APPENDIX F
Baseline Pumping Allocation Methodology

The Groundwater Sustainability Plan (GSP) includes a baseline pumping allocation for each identified non-de minimis groundwater user in the Borrego Springs Subbasin (Subbasin). The "baseline pumping allocation" is defined as the amount of groundwater each pumper in the Subbasin is allocated prior to SGMA-mandated reductions. It is further defined as the verified maximum annual production, in acre-feet per year (AFY), for each well owner over the baseline pumping period. The baseline pumping period is the 5-year period from January 1, 2010 through December 31, 2014. This was to consider water use that was being used prior to SGMA taking effect on January 1, 2015 (California Water Code 10720.5(a)).

The County of San Diego (County) sent letters via U.S. Mail to each non-de minimis pumper in January 2018, July 2018, and January 2019 with a request to provide the Groundwater Sustainability Agency (GSA) any historical groundwater production data or other information to help the GSA develop the baseline pumping allocation. Any data provided by pumpers was agreed to be kept confidential by the GSA to the maximum extent allowed by law including but not limited to Government Code 6254. Identified non-de minimis pumpers included one municipal pumper (Borrego Water District), 30 agricultural pumpers, 6 golf courses, and 4 other pumpers (Anza-Borrego Desert State Park, Borrego Air Ranch Water Company, Borrego Springs Elementary School, and La Casa Del Zoro Resort and Spa [Figure F-1]. In cases where the GSA could validate submitted historical groundwater data, the GSA used the data to develop the baseline pumping allocation.

After the GSA reviewed data submitted from pumpers, baseline pumping allocations utilizing validated historical production data were determined for Borrego Water District, Anza-Borrego Desert State Park (Palm Canyon), and one agricultural pumper. The GSA further determined for the Borrego Air Ranch Water Company (provides water to individual residences) that the baseline pumping allocation would be estimated based on a demand of 0.5 acre-feet per year for each residential unit. For all other pumpers, the GSA developed a water-use estimate approach (Evapotranspiration Method) discussed below. The County sent letters via U.S. Mail to each non-de minimis pumper in March 2019 to provide individual baseline pumping allocations. The baseline pumping allocations are summarized by beneficial use categories in GSP Chapter 2, Table 2.1-7.

EVAPOTRANSPIRATION METHOD

This approach includes the use of available aerial imagery to determine irrigated areas on each parcel, which is multiplied by a water use factor for each crop type. The following outlines the methodology for measuring total irrigated area and calculating the water use factor.

Area Irrigated: The area of irrigation was determined using ArcGIS (GIS), a computer based mapping and data analysis software. A 1:2,000 scale was used to create polygons of irrigated area over available aerial imagery from the National Agriculture Imagery Program (NAIP). Available years of aerial imagery included 2010, 2012, and 2014. The total area of each polygon was calculated using coordinate system NAD 1983, State Plane California VI, feet. One exception to this approach was for Rams Hill Golf Course. It was not in full production during the baseline period of 2010 through 2014 due to closure of the golf course that occurred in 2010. It was in full production prior to 2010 and again after 2014. Aerial imagery from 2017 was selected to capture full golf course irrigation.

Water Use Factor: The water use factor estimates the total applied groundwater lost through the evaporation from soil and transpiration from plants (evapotranspiration). These factors are specific to each vegetation type. Turf, ponds, palms, citrus, nursery, and potatoes were identified and considered for all sectors. Table F-1 provides the water use factors for each irrigation use type.

Table F-1
Water Use Factors

Use Type	Water Use Factor (Feet per Year)
Citrus	6.29
Date Palms[a]	7.74
Landscape (Decorative)	3.63
Landscape (Native)	2.76
Nursery	4.84
Palms (Ornamental)	4.03
Ponds[b]	5.75
Potatoes[c]	2.50
Turf	6.45

Source: Water Use Classification Landscape Species IV (WUCOLS IV), DWR 2018, Borrego Water District and County of San Diego 2013.
Notes:
a. Includes additional water required for a 30% cover crop (turf) that is irrigated in the understory of the date palms.
b. Applied to golf courses only. Surface water evaporation based on pan evaporation data from the Imperial Valley (Salton Sea Salinity Control Research Project U.S. Department of Interior 2004).
c. Approximately 2.5 acre-feet per acre are applied to potato fields per information obtained from the potato farmer in the Subbasin.

The water use factor is calculated using local station specific evapotranspiration (ETo), documented plant factors, and irrigation efficiency by irrigation type (Equation A). The water use factor for citrus and date palms also includes a factor for leaching (Equation B).

The equations below present the calculations used to determine the water use factor.

Equation A

$$Annual\ Water\ Use\ Factor = \frac{ETo * PF * 1\ Acre}{IE}$$

Equation B

$$Annual\ Water\ Use\ Factor = \left(\frac{ETo * PF * 1\ Acre}{IE} * CLF\right) + \left(\frac{ETo * PF * 1\ Acre}{IE}\right)$$

Where:

ETo = Reference Evapotranspiration (feet/year)
PF = Plant Factor
IE = Irrigation Efficiency
CLF = Citrus and Date Palms Leaching Factor

The following section describes the factors, which contribute to calculating the water use factors.

Reference Evapotranspiration: Reference evapotranspiration (ETo) is based on potential evapotranspiration (ET) from turf grass/alfalfa crop, which assumes a continuous source of moisture and does not consider summer plant dormancy. Therefore, ETo is an overestimation of actual ET, which varies with the vegetation type since some plants consume significantly more water than others. The ETo was determined from the California Irrigation Management Information System (CIMIS) station #207 located in Borrego Springs (DWR 2018). ETo was selected as 6.45 feet from 2010, which was the highest year during the 2010-2014 baseline period.

