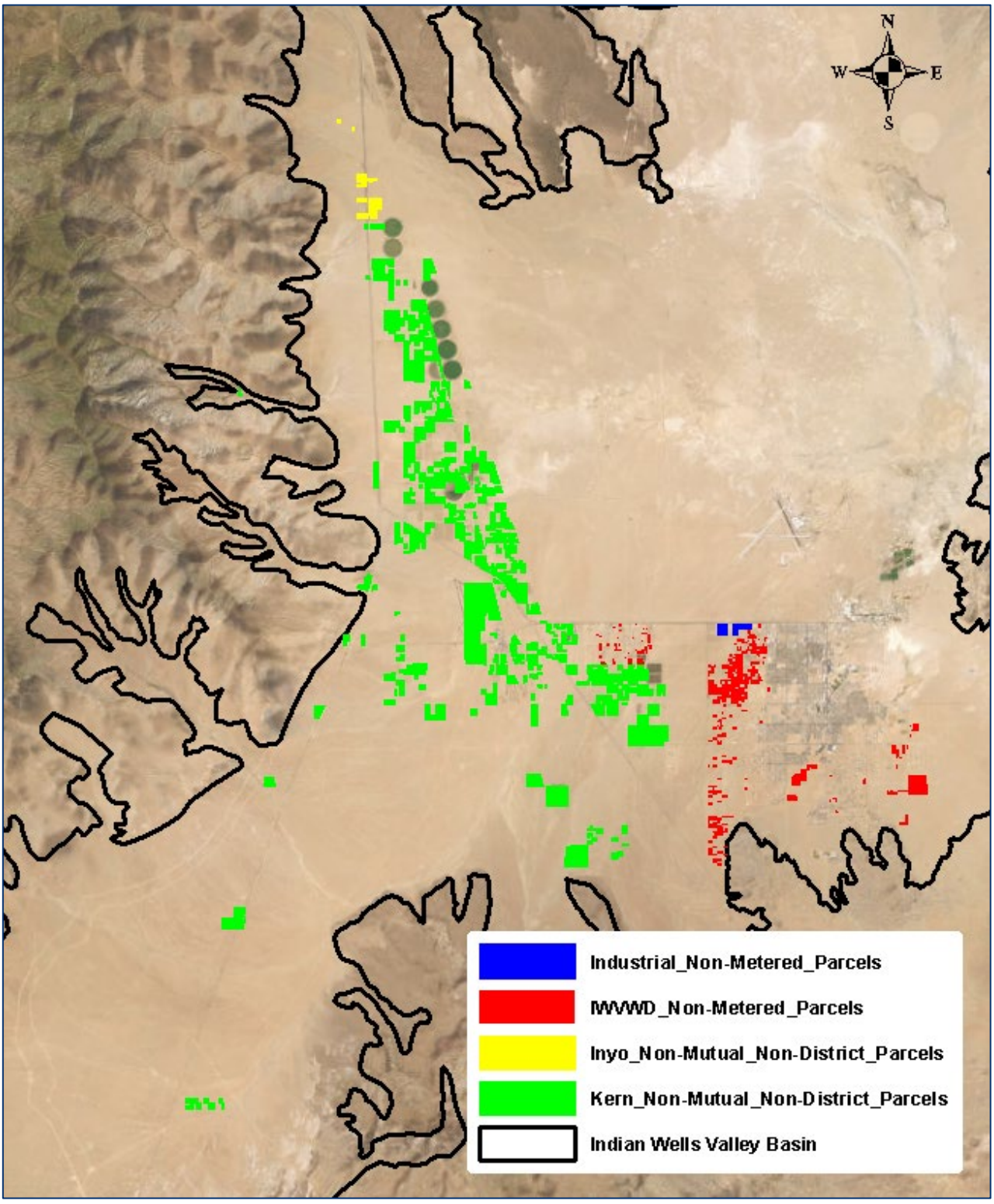

Figure 1: Location of Parcels with Domestic Wells

Estimation of Pumping Rates

Out of the 1,507 parcels, 27 parcels have reported pumping rates as identified in the legally-required initial disclosures that were reported by pumpers in the groundwater adjudication process. For these 27 parcels, the average pumping rate for the period from 2011 through 2023 is 0.95 acre-feet per year (AFY) per parcel. Given the lack of reported pumping data for the majority of the parcels, the following approach was adopted.

Each residential parcel is expected to consume water across three main categories:

1) **Indoor Water Usage**: This includes water used for activities inside the home, such as drinking, cooking, and sanitation.
2) **Outdoor Water Usage**: This covers water used for watering lawns and general irrigation of landscaping.
3) **Water Usage in Evaporative Coolers**: This pertains to the water used by evaporative cooling systems, which are commonly employed in arid regions.

The estimated water usage per parcel for each of these categories is summarized below:

1) Indoor Water Usage

Indoor water usage per household can vary significantly depending on factors such as geographic location, household size, water conservation practices, and the efficiency of appliances and fixtures. However, some general estimates can provide a rough idea of typical indoor water usage. In the United States, the average per capita indoor water use ranges from approximately 50 to 100 gallons per day.[1]

In California, the current standard for residential indoor water use is set at 55 gallons per person per day.[2] Based on this standard, and assuming an average household size of three occupants, the indoor water usage per parcel is estimated to be approximately 0.18 acre-feet per year (AFY).

When applied to the 1,507 parcels in question, the total indoor water usage is estimated to be approximately 280 AFY.