Table F-2
2010-2014 Reference Evapotranspiration (ETo) for Borrego Springs

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total (Inches)	Annual Total (Feet)
2010	2.41	3.21	8.81	9.84	8.58	9.22	9.51	9.11	7.44	4.36	2.88	1.98	77.35	**6.45**
2011	2.68	3.35	5.55	7.12	8.77	8.23	7.98	8.47	6.43	4.92	2.72	2.11	68.33	5.69
2012	2.85	3.56	5.33	6.77	7.66	9.47	8.77	8.04	7.09	5.04	3.2	2.23	70.01	5.83
2013	2.54	3.57	5.75	7.56	8.64	9.02	8.01	7.57	6.46	5.05	3	2.27	69.44	5.79
2014	2.67	3.66	5.94	7.23	8.66	9.13	8.83	8	6.97	4.55	3.14	1.58	70.36	5.86

Source: Borrego Springs CIMIS Station #207 (DWR 2018).

Plant Factor: The plant factor is the percentage of evapotranspiration needed to maintain acceptable health, appearance, and growth of a specific plant type. Plant factors were obtained from the Water Use Classification of Landscape Species (WUCOLS) database. Additionally, the County has relied on documented plant factors used for assigning water credits, which are outlined in the Memorandum of Agreement between the Borrego Water District and the County of San Diego Regarding Water Credits (MOA). The plant factor used in this report either was based on an average of recent WUCOLS data or documented County plant factors, whichever was higher. For Date Palms, the highest plant factor range was selected.

Table F-3
Plant Factors

Type	Plant Factor (MOA)	Plant Factor Range (WUCOLS VI)	Proposed Plant Factor Used
Citrus	0.65[a]	0.4 - 0.6	0.65
Date Palms	N/A	0.4 – 0.6	0.6
Landscape (Decorative)	N/A	0.30 – 0.6	0.45
Landscape (Native)	N/A	>0.1 – 0.6	0.3
Nursery	0.6	0.4 - 0.6	0.6
Palms (Ornamental)	0.5	0.4 – 0.6	0.5
Potatoes	N/A	N/A[b]	N/A
Turf	0.63[c]	0.6 – 0.8	0.7

Source: BWD and County 2013, WUCOLS 2014, UCCE CDWR 2000
N/A = not available
a. Source: UC Cooperative Extension and Department of Water Resources, A Guide to Estimating Irrigation Water Needs of Landscape Plantings in California, 2000
b. There is no plant factor for potatoes in WUCOLS VI. Approximately 2.5 acre-feet per acre are applied to potato fields per information obtained from the potato farmer in the Subbasin.
c. An average of warm and cool season.

Irrigation Efficiency: Irrigation efficiency is the amount of water supplied to a plant type compared to the amount consumed. Two common irrigation methods in the Subbasin are rotor and drip. The irrigation efficiency was determined from the Turf and Landscape Irrigation Best Management Practices prepared by the Water Management Committee of the Irrigation Association (Water Management Committee of the Irrigation Association 2004). Table 4 presents the irrigation efficiencies used by irrigation method.

Table F-4
Irrigation Efficiency

Irrigation Method	Irrigation Efficiency
Rotor[a]	0.7
Drip[b]	0.8

Source: BWD and County 2013, Water Management Committee of the Irrigation Association 2004.
a. Rotor used for turf and decorative landscaping
b. Drip used for citrus, nursery, palms, and native landscaping

Salt Leaching: Leaching for salts is the overwatering of an area to flush excessive salts below the root zone. Leaching typically occurs in arid environments with high evapotranspiration rates. Because leaching is necessary for the health of citrus and date palms in the Subbasin, a leaching requirement of 20% of the water use factor is assumed based on optimal crop yield and source water with total dissolved solids (TDS) concentration of less than 1,000 mg/L.[1] The leaching requirement is provided in Equation C (Rhoades 1974; and Rhoades and Merrill 1976):

Equation C

$$LR = ECw/\ 5(ECe) - ECw$$

where:

LR = the minimum leaching requirement needed to control salts within the tolerance (ECe) of the crop with ordinary surface methods of irrigation
ECw = salinity of the applied irrigation water in deciSiemens per meter[2] (dS/m)
ECe = average soil salinity tolerated by the crop as measured on a soil saturation extract.

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1 A 20% leaching requirement for citrus and date palms is assumed taking into account typical Subbasin water quality (i.e. <1,000 mg/L TDS and average soil salinity tolerated by grapefruit of 1.8 dS/m for optimal yield (Ayers and Westcot 1985).

2 Soil and water salinity is often measured by electrical conductivity (EC). A commonly used EC unit is deciSiemens per metre (dS/m). The ratio of total dissolved solids (TDS) to EC of various salt solutions ranges from 550 to 700 ppm per dS/m, depending on the compositions of the solutes in the water. Simple relationships are used to convert EC to TDS, or vice Versa:
TDS (mg/L or ppm) = EC (dS/m) x 640 (EC from 0.1 to 5 dS/m)
TDS (mg/L or ppm) = EC (dS/m) x 800 (EC > 5 dS/m)
Source University of California Salinity management: http://ucanr.edu/sites/Salinity/Salinity_Management/Salinity_Basics/Salinity_measurement_and_unit_conversions/

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