2) Outdoor Water Usage

Evapotranspiration (ET) data is a crucial tool for estimating the amount of water required for outdoor landscapes. ET represents the combined loss of water from the soil through evaporation and water used by plants through transpiration. Through understanding ET, the water needs of various landscapes can be estimated, ensuring that plants receive enough water to stay healthy without the risk of overwatering.[3]

Landscape evapotranspiration (ET) is calculated by multiplying the reference ET (ETo) by the crop coefficient (Kc). In the IWV, the average ETo is estimated to be approximately 66.47

[1] WaterSense Statistics and Facts - EPA WaterSense

[2] https://water.ca.gov/Programs/Water-Use-And-Efficiency

[3] https://ocds.ocpublicworks.com/sites/ocpwocds/files/2021-06/Guide%20to%20Estimating%20Irrigation%20Water%20Needs.pdf

inches per year.[4] This value represents the amount of water that would evaporate and transpire from a well-watered reference crop, such as grass.

The crop coefficient (Kc) is a dimensionless factor that adjusts the ETo to reflect the specific water needs of different types of vegetation. According to the Food and Agricultural Organization (FAO), the Kc for typical vegetation in California's desert regions is around 0.2.[5] This coefficient varies depending on the type of plants, with some requiring more water than others.

However, not all the water applied through irrigation systems is effectively used by the plants. Water can be lost due to runoff, deep percolation beyond the root zone, or evaporation. To account for these losses, the irrigation efficiency (IE) of the system must be considered. This factor varies depending on the type of irrigation system used, such as drip or sprinkler systems.

For estimating purposes, a conservative IE factor of 0.75 is assumed. This means that 75% of the water applied through irrigation is expected to be effectively used by the plants, while the remaining 25% is lost. A higher IE indicates a more efficient system, which in turn reduces the overall water usage for irrigation.

The average area of residential parcels identified with domestic wells is 5.87 acres. In order to better refine the average parcel irrigable acreage, an analysis of aerial imagery of inhabited parcels larger than 10.0 acres was conducted, with the portion containing native desert vegetation being omitted from the irrigable acreage calculation. While preventing these larger parcels from disproportionately impacting the overall acreage calculation, it ultimately resulted in a minor decrease in average irrigable parcel size to 5.49 acres as fewer than 10% of parcels were larger than 10.0 acres. (**Table 1**). To accurately estimate outdoor water usage, it's necessary to quantify the irrigable area within each parcel. The Landscape Area Measurements (LAM) Project, a state-wide initiative utilizing remote sensing and machine learning, was designed to estimate land cover and land use across urban residential spaces in California.[6]

In 2018 and 2021, the Department of Water Resources (DWR) contracted Quantum Spatial, Inc. (now NV5 Geospatial) to complete the LAM Project, which provided estimates of outdoor landscape area measurements for single-family and multi-family residential parcels across all qualifying urban retail water suppliers in California. According to this study, approximately 9.6% of each residential parcel in the IWVWD area is considered irrigable. This percentage is applied to the total parcel area to estimate the total water requirement (WR) per parcel.

Some of the total WR is naturally met by rainfall during the winter months. The IWV Basin receives an average of approximately 3.42 inches of precipitation annually, as recorded at the China Lake station.[7] After accounting for this precipitation, the net outdoor water

[4] https://www.waterboards.ca.gov/lahontan/water_issues/programs/snmp/docs/iwvwd_snmp_april2018.pdf

[5] https://www.fao.org/4/X0490E/x0490e0b.htm

[6] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Water-Use-And-Efficiency/2018-Water-Conservation-Legislation/Performance-Measures/LandscapeAreaMeasurements.pdf

[7] https://wrcc.dri.edu/WRCCWrappers.py?sodxtrmts+041733+por+por+pcpn+none+msum+5+01+F

requirement per parcel is calculated to be 0.63 acre-feet per year (AFY). Therefore, for the 1,507 parcels identified, the total outdoor WR is expected to be approximately 950 AFY.

Table 1: Estimate of Outdoor Water Requirement (WR) per Parcel

ETo	Kc	IE	Average Parcel Area (adjusted)	Irrigable Area	Total WR per parcel	Precipitation per parcel	Net WR per parcel
in/year	unitless	unitless	Acres	%	AFY	AFY	AFY
66.47	0.20	0.75	5.49	9.6	0.78	0.16	0.63

3) Evaporative Coolers Water Usage

Evaporative coolers, also known as swamp coolers, are commonly used by residents in arid environments to cool their homes. In the IWV basin, each household is expected to use between 70 and 200 gallons per day (GPD) for approximately 200 days per year with these coolers, which translates to an annual usage of 0.04 to 0.12 acre-feet per year (AFY) (Karpiscak et al. 1998).

By taking an average usage of 0.08 AFY per household and applying it to the 1,507 parcels in question, the total water usage by evaporative coolers is estimated to be approximately 120 AFY.

Conclusions

In summary, the total average annual water usage by the 1,507 residential parcels identified is estimated to be 1,350 acre-feet per year (AFY) based on 0.90 AFY per parcel. This total includes various categories of water consumption: approximately 280 AFY is anticipated for indoor usage, which covers activities such as drinking, cooking, and sanitation. An estimated 950 AFY is allocated for outdoor usage, which typically includes irrigation of landscaping, gardens, and other outdoor areas. Additionally, approximately 120 AFY is expected to be used by evaporative coolers, which are commonly employed in arid regions to provide cooling through the evaporation of water.

The average estimate of 0.90 AFY per parcel is comparable to the 0.95 AFY of the reported pumping average available for 27 parcels in the IWV Basin. Thus, the estimation methods used in this evaluation provide a reasonable estimate of the domestic well water demand in the IWV Basin.

References

Karpiscak, M.M., Babcock, T.M., France, G.W., Zauderer, J., Hopf, S.B., and K.E. Foster, 1998. Evaporative Cooler Water Use in Phoenix. Journal of American Water Works Association, vol. 90, iss. 4., p. 122-130